System of Systems Engineering Collaborators Information Exchange (SoSECIE)

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Application of Live-Virtual-Constructive Environments for System-of-Systems Analysis

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Abstract
Live-Virtual-Constructive (LVC) simulation environments are well established as training and testing solutions. Although the DoD has the requirement to perform detailed analysis of complex systems of systems (SoSs) that could be represented by LVC simulations, such an approach is not generally adopted. This presentation addresses the complexity of SoS analysis, compares and contrasts the modeling and simulation (M&S) requirements for SoS analysis vs. training and testing, and uses the results to identify the benefits and drawbacks of applying LVC to SoS analysis. It also includes specific recommendations for addressing the benefit/drawback analysis.

SoS analysis is most often encountered during the systems engineering process within the technology development and engineering phases of major acquisition programs. The vast majority of these analyses are performed by engineers of various disciplines using monolithic constructive simulations that model multiple systems and the interactions among those systems. The results of these simulations are typically used in conjunction with other engineering level simulations and engagement simulations.

The use of multiple simulations, run simultaneously and interoperating in a distributed environment is not common practice, precluding assessment of all aspects of SoS performance. Verifying that a fully integrated SoS meets mission requirements in defined tactical or operational situations represents a completely different intended use. Exhaustive testing is prohibitively expensive, even in circumstances where individual systems are all extant, at least in prototype form. Standalone modeling and simulation (M&S) tools don't represent the complexity of the full mission space with a degree of fidelity adequate to answer the questions posed. Other methods and tools must be employed. Working from the intended use to narrow evaluation criteria and test cases can produce an acceptable M&S solution, but adequate representation of SoS complexity often comes at the expense of generality.

In the test and training domains, combinations of LVC M&S assets are regularly used to address SoS issues. This requires integrating dozens or hundreds of heterogeneous systems potentially developed with different objectives, assumptions, and software engineering baselines, i.e. a significant engineering undertaking. The late development phases at which training or testing occur have enabled these M&S approaches to be effective. Analysis applications typically involve the examination of a very large tradespace of conceptual options, which must be evaluated to identify the most promising system concepts to take forward into design. While

achieving a composable LVC capability is a significant engineering challenge, it is possible and the benefits are manifold. A composable LVC environment enables SoS engineering analysis, requirements validation, distributed integration, incremental test, and end-to-end SoS evaluation, experimentation, and training. In such an environment, system simulations, based on key performance parameters, work together to represent overall SoS capability as requirements are written. Real and simulated systems can plug in, using actual interfaces, to work with other actual or simulated systems to integrate, test, and evaluate as you go. As a result, engineering in the simulation is cheaper and safer because it is quicker to clean up mistakes and reset to try the next good idea. In this presentation, the authors: 1. Address the complexity of SoS analysis; 2. Compare and contrast the modeling and simulation requirements for SoS analysis vs. training and testing; 3. Synthesize the benefits and drawbacks of applying LVC to SoS analysis identified in the presentation; and 4. Make specific recommendations for addressing the benefit/drawback analysis.

Biography

Dr. Katherine L. Morse is a member of the Principal Professional Staff at the Johns Hopkins University Applied Physics Laboratory where she researches technologies for improving distributed simulation. She received her B.S. in mathematics (1982), B.A. in Russian (1983), M.S. in computer science (1986) from the University of Arizona, and M.S. (1995) and Ph.D. (2000) in information & computer science from the University of California, Irvine. Dr. Morse has worked in the computer industry for over 30 years, more than 10 of them contributing to open international standards. She has served in multiple leadership positions in the Simulation Interoperability Standards Organization (SISO) and is the current chair of the SISO EXCOM. Her Ph.D. dissertation is on dynamic multicast grouping for data distribution management, a field in which she is widely recognized as a foremost expert. She is a member of Phi Beta Kappa, Dobro Slovo, ACM, and a senior member of IEEE. Dr. Morse was the 2007 winner of the IEEE Hans Karlsson Award.