***SysML v2 RFP WG,***

The following is a summary and follow-up actions from the 1 day face-to-face meeting at the INCOSE IW in Torrance, California on January 29, 2016. The meeting summary and related material is posted on the Torrance meeting page at:

<http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-roadmap:torrance_incose_iw_january_2017_meeting_presentations#presentations>

This meeting was intended to be a working session to make progress in very specific areas, and to take advantage of the availability of several individuals, some of whom do not generally attend the quarterly OMG meetings. This meeting was not intended to be an information session, but Sandy did present the attached overview presentation to the broader INCOSE IW on Saturday, January 28 as part of the MBSE Workshop. A slightly earlier version of this presentation is also available from the INCOSE MBSE Wiki at <http://www.omgwiki.org/MBSE/doku.php?id=mbse:incose_mbse_iw_2017> .

**Meeting objectives.** The meeting objectives were to make progress in the following areas to support the requirements for SysML v2 RFP:

* Integrate the Analysis Concepts with Properties & Expressions Concepts
* Develop an initial approach to represent probability/uncertainty
* Refine the Structural Concepts
* Integrate the Interface Concepts with Structural Concepts

**Meeting agenda.**

09:00 – 10:00     SysML v2 Analysis concept and requirements – Manas Bajaj

10:30 – 11:15     Representing uncertainty with probabilities in SysML v2 – Chris Paredis

11:15 – 12:00     Arcadia/Capella considerations for SysML v2 - Stéphane Bonnet

13:30 – 15:00     SysML v2 Structure modeling concepts and requirements – Hans Peter

15:30 – 16:00     SysML v2 Structure modeling concepts and requirements – Hans Peter

16:00 – 16:30     Visualization concept and requirements – Chris Screiber

16:30 – 17:00     Model management concept – Laura Hart

**Follow-up actions.**

* Manas, Sandy, and John to coordinate on integrating the analysis concepts into SECM.
* Chris P will work with Hans Peter to integrate the uncertainty concepts into the Properties & Expressions model and provide some examples
* Hans Peter will update the Structure model to reflect the refinements from the meeting along with examples
* Marc will coordinate with Chris P on how to represent physical interactions as part of the interface concepts.
* Marc will coordinate with Hans Peter to integrate the interface concepts with the structure concepts
* Marc and Hans Peter will coordinate with John W to integrate the Structure and Interface concepts into the SECM.
* Stephane to coordinate with Sandy on his possible participation in the SysML v2 effort that may include the functional/behavior concepts, the API requirements, and usability concerns.

**Analysis concepts.** Manas Bajaj presented the analysis concepts for SysML v2 which are available in presentations on the Analysis Concepts page of SysML v2 RFP Wiki at <http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-roadmap:system_analysis_workgroup> . The intent of this discussion was to identify the core concepts that we explicitly want to capture in the Systems Engineering Concept Model (SECM) to reflect in the requirements in the SysML v2 RFP. The following are the list of concepts that wel agreed to incorporate into the SECM. Some other concepts are already addressed in the Properties & Expression concepts and the Structure concepts, and are not included here.

* Analysis model\*
* Analysis context\*
* Analysis
* Analysis composition (supports ability to compose analysis)
* Analysis objectives\*
* Analysis run/execution\*
* Analysis result\*
* Rationale
* Decision
* Meta data such as accuracy of the analysis, who performed the analysis, etc.\*

\*The concepts appended with an asterisk will be further generalized and integrated with other concepts such as verification.

Manas will provide definitions for these concepts to include in the SECM, and integrate these concepts with the analysis service requirements.

**Modeling uncertainty in SysML v2.** Chris Paredis presented the attached presentation on modeling uncertainty in SysML v2. He did not have time to go through the entire presentation, but we did come to some agreements. In particular, the foundation to be used in SysML v2 for modeling uncertainty is probability theory.  Chris discussed some of the basics of this theory including probabilities, random variables with probability distributions including joint distributions, and stochastic processes. We also agreed on a general approach for how to represent probabilities and probability distributions in the model.

Sandy asked that we be explicit on the meaning of the probability distribution. In particular, he used the example of defining the distribution on the accuracy of an alignment property such as the boresight alignment of an optical system. For this case, the distribution can refer to the variation from one production unit to another, or alternatively, can represent the distribution over time (stochastic process) for a particular optical system. Chris and Hans Peter felt this needed to be clarified as part of the definition of the property. However, Sandy feels this should be made more explicit in the model.

Chris also noted that requirements do not generally specify a distribution, but rather a lower and upper bound. There is more discussion needed on this, such as when specifying tolerances in a tolerance stack.

Chris will follow-up with Hans Peter with support from Manas Bajaj and Andy Ko to integrate the above concepts into the Properties & Expressions model.

**Structure concepts.** Hans Peter presented the structure concepts for SysML v2 which are available in presentations on the Analysis Concepts page of the SysML v2 RFP Wiki at <http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-roadmap:property_modeling_core_team> . The SysML v2 concepts are intended to build on the structure concepts in SysML v1, but address some of the fundamental limitations of SysML v1. Hans Peter has applied these concepts as part of the modeling approach used by the participants of the Concurrent Design Facility (CDF) at the European Space Agency, as has Harald Eisenmann at Airbus Defence and Space. The following is a brief overview of the updated concepts as discussed at the meeting. These concepts will be reflected in future updates to the model.

The concepts support models of definition, models of configuration, and models of instances.

The **Definition model** includes the concept of Element Definition and Element Usage similar to blocks and parts.  Each Element Definition includes at most one level of nested parts, which are called direct usages. For example, the definition of a Car has 4 wheels, and may also include other direct features of the Car such as its weight. Similarly, the definition of the Wheel may include 4 lug bolts identified by their respective positions on a wheel, along with direct features of the Wheel, such as the wheel diameter.

The **Configuration model** adds the concept of Element Configuration. The Configuration model is used to compose a Product Structure of nested Element Definitions and Element Usages. The Element Configuration refers to the applicable Element Definition, and the particular Element Usage. In the above example, an Element Configuration for a lug bolt can refer to a particular lug bolt usage (e.g. position 1 on the right front wheel).

The **Instance model** adds the concept of Element Instance. The Instance model provides representation of individual elements that may exist in the real world, such as the specific lug bolt on the right front wheel of a specific car sitting on the factory floor. The Element Instance refers to a particular Element Configuration, but adds the unique identification such as its serial number.

We noted that the Element Definition can include variation points for an Element, such as the number of Wheels for a Car that may include an optional spare wheel, and perhaps different classes of Wheels (e.g., wide rim vs narrow rim). The Configuration model will define the specific variant such as a Configuration with the spare Wheel, and another Configuration without a spare wheel.

By default, the Element Configuration and Element Instance are assigned the same values as the Element Definition. However, each Element Configuration and each Element Instance can over-ride the values of the Element Definition to define localized usages. For example, the configuration for the lug bolts on the front wheels may have a different torque than the lug bolts on the rear wheels, and the instances on the factory floor may have different measured values than the design values in the Configuration model.

It was also noted that a user requires considerable flexibility to create these models. For example, a modeler may start by defining the configuration model, and the tool will generate the definition model in the background, or the modeler may start by defining an instance model and the configuration model and definition model are generated by the tool. Alternatively, the modeler may start with the Element Definition and Element usages and create an Element library, and then create the configuration and instance models.

**Interface concepts**. Marc Sarrel presented the interface concepts for SysML v2 which are available in presentations on the Interface Concepts page of SysML v2 RFP Wiki at <http://www.omgwiki.org/OMGSysML/doku.php?id=sysml-roadmap:interface_concepts_modeling_core_team> . An interface in SysML v2 includes two interface ends and the connection between them. The patterns of definition and usage apply. The usage of an interface end corresponds to a SysML v1 port, and the definition corresponds to a port definition (e.g., interface block or block). The definition and usage pattern also applies to the connection where the usage corresponds to a connector and the definition corresponds to an association. Constraints can be applied to the association to represent constraints associated with physical interactions, or protocol constraints associated with information flow.  The interface concepts support both nested ports, such as the pins on an electrical connector, and layered interfaces such as an OSI stack.

The intent of this discussion was to identify how the interface concepts integrate with the structure concepts above. The general approach is that the interface definition and usage pattern are just specializations of the Element Definition and Element Usage pattern. This enables interfaces to be configured and instantiated using the Structure Concepts. Marc will work with Hans Peter to integrate the interface concepts with the structure concepts, and also work with Chris Paredis on how to represent the physical interactions similar to Modelica cross and through variables. In addition, Hans Peter will integrate the concept of flow property into the Property & Expressions model.

**Arcadia/Capella Considerations for SysML v2.** Stephane Bonnet leads the development of the Arcadia/Capella methodology and tool for Thales. This capability is now open source, and has seen significant adoption within Thales and other companies, primarily in Europe. Up until 2007, Stephane and his team attempted to leverage UML as its foundation, but encountered many usability issues. As a result, the Thales team evolved the Arcadia/Capella approach to address many of these limitations. Stephane presented some of these issues related to functional analysis, instance modeling, and the model queries, and the approach they have taken to address them, which is summarized in the attached slides. Some aspects of the approach are included below, but there is much to be learned from this approach.

* The ability to derive connections between higher level functions based on the connections between their lower level functions. The approach supports flexible usage scenarios including combinations of top-down or bottoms-up functional analysis. The connections can be created by connecting lower level functions, and then deriving the connections at the higher level, or alternatively connecting the higher level functions, and readily assigning these connections to lower level functions.
* The ability to define components and allocate functions to them, and display the components with their functions and their inputs and outputs across functions and components. Ther approach uses color to distinguish component from function.
* The ability to make copies of components and functions, and retain a relationship between the copy and its source, and further create localized usages associated with the copies. They hide the more complex concepts of definition and usage from the modeler.
* The ability to query the model in ways that are meaningful to the user, without being subject to the complexity of the underlying metamodel.

Stephane is going to explore with his management how he may engage the SysML v2 RFP and follow-on effort. This would be a very welcome opportunity to leverage his ideas and expertise.

**Visualization concept.** Chris Schreiber presented elements of the visualization concept (refer to slide 19 of the attached SysML v2 overview presentation). We then reviewed and updated the draft requirements for the concrete syntax, which are included below, along with the changes from the discussion that are highlighted in yellow.

*Concrete syntax requirements.* SysML v2 shall:

* Provide a flexible view and viewpoint capability that includes graphical, textual, tabular, and numerical presentation methods
* Provide support for composite viewpoints and navigation between view
* Provide standard viewpoints and views for SysML v1 diagrams (assists transition from v1 to v2)
* Provide a standard mapping language between concrete syntax and abstract syntax
* Provide a standard graphical concrete syntax that maps to the abstract syntax
* Provide a standard textual concrete syntax that maps to the abstract syntax
* Provide ability to specify domain specific concrete syntax (e.g., symbol sets) that maps to the abstract syntax
* Provide a simple geometric view as a standard diagram\*
* Provide a standard viewpoint library (platform independent model with platform bindings)
* Provide diagram interchange and/or exchange of the viewpoint method to regenerate the view
* Provide persistent views to support documentation and reports

\* The geometric view is intended to specify geometric envelopes and requires concepts of shape and coordinate system. Refer to STEP standards.

In addition, SysML v2 should provide visualization services such as support for auto-layout, dynamic, interactive visualization (e.g., user select scope of model, filters, layers, etc.), as well as manual diagram layout capability. The ability to specify diagram layers that consist of a group of diagram elements which can be displayed (e.g., turn on or off, assignment of colors or offsets, etc.), is considered an essential feature of SysML v2 views.

**Model management concept.** Laura Hart presented the model management concept (refer to slide 13 of the attached SysML v2 overview presentation).  A fundamental part of the concept is that the SysML v2 model management is required to manage changes to the SysML model plus its links to other models. An issue was noted as to whether the SysML v2 model management would also manage analysis results that are fed back to the SysML model from an analysis model. Laura also highlighted the model management functions including versioning, configuration control. change management, permissions and controls, model differencing, branch and merge, and others. Harald asked wither model checking is considered part of model management, and Sandy noted this is currently considered part of model analysis.

Regards,

Sandy

Sanford Friedenthal

SAF Consulting

[safriedenthal@gmail.com](mailto:safriedenthal@gmail.com)

(c) 571 215-7188

**Attendees:**

'Manas Bajaj' <manas.bajaj@intercax.com>;

'Conrad Bock' <conrad.bock@nist.gov>; '

BONNET Stephane' <stephane.bonnet@thalesgroup.com>;

'Burkhart Roger M' <BurkhartRogerM@JohnDeere.com>;

'Cole, Bjorn (312C)' <Bjorn.Cole@jpl.nasa.gov>;

Hans-Peter.de.Koning@esa.int; 'EISENMANN,

Harald' <harald.eisenmann@airbus.com>;

'Barnard Feeney, Allison (Fed)' <allison.barnardfeeney@nist.gov>;

'Laura Hart' <lauraehart1@gmail.com>;

'Jarosz, Jason P' <jpjaros@sandia.gov>; nerijus@nomagic.com; '

Karban, Robert (313D)' <Robert.Karban@jpl.nasa.gov>;

'Andy Ko' <ako@phoenix-int.com>;

'Dr. Chris Paredis' <chris.paredis@me.gatech.edu>;

'Post, Kyle (K.R.)' <kpost1@ford.com>; [aqamar2@ford.com](mailto:aqamar2@ford.com);

'Sarrel, Marc A (393A)' <marc.a.sarrel@jpl.nasa.gov>;

'Schreiber, Chris' <chris.schreiber@lmco.com>;

'Rick Steiner' <rick@ricksteiner.net>;

'Sawyer, George A (US)' <george.a.sawyer@baesystems.com>;

'Walley, George (G.E.)' <gwalley2@ford.com>;

'Richard Welling' <nilglew@mac.com>;

John Watson <johncwatsonsr@msn.com>