Model-Based Systems Engineering: A Practical Approach

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Agenda

• Why invoke Model-Based Systems Engineering?
• What is Model-Based Systems Engineering?
• What we did on the Surrogate SATCOM IRaD
• What should you do?
“Process is not the enemy – bad process is.”

Why

- Systems Engineering V Model
Why (cont.)

• Communication
  – Common understanding
    • What the system is supposed to do
    • What the system parts are called
      – Normalized terminology
    • How the system is configured
      – Define subsystems and components
      – Identify interfaces
      – Logical and Physical

• Coordination
  – Multiple engineering efforts
    • Who’s developing which parts of the system
  – Accommodate changes

Effective Development is the Goal
Why (cont.)

• Collaboration
  – Develop models
    • Requirements: CONOPS, COIs, Missions, etc.
    • Architecture: OV1, Block Diagrams, Data Flows, Drawings, etc.
    • Operation: Mock-ups, Test and Demo plans, etc.
  – From different points of view
    • Business Development
    • Hardware
    • Software
    • Cybersecurity
    • Test
    • Deployment
    • Sustainments, Logistics, Operations and Maintenance
• **Model-based systems engineering** (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases

• A **model** is an approximation, representation, or idealization of selected aspects of the structure, behavior, operation, or other characteristics of a real-world process, concept, or system, i.e. an **abstraction**

• A model usually offers different **views** in order to serve different purposes
  - A **view** is a representation of a system from the perspective of related concerns or issues
What – Model Examples

• Video games
• Weather maps
• Schedules
• Test Configurations
What – View Examples

- Hardware
- Software
- System
  - Logical
  - Physical
  - Operational
How

• Operational
  – CONOPS, Missions
  – COIs, MOEs, MOPs
  – OV1
  – Requirements
  – Test and Demo Plans

• Functional
  – Decomposition
  – Data Flow Diagrams
  – Use Cases

• Logical
  – Context Diagrams
  – Architecture Block Diagram
  – Interconnect Diagrams
  – Architecture Flow Diagrams

• Physical
  – Product Entity Diagram
  – Drawings
  – Equipment Configuration Diagrams
  – Checklists

Capture the Thinking
How – Operational

- CONOPS, Missions
- COIs, MOEs, MOPs
- OV1
- Requirements
- Test and Demo Plans

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<th>MOE</th>
<th>MOP</th>
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#### CONCEPT FOR THE PROPOSED SYSTEM

The RSMS is a hardware and software solution applied to an existing irrigation system to monitor soil conditions and control the application of water-based soil amendments according to a tailorable parametric model. The RSMS can be configured to accommodate present and short-term forecast weather conditions. The human system interface (HSI) provides access to the monitoring and control functions, and allows the user to tailor the parameters of the heuristic model to best suit ongoing local conditions. Sensors are hot-swappable, are easily moved, and operate wirelessly.

**Objective 3.2**

Demonstrate exchange of data from ground sensor to central control station via the sensor network.

**Entry Criteria**
- Scenario dry run completed.
- Transmission load simulator calibrated.
- Test readiness reviewed and approved.

**Exit Criteria**
- Data transmitted from sensor, data received at central control station for post-processing and verified by test engineer.

**Test Scenarios**
- General: Sensor data transmission, single channel
- Scenario 1: 20 kHz Tx in sensor network
- Scenario 2: 5 kHz Tx in sensor network

**Test Output Data**
- Sensor data logged by central control station.
- System configuration files.

**Data Analysis**
- **Message latency**: Determine average elapsed time between transmission of sensor data from the source sensor and receipt of the sensor data at the central control station.
- **Message quality**: Sensor data transmitted matches data received.
How – Functional

- Decomposition
- Data Flow Diagrams
- Use Cases
How – Logical

- Context Diagrams
- Architecture Block Diagram
- Architecture Flow Diagrams
- Interconnect Diagrams
How – Physical

- Product Entity Diagram
- Drawings
- Equipment Configuration Diagrams
- Checklists
Tie It All Together
Questions
Actions for Success

- Document and review the system development plan
  - SEMP or SEIT Plan (what, who, when)
- Document and review system operational concepts
  - CONOPS
  - Missions
  - OV1s
  - COIs, MOEs, MOPs
- Identify, document, and review operational requirements
- Describe, document, and review the system functionally
  - Functional Decomposition
  - Data Flow Diagrams
  - Use Cases
- Identify, document, and review system requirements
Actions for Success (cont.)

❑ Describe, document, and review the system at the logical level
  ○ Context Diagrams
  ○ Architecture Block Diagrams
  ○ Interconnect Diagrams
  ○ Architecture Flow Diagrams

❑ Describe, document, and review the system physically
  ○ Product Entity Diagrams
  ○ Drawings
  ○ Equipment Configuration Diagrams

❑ Document and review system test and demo plans and procedures

❑ Create and use checklists
Know Your Audience