Definition of large, complex systems requires an understanding of system performance, cost and risk during each of the system's lifecycle phases (i.e., design, development, testing, deployment and operations). Accurate representations of the system's: (1) functional and physical interfaces are required to facilitate the analysis, design, and integration of the system and its elements; (2) costs, operational plans, and risks are required to balance the programmatic aspects of the system; and (3) performance projections and margins are required to understand payload options. Achieving an understanding of these complex interactions requires the development, analysis and refinement of models and simulations (M&S) across the lifecycle of the system in order to support a variety of analysis activities. Models currently being developed for Exploration Systems and Space Operations are categorized as subjective, constructive, operator-in-the-loop, hardware- and software-in-the-loop, and in-service operations. These models and simulations are used to address requirements generation, design definition, verification of requirements, testing and sustaining engineering. SBIR Topic X1 is aimed at addressing pressing issues that are still lingering in the area of analysis and M&S. Data required to perform analysis and execute models/simulations must be consistent, valid and cohesive across the analyses. Approaches to dealing with analysis data management and manipulation through the lifecycle are sought. The integration of cost and risk models early in the lifecycle of a system's analyses must be achieved to ensure that programmatic factors drive our plans. Modeling and simulation is key to achieving NASA's vision by providing the data required for early key decision-making.

**Subtopics**

**X1.01 Full Data Coherency Systems for Engineering Systems Modeling and Simulation**

**Lead Center:** MSFC  
**Participating Center(s):** ARC, GRC, JPL, LaRC  

In addressing the accuracy of analysis results, which are used to make program/project decisions, we typically assess the data, the models/simulations, and the analysts. This subtopic area will address the first of these concerns. Verification and validation approaches typically address the validity of the data used to perform the analysis. However, they do not address the issue associated with data cohesiveness and consistency. An issue in the development of integrated modeling/simulation for complex engineering systems arises when information is fed to the models with inconsistent coherency, where “coherency” is defined as appropriate versions, semantics/syntax, abstraction/resolution, and sequence. When, for example, serial/parallel simulations are run with revised input data from one source, other sources may or may not need to be held constant; similarly, input data of varying heritage, semantics, resolution, etc., may result in unexpected and inaccurate simulations. Proposals are sought for systems that manage full data coherency (not just version or sequence control) in modeling and
Traditional, and at times typical, analysis of new systems involves an assessment of the system's performance independent of the cost and risk associated with the design. Specifically, the cost and risk are assessed after the design, requiring integration "after the fact". The SE&I process, however, requires a balancing of cost, risk and performance throughout a system's lifecycle. An additional challenge associated with this subtopic area is the use of cost and risk techniques early in the design process where there exists little data (i.e., performance, cost, and risk) from which to draw upon for developing the cost/risk algorithms, associated relationships, and verification/validation artifacts. An approach for integrating cost and risk models early in the assessment, ensuring that they drive the design and not vice-versa, is required to address the challenges in the agency. Proposals are sought to address: (1) the integration of cost and risk models into a seamless integrated solution; (2) the early application of cost and risk modeling into the analysis cycle of a system; and (3) the approach to verification and validation of the integrated cost/risk models.