GSAW 2019 Tutorial A:

Model Based Systems Engineering for Ground Systems

Length: Full day

Overview:

Course Outline

1. **MBSE Introduction and Overview**
    - Overview of Model-Based Systems Engineering
    - Fundamental Concepts of Modeling
    - Models of Computation
    - Computer-Aided Verification Techniques
    - Example Application of Models in Systems Engineering

2. **Front End Diagrams**
    - Package Diagrams
        - Diagram, description, purpose, and benefits
        - Model organization
        - Package relationships (contains, imports, extends)
        - Specialized packages: views/viewpoints, libraries, profiles

    - Use Case Diagrams
        - Diagram description, purpose, and benefits
        - Use case, actor, and subject
        - Basic relationships: association, include, extend, and generalization
        - Scenarios

    - Requirements Diagrams
        - Relationship between requirements and use cases
        - Creating requirements diagrams
        - Requirements relationships to other model elements
        - Representing requirements in tables and matrixes
        - Building a use case model using the basic set of SysML constructs

3. **Structure Diagrams**
    - Block Definition Diagrams
        - Definition vs. usage;
        - Block features including value types, value properties, parts, references, and operations.
        - Block Definition Diagram description, purpose, and benefits; compartments; relationships between blocks including specialization and associations
        - Multiplicities

    - Internal Block Diagrams
        - Internal Block Diagram description, purpose, and benefits
        - Instantiations
        - enclosing blocks and representation of parts.
        - flow ports and standard ports
        - connectors and item flows

- Parametric Diagrams
  - Interpreting constraint blocks on Block Definition Diagrams
  - Parametric Diagram description, purpose, and benefits
  - constraint properties, constraint parameters, and constraint expressions
  - connecting constraint properties and value properties with binding connectors
  - quantitative examples

4. **Behavior Diagrams**
   - Activity Diagrams
     - Activity Diagram description, purpose, and benefits
     - I/O flow including object flow, parameters and parameter nodes, and pins
     - control flow including control nodes
     - activity partitions (swimlanes)
     - and actions including decomposition of activities using call behavior action
     - send signal action
     - accept event action.

   - Sequence Diagrams
     - *Messages; Lifelines:* Selectors, lifeline decomposition, Activations (including nested).
     - *Interaction operators:* Advanced interaction operators, Combining interaction operators, Nesting interaction operators.
     - *Interaction Decomposition:* Interaction Use or References, Gates.
     - *Constraints:* Observations and Timing Constraints, State invariants.

   - State Machines
     - State Machine Diagram description, purpose, and benefits
     - states and regions including state, regions, initial state and final state
     - transitions including trigger by time and signal events, guard, and action (i.e. effect)
     - and behaviors including entry, exit, and do

Instructors: Mark McKelvin Jr. and Myron Hecht, The Aerospace Corporation

Biographies:
Dr. Mark L. McKelvin, Jr. is a Senior Engineering Specialist in systems and software engineering at The Aerospace Corporation and President of the INCOSE-LA Chapter. Dr. McKelvin specializes in the use of model-based engineering techniques to develop solutions to architecture design challenges for cyber-physical and software-intensive systems. He is also a Lecturer in the System Architecting and Engineering graduate program at the University of Southern California, Viterbi School of Engineering where he teaches courses in Model-Based Systems Engineering and Systems Engineering Theory and Practice. Prior to joining the Aerospace Corporation, Dr. McKelvin worked at NASA/JPL as a software systems engineer, electrical systems engineer, and a lead fault protection engineer on a major flight system. His interests are in the application of modeling, analysis, and design of engineered systems, including cyber-physical, embedded, and software systems. He holds a Ph.D. in Electrical Engineering and Computer Sciences from the University of California, Berkeley with an emphasis in Electronic Design Automation.

Myron Hecht is a Senior Project Leader at The Aerospace Corporation where supports large satellite and ground systems acquisitions by the U.S. Air Force including GPS, military communications, and other applications. His current research is on Model Based System Engineering and its application to quantitative and qualitative reliability, availability, and safety analysis methods. He has previously made research contributions in the areas of integrated hardware/software reliability modeling analysis, fault tolerant computing, and real time distributed control systems. Myron is consultant to the Nuclear Regulatory Commission in digital instrumentation and control systems, a lecturer at the UCLA School of Engineering and Applied Sciences teaching both reliability and model based systems engineering, and has served on multiple standards committees for systems engineering, reliability, computers in nuclear power plants, and software in avionics systems. He is an author of 90 refereed publications in reliability, safety, products liability, and systems engineering. He holds a B.S. in Chemistry, and M.S. degrees in nuclear engineering, an M.B.A., and a J.D. degree all from UCLA.

Description of Intended Students and Prerequisites:
Familiarity with ground systems architecture and general systems engineering processes.

What can Attendees Expect to Learn:
MBSE background and fundamentals, Types and uses of SysML diagrams, use of SysML in an MBSE process.