System of Systems Engineering Collaborators Information Exchange (SoSECIE)

March 28, 2013
11:00 a.m. to Noon Eastern Time

Modeling an Acquisition Decision-Making Process for the FAA NextGen System of Systems

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Abstract
The Next Generation Air Transportation System (NextGen) is the Federal Aviation Administration (FAA)'s vision of the National Airspace System (NAS) for the next 15 years. This wide-ranging initiative will transform the NAS by using 21st century technologies, such as satellite navigation and automation, to ensure it meets future safety, security, capacity, efficiency, and environmental needs. The resulting system will be dynamic, scalable, networked, and fully digital. The genesis of this transformation is the FAA's NAS Enterprise Architecture (EA). The NAS EA defines the NextGen goals in a set of Operational Improvements (OIs).

The acquisition process for NextGen is extremely challenging. This presentation discusses a task sponsored by the FAA to develop a model and analysis framework to help decision makers better understand the complex set of causal relationships for developing and deploying OIs in the NextGen System of System (SoS). To represent the interests of most stakeholders, discussions were held with more than 35 success-critical stakeholders from the senior levels of the FAA, NASA, Industry, and the Joint Planning and Development Office (JPDO). There is a confluence of technical and, more importantly, non-technical factors that reflect what people know about the complex SoS interactions can be more important than most technical factors in effectively rolling out capabilities.

To simplify the problem, NextGen is being implemented through a time-phased series of OIs, each of which is broken down into a series of OI Increments (OII). OIIs can be allocated to different systems that are developed by different programs across the NAS SoS. The acquisition of each OII is defined to support a capability (or sub-capability) and has a predicted cost, schedule, benefit, and risk. Capability rollouts of the OIs don't always play out as originally planned; for example, technologies mature more slowly than expected or implementing a derived OII requires more software than originally planned. Capabilities often have dependencies, where one OII may require features delivered in another OII. OII dependencies are not digitally formalized, and therefore people estimate the impact of interdependencies between OII. It is difficult to understand the relationships between OIs and even more difficult to understand the implications of changing one or more OIIs. This difficulty continually challenges those responsible for planning, developing, and deploying OIs. Missing cost or schedule targets on any one OII can impact the realization of the benefits of an OI due the challenges of understanding the complex set of technical and non-technical factors required for integrating and deploying OIs with SoS dependencies.

The objective is to create an analysis and modeling framework to support the decision making process. There are a large number of factors that contribute to cost, schedule, and benefits. It is important to identify the most important factors and the data sources for those quantitative and qualitative factors. It is uncertain if the available data is sufficiently complete and correct to be useful for modeling purposes. It may be necessary to use surrogates for the "real" data based on what people know.

The approach is to develop hybrid Bayesian network framework combining causal and probabilistic representation of quantitative data and qualitative factors that can provide probabilistic visualizations of cost, schedule and benefit risks that enable stakeholders to make better decisions of meeting cost, schedule and benefit targets than has been done with other methods and models to date. The significance impact of the non-technical factors as it relates to meeting cost, schedule, benefits with acceptable risks drove the recommendation to research a Bayesian Network (BN) modeling approach that combines quantitative and qualitative subjective expert judgment related to many of the non-technical factors. NextGen modeling and simulation tools that are tailored to the specific benefits of the OI provide some of the quantitative inputs. The process of validating the modeling framework involves using historic cost, schedule and benefits data as quantitative inputs.

This presentation discusses the task approach, and current progress in how the model framework provides a means to support acquisition decision-making through tradeoff and impact analysis of potentially competing OIs. The presentation shows how risk-based visualizations of cost, schedule, and benefits help stakeholders understand complex causal relationships, where an informed decision can minimize the impacts of cost overruns and schedule slips.

Biography

Dr. Mark R. Blackburn is a Research Associate Professor with Stevens Institute of Technology and primarily responsible for research focused on methods, modeling, simulation, visualization, and automated tools for reasoning about computer-based systems. Current interests include concept engineering, model-based verification mechanisms for run-time verification of complex adaptive systems and research in use of Bayesian networks for prediction and estimation.

Dr. Art Pyster is a Distinguished Research Professor and Deputy Executive Director of the Systems Engineering Research Center at Stevens Institute of Technology. He is also an INCOSE fellow, member of their Board of Directors, and INCOSE Director for Academic Matters. Previously, Dr. Pyster served in a number of executive positions, including Deputy CIO for the Federal Aviation Administration.