A Model-Driven Systems Engineering Approach for Unmanned Aircraft Airspace Integration

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Outline

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Purpose

- Highlight the benefits of using a Model-Driven Systems Engineering (MDSE) approach to address the issue of integrating Unmanned Aircraft (UA) into the National Airspace System (NAS)
- Present a practical application of system model and architecture development
Problem Description

- Increasing need to operate UA in the NAS
  - DoD – Training
  - DEA – Drug interdiction
  - CBP – Border security
- FAA has two primary safety issues
  - Command and control redundancies
  - “Sense and Avoid” capability
Problem Description (cont’d)

- Current NAS access for UA requires a Certification of Authorization (COA)
  - 60 day review cycle
  - 1 year maximum life span
  - May include special provisions or restrictions
- UA technology advancing ahead of regulatory policy
  - Beyond line of sight control
  - High altitude
  - Long range and endurance
Global Hawk, Predator, and Fire Scout
UA Regional Airspace Integration Strategy

- **Objective**
  - Gain or expand access in selected regions via COA process
    - Patuxent River Naval Air Station, MD
    - Beale AFB, CA
    - Creech AFB, NV
    - Ft. Huachuca, AZ

- **Constraints**
  - Use of current technologies
  - Comply with current FAA regulations

- **Goal**
  - Facilitate COA process
Approach

- Use a Model-Driven Systems Engineering (MDSE) methodology
  - Build a system model of Global Hawk mission operations at Patuxent River, MD
  - Produce architecture artifacts
- Use artifacts to reach common understanding between ATC and Global Hawk operators in order to facilitate COA process
- Use artifacts to identify
  - Problem areas
  - Issues that need clarification or resolution
Why MDSE

- Modeling is a formal way to visualize something
- Assists stakeholders in understanding something that is not easily comprehensible
- A form of communication
  - Provide operators a means to convey their planned mission operations
  - Provide regional Air Traffic Controllers (ATC) a way to better visualize the planned operations
  - Provide a means to discuss and resolve contingencies

“If you don’t model it, you won’t understand it.”
Ivar Jacobson
Process

- Decompose mission operations into Use Cases
  - Plan Operational Mission
  - File Flight Plan
  - Start, Taxi, Takeoff
  - Operate in Patuxent River Airspace
  - Land, Taxi, Shutdown
- Identify common Use Cases
  - Monitor Weather
  - Report Health and Status
  - Handoff Control
  - Traffic Deconfliction
  - Perform Sense and Avoid
Process (cont’d)

- Model Use Cases
  - Develop Activity Diagrams for each Use Case
  - Validate Activity Diagrams with stakeholders
  - Identify problem areas and issues
  - Revise Activity Diagrams with proposed changes
  - Develop related architecture artifacts
Importance of Activity Diagrams

- Cornerstone of model
  - Shows sequence of activities
  - Identifies actor responsible for each activity
  - Primary artifact used to communicate with stakeholders
  - Easy to understand (sequential)
- Helps produce other artifacts
  - Operational Node Connectivity Diagram
  - Operational Information Exchange Matrix
Architecture Artifacts

- High-level Operational Concept Graphic (OV-1)
- Use Case Diagrams
- Activity Diagrams (OV-5)
- Operational Node Connectivity Diagram (OV-2)
- Operational Information Exchange Matrix (OV-3)
- Organizational Relationship Chart (OV-4)
- Overview and Summary Information (AV-1)
- Integrated Dictionary (AV-2)
Unclassified

Architecture Artifacts
High Level Operational Concept Graphic
Architecture Artifacts
Use Case Relationships
Architecture Artifacts
Operational Node Connectivity Diagram
Architecture Artifacts
Operational Node Connectivity Diagram
Problem Areas Identified

- No visual of traffic at Global Hawk ground station
  - Required for “Sense and Avoid” capability
- Contingency landings – requires flying through controlled airspace to use alternate runway
  - Provision – chase plane required for contingency landings
Findings

- MDSE process could serve as template to facilitate COA process in other regions
- Each region needs its own model
  - Airspace configuration differs from one region to another
- Use Case decomposition allows for some re-use
  - Monitor Weather
  - Report Health and Status
  - Traffic Deconfliction
Conclusions

- Model-Driven System Engineering:
  - Useful for facilitating communications among stakeholders
  - Easy to comprehend
  - Assists in reaching mutual understanding between ATC and Global Hawk operators
  - Helps to identify problem areas
  - Provides building block approach for other regions
  - Activity Diagrams - key element of architecture
Questions