Mathematical Formalism DSIG Co-chair Meeting Notes

Wednesday, the 22nd of March 2023

OMG Q1 Technical Meeting, Reston

Mathsig Co-chairs met at Reston to review the outcome of the presentation to the SE DSIG on Tuesday, "Implementation of ROSETTA in SysML v2 and Underlying Mathematical Formalisms" [mathsig/23-03-01]. The purpose of the presentation was to share initial findings on investigating the feasibility of implementing ROSETTA and UPR in SysML v2. These were based on a focused comparison of concepts in SysML V2, ISO/IEC/IEEE 15288:2015, and ROSETTA when applied to an elementary radar design problem. The comparison was organised around the requirements transformation of stakeholder and user needs into a technical view of the solution. No comparison was made to the SysML v2 RFP.

Sufficient detail of the multi-objective multi-attribute analysis of the problem was provided that an interested party with minimal skills in basic algebra should be able to independently replicate the analysis for the design solution. Understanding the logical flow of the arguments though does not need such skills. The analysis included a representation of the solution in UPR 1.0 which was followed by matrix and graphical representations in ROSETTA of the underlying mathematical foundations of the problem definition, and then implementation in Definition Elements (SysML v2). Complemented by other Mathsig work, it was possible to assess four of the six SysML v2 capabilities as being feasible:

Requirements:	Constraint Definition → metric expressions → UPR 1.0
Structure:	Definition Elements → ROSETTA
Analysis:	→ 'Solver' e.g., Maple (Jet Engine example)
View & Viewpoint:	Graphical or Tabular → ROSETTA

The Behavior and Verification capabilities were not assessed due to limitations in time to prepare the analysis for presentation and time allotted in the SE DSIG session.

It was possible though to assess the concept of *requirements transformation* in ISO 15288 by means of mathematical interpretation. This led to a discovery that the conversion of units between the system objectives for detection of aircraft and radiation safety resulted in a *design decision* on the hazard perimeter of the radar with implications on radar installation <<requirements>> allocated to civil engineering. This is an archetypical example of system interrelations i.e., relations between relations vis-à-vis relations between system elements (parts). This is beyond the scope of the RFP.

It should be noted that questions of interrelations (relations between relations) cannot be within the RFP scope. The reason is that SysML v2 is based on KerML which is based on the predicate calculus, a (first order) language in mathematical logic that expresses first order relations. Interrelationship is a higher order concept, as noted in published research posted on the OMG Mathsig website.

However, if all the mathematical expressions of a problem or solution can be captured in SysML v2 artefacts, it should be possible to synthesise and normalise the system relations and interrelations as Maple did with the Jet Engine example.

UPR: UML Profile for ROSETTA
ROSETTA: Relational Oriented Systems Engineering Technology Trade-off & Analysis framework
RFP: Request for Proposal