System of Systems Engineering Collaborators Information Exchange (SoSECIE)

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Scaling Model-Based System Engineering Practices for System of Systems Applications

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This presentation describes an effort to improve the scalability of traditional Model-Based Systems Engineering (MBSE) techniques for System-of-Systems (SoS) applications. Our main objectives were to lower the barrier to entry for complex enterprise-level systems to be able to take advantage of existing MBSE standards and identify areas for MBSE capability improvements to facilitate scalability. Another objective was to explore how these new MBSE methodologies could enable domain experts with limited software background to start designing executable SysML architectures via MBSE tools and our software plugins. This effort was part of a research project funded internally by MITRE, and has thus far centered around IBM® Rational® Rhapsody®. To improve the scalability of MBSE for SoS applications in Rhapsody, we implemented two new capabilities. First, we created an abstract killchain model which can serve as the base for a variety of derivative, context and domain-specific models. This "Base" model provides useful abstractions to capture key functional aspects of a SoS architecture, which can then be inherited by the derivative model capturing domain-specific behavior. The Base model also provides a container of reusable profiles and plugins. Second, we created a "Comma Separated Variable (CSV) Importer," which can facilitate meaningful exchange of information between subject matter experts (SMEs) and software engineers and can jump start the modeling process for those engineers. A SME or modeler first specifies the SoS communications architecture (either publish-and-subscribe or ports-and-links) in the .csv file. The tool then instantiates that architecture in IBM Rational Rhapsody.

The second portion of this talk documents an effort to develop a scalable system-of-systems (SoS) architecture analysis method that could address the combinatorial explosion associated with the analysis of SoS alternative architectures to inform SoS design and evolution. The objective was to create a light-weight quantitative approach to prioritizing SoS alternative architectures modeled in the System Modeling Language (SysML) or Unified Modeling Language (UML) by applying graph theoretic and network analysis techniques. We focused on formulating and implementing a lightweight method that would provide insight into the resilience of SoS architectures. To expedite the analysis, a decision was made to focus on what we can determine from the structural properties of the architecture representation itself. As a proxy measure of resilience we evaluated robustness, given that it is not heavily tied to SoS performance. Through an exploration of the graph theoretic and network science literature for measures for robustness, the algebraic connectivity value was found to heavily influence the

stability and robustness of architectures. A plug-in to IBM's Rational Rhapsody was developed to implement the analysis method for evaluating SysML and UML architectures.

Biography

Dr. Aleksandra Markina-Khusid is a Principal Systems Engineer in the MITRE Corporation Systems Engineering Technical Center. She leads the Model Based Trade Space Analysis group at MITRE supporting several SoS modeling efforts for the Department of Defense and Department of Homeland Security. She holds Bachelor of Science degree in Physics, Master of Science and Doctor of Philosophy degrees in Electrical Engineering, and a Master of Science in Engineering & Management, all from the Massachusetts Institute of Technology.

Ms. Janna Kamenetsky is a Principal Software Engineer in the MITRE Corporation Systems Engineering Technical Center. She is the MITRE Model-Based Engineering Capability Area Team lead. She holds a Bachelor of Science degree in Computer Science from Northeastern University and is pursuing an Master of Science degree in Systems Engineering at Worcester Polytechnic Institute.