INCOSE MBSE Patterns Working Group
Project Charter

1 Project Name:

The name of the project is the Semantic Patterns for Systems Engineering (SP4SE) Project.

2 Project Objectives and Intended Outcomes Summary:

The objectives and intended outcomes of this project are to:

1) Improve shared systems engineering community-wide knowledge for more effective life cycle engineering of systems, through the identification, availability and distribution, and use of model-based ontological patterns supported by related semantic web standards and technologies.
2) Optimize the compatibility and leverage enjoyed through the integrated use of existing, emerging, or evolving systems modeling languages and modeling tools, model-based ontological patterns, semantic technologies, and related standards.
3) Modularize the availability and use of the above components across different domains, levels of abstraction, life cycle stages, and business situations.
4) Lower barriers to understanding and effective use of the above, by providing educational opportunities and examples along with feedback to related suppliers, and by minimizing complexity and cognitive or other barriers to use by a larger community.
5) Develop effective means of collaboration across the participating organizations, meeting their expectations and needs as well as those of the systems community served.
6) Maintain and evolve the related community resources for continued effective use.
7) Improve leverage of existing technical resources—theory and practice as well as technologies for representing and using collaborative knowledge in various domains.

Emphases: Note the above objectives are not limited to the information content alone, but also include the methods, skills, and capabilities to use that content and the tooling that supports it. The earliest emphasis content is the basic ontological content for systems engineering itself.

3 Project Stakeholders and Related Parties

Refer to **Figure 1** below. The backgrounds, needs, and expectations of the team's three directly collaborating organizations (discussed in **Table 1** below) must be met to have a productive collaboration. The needs and expectations of the other stakeholders in **Figure 1** must be met to succeed in having the impacts sought.

4 Project Deliverables:

1) Packaging Plan and User CONOPS:
   a. Ontologies modularization plan, identifying ontologies to be created or packaged, briefly summarizing their scope(s), along with known content sources to be considered for inclusion.
   b. SysML v2 ontologies CONOPS, summarizing the high-level plan for users' integrated use of the emerging v2 toolset, its internal metamodel, OWL DL bidirectional transformer, specialized ontologies add-on capability, and semantic tools, across the life cycle of models. (Refer to **Figure 1** below.)

c. Documentation, education, and examples plan listing items to support the above CONOPS.
d. Simple demonstration and test plan appropriate to the project objectives and the information and tooling involved.

2) Approximate schedule and efforts projected to accomplish the above (insert in Section 8 below).
3) Packaged ontologies, with supporting documentation and initial test results.
4) Library organization of these patterns, and means of access to the Deliverables.

5 Project Opportunities and Risks

This project is defined with expectation of accelerating rate of progress of SP4SE work of the last year. It is important to understand why the project team believes the approach described here provides that acceleration.

There is opportunity in the availability of existing resources in the three collaborating organizations, per **Figure 1.** However, there are also background differences between the three organizations that must be adequately understand and addressed. It is not believed that these differences are direct conflicts or incompatibilities, but it is important to understand and accommodate them. Refer to the background comparisons of **Table 1** below and the resources of Table 1 and Figure 2 below. **Figure 2** lists additional resource opportunities and history.

6 Potential for INCOSE Tech Ops Products

The Deliverables are not expected to be exclusive to INCOSE. There are multiple opportunities for INCOSE education or other member benefits from this project. If and as identified, these can be described in a related INCOSE Technical Product Plan.

Consistent with the preliminary work already performed by representatives of the collaborators, there is an expectation that targeted deliverables of this work will be made available on a basis similar to open source software:

1. A non-commercial common copyright owner will utilize one of the widely used “commons” licensing packages to make the assets legally available for use by others.
2. A public access repository (e.g., github) will be used to publish and make available the assets; a similar repository and development protocol will be used to manage the assets over their earlier and subsequent life cycle stages.

The copyright owner of (1) need not be the distribution entity or one of the collaborating entities listed, but INCOSE is the initially intended candidate to serve as the copyright owner, since it seeks to offer such other systems engineering assets already. In the event INCOSE ownership of the copyright is not feasible, other non-commercial entities that could serve as the copyright owner have already been identified.

7 Project Collaborating Organizations and Representatives

The following parties represent the three collaborating organizations listed in **Figure 1** and **Table 1** below:

1. Steve Jenkins, NASA JPL, leader of JPL ontologies and semantic technologies effort as used in the JPL Open CAESAR Project.
2. Hans-Peter de Koning, European Space Agency (ESA), member of the OMG SysML v2 Submission Team
3. Bill Schindel, ICTT System Sciences, Chair of INCOSE MBSE Patterns Working Group

Other individuals have already been or may be added to this project.

8 Prerequisite or Early Actions

Certain preparatory, qualifying, or otherwise early actions would be important to conduct first in order to validate assumptions, test potential areas of risk, and support the details of plans for what would follow:

1. S*Metamodel folks would need to practice use of OWL2 DL (plus use of OML to generate it) to represent S*Models and S*Patterns, to gain facility in these subjects and to determine suitability of the combination of ideas, technologies, and people.
2. Represent the S*Metamodel in OWL2 DL (this activity could be the way to carry out (1) above also provides learning about S*MTM by others).
3. Test ability to express Open CAESAR ontologies in terms of S*Metamodel constructs, see how much of this can be accomplished with what effort, and understand the origins and resolutions of any issues encountered in doing so. (This activity would provide learning opportunity for both groups.)
4. Test ability (when available) of emerging SysML V2 inclusion of OWL 2 formalization of ontologies to express Open CAESAR ontologies.
5. Describe and carry out a few CONOPS tests of downstream users of ontologies/patterns in their modeling or similar work. For example, the current Open CAESAR and Patterns WG work use somewhat different CONOPS in terms of when ontological/pattern constraints are expressed during use of actual modeling tooling (as a batch run against a completed model versus as a constraint, versus as a pattern configuration process leading to a configured pattern-valid model. (Use of checking reasoners after specific model construction, versus use of pattern configurators to build the specific model.) Each may have a good place, but they represent a modeler CONOPS difference between the two groups for now.
6. Firm up the copyright owner plan discussed in Section 6.

Although the team is relatively optimistic on the above steps, we recognize a few carry some risk and in the worst case might lead to either stepping back or re-planning. Addressing them as pre-requisite first actions would therefore be prudent.

9 Project Schedule:

Schedule, including meetings, milestones, and overall is to be determined by the team. It is suggested that key milestones include INCOSE, OMG, and JPL public events, along with regular periodic meetings, work sessions, and deliverables.

10 Project References:

1. Elaasar, Maged, “JPL Open CAESAR Initiative”, NASA JPL MBSE 2019 Symposium, Pasadena, January 2019. Retrieve from:
   https://www.slideshare.net/MagedElaasar/open-caesar-initiative?from_action=save
2. Seidewitz, Ed, “SysML v2 and MBSE: The Next Ten Years”, Models 2018, Copenhagen, October 2018. Retrieve from:
   https://www.slideshare.net/seidewitz/sysml-v2-and-mbse-the-next-ten-years
3. “MBSE Patterns Working Group”, INCOSE 2018 International Symposium, July, 2018. Retrieve from:
   https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:mbse_patterns_wg_mtg_slides_is2018_july_2018_v1.2.2.pdf

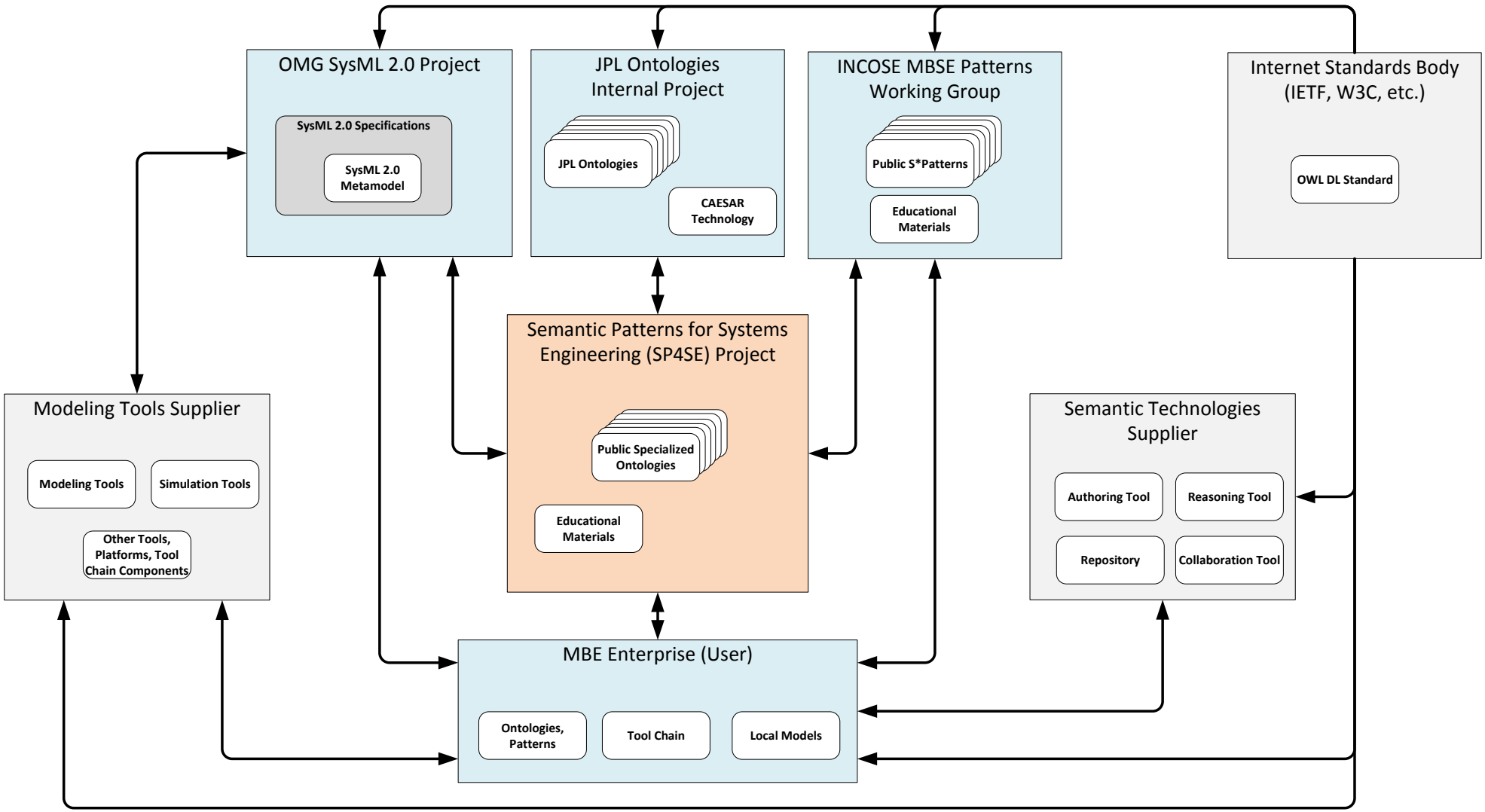

Figure 1: Interaction in the planned collaboration project

Table 1: Current Situation--Different Historical Backgrounds and Emphases, Going Into Proposed Project (Not incompatible, but with different emphases)			
Ontological Patterns Source→	**OMG SysML v2 Submission Team**	**NASA JPL Open CAESAR Team**	**INCOSE MBSE Patterns WG**
Historical & Organizational Origin→	SysML originated from SysML Partners group, including INCOSE, OMG, tool vendors, OEM users. SysML v1 was first released in 2006 and has seen a number of incremental updates to current SysML v1.6 per March 2019. SysML v2 is a major update to SysML v1.x, including replacement of the previous UML-based Metamodel with a new minimalist SE-oriented Metamodel as well as a number of normative, extensible model libraries	Development and use of multiple JPL systems ontologies (base, mission, and other ontologies) in support of different JPL-engineered space missions over years of experience. Initial emphasis was internal to NASA, adding later public sharing projects and open collaborations in more recent years.	Formed as INCOSE WG, part of INCOSE-OMG MBSE Initiative, over six year period, with focus on S*Models and S*Patterns, based on 15 years' ICTT experience with S*Metamodel, to strengthen system modeling while reducing related effort. Most projects in partnership with other INCOSE WGs or partners outside of INCOSE.
Relevant Aspects Emphasized→	Align SysML Metamodel closer to SE needs vs. past software engineering emphasis of UML derived metamodel. Add bi-directional transformation capability between SysML v2 models and equivalent OWL DL ontologies, possibly supplemented with SWRL rules. This enables use of existing OWL DL automated reasoners to formally check standard and user-defined rules concerning consistency, completeness and model quality .	Special emphasis on ontological rigor and automated ability to inspect application models against ontologies, using post model authoring automated reasoners that are already available from third parties and heavily verified through other WWW applications. Ability to extend to other types of model checking (e.g., numeric) in future.	Special emphasis on physical science and semantics subset rigor to bring systems modeling closer to the history, tools, and methods of physical sciences, compared IT history of business process automation and databases. S*Metamodel emphasis on smallest model sufficient for life cycle purposes of engineering and science. Special emphasis on doing less model creation through use of trusted S*Patterns, invoked simultaneously with model authoring through use of S*Pattern Configuration process.

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Scope of Information	SysML v2 goals include diverse improvements based on 1.x experiences. Given the stated SysML v2 interest in improving the environment for engineering, it is assumed that metamodel interests may go beyond designed system, but could also be addressed by partitioned ontologies (target engineered system, planning, engineering, etc.), using the planned specialized ontologies addition capability. It is not known to writer if that is current plan.	Provide multiple separate but related JPL systems ontologies (base, mission, engineering, and other ontologies) intended as specialized add-ons when needed. Term "pattern" has been used for meaningful fragments of a whole ontology—slightly different use of the term "pattern" than in INCOSE Patterns WG.	"S*Pattern" term refers to scope of whole S*Metamodel or less, not just model fragments. S*Patterns at whole system level, as well as pieces; not distinguished from Ontology. Emphasis has been on making S*Patterns friendly, intuitive, easy to configure, Feature-based, with formal checking rules in real time and more limited than OWL DL (of interest to enhance in this project). Separation (but connection) of ontologies for basic SE foundation (S*MTM), domain systems of interest, manufacturing systems, operations systems, etc.
Historical Patterns, Ontologies, Metamodels, Domains, Past Uses, Maturity→	SysML v1.x used metamodels derived from UML. Approximately 12 years of experience in the SysML v1.x series, domains including mil/aero, automotive, other, on COTS and open source tools from multiple tool suppliers.	Use on NASA JPL science missions over multiple years, missions. Recently expanded to include collaboration with other enterprises in different domains.	Wide variety of S*Patterns created across diverse domains listed in Figure 2 below, over last 15+ years. Includes experience with S*Metamodel mapping to other languages and toolsets over same period.
Modeling Languages:	SysML, with v2 in progress.	Models in SysML, mapped to OWL DL for reasoning, other queries.	S*Metamodel mapped to multiple third party or standards-based languages and tool schema, including but not limited to SysML. S*Metamodel is tool and language neutral, through formal mappings to each.
Technologies, Toolsets:	SysML tools developed by third party COTS and open source suppliers, to comply with SysML specification. Related OMG standards-based technologies (e.g., MOF, etc.)	Third party COTS SysML Modeling Tools; JPL CAESAR integration technology; ontology authoring tools; reasoning & query tools	Multiple third-party COTS modeling tools, engineering and requirements toolsets, simulators, PLM platforms, other tool chain components. (e.g., Magic Draw/CSM, Enterprise Architect, IBM Rhapsody, Siemens TeamCenter PLM, IBM DOORS, others)

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Downstream Modeling User CONOPS	Some form of utilization of OWL DL capability is being included in SysML v2	Following specific model construction, modeler runs reasoners on model to determine any exceptions to ontologies invoked.	During specific model construction, applicable pattern (ontology) is applied by the Pattern Configuration Process, to construct a conforming model.

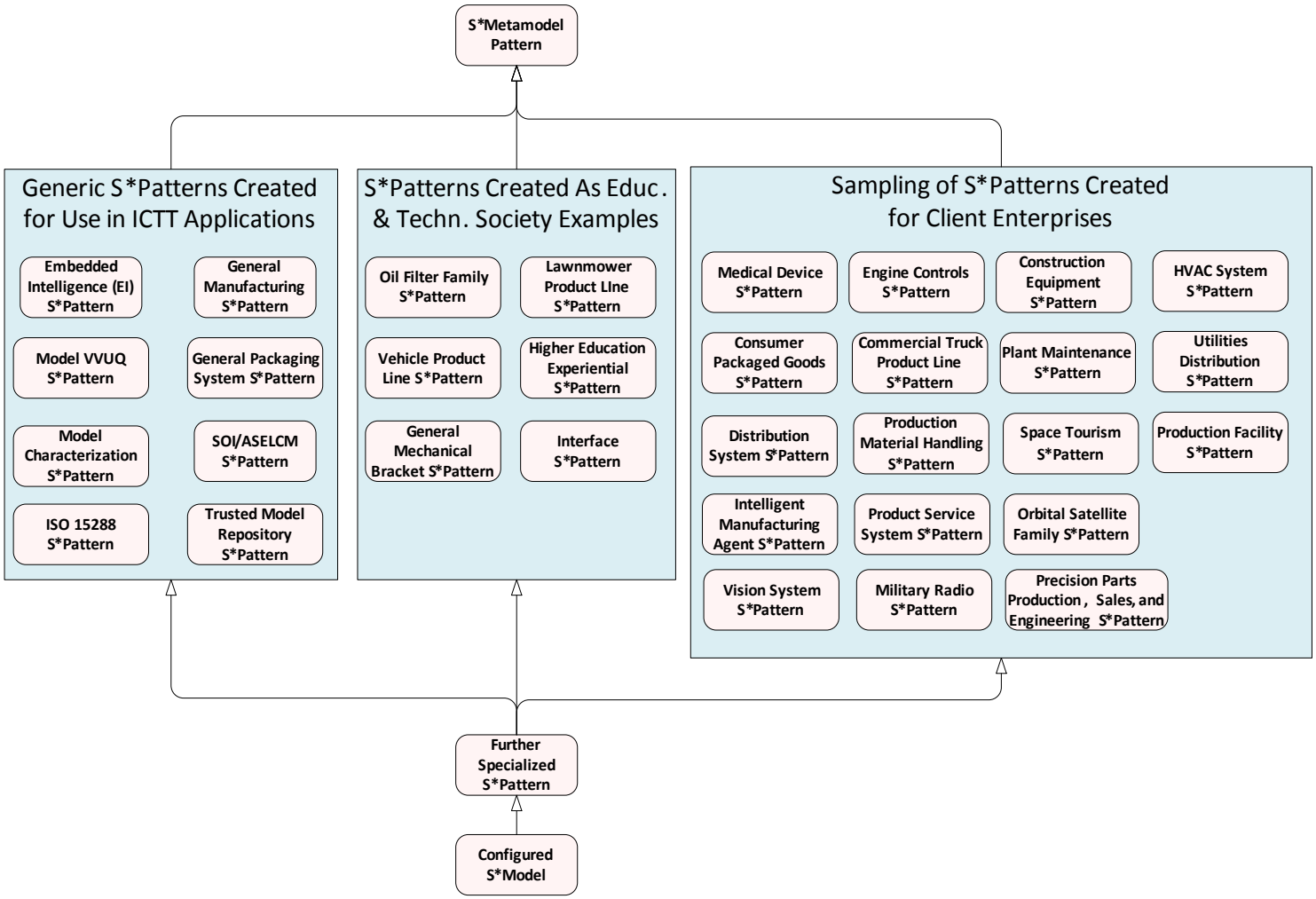

Figure 2: Sampling of S*Patterns Created in Past Work by INCOSE Patterns WG and ICTT System Sciences