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

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Outline

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- UA Regional Airspace Integration Strategy
- Approach
- Why MDSE
- Process
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- Architecture Artifacts
- Problem Areas Identified
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- Conclusions
- Questions

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

Global Hawk

Predator

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

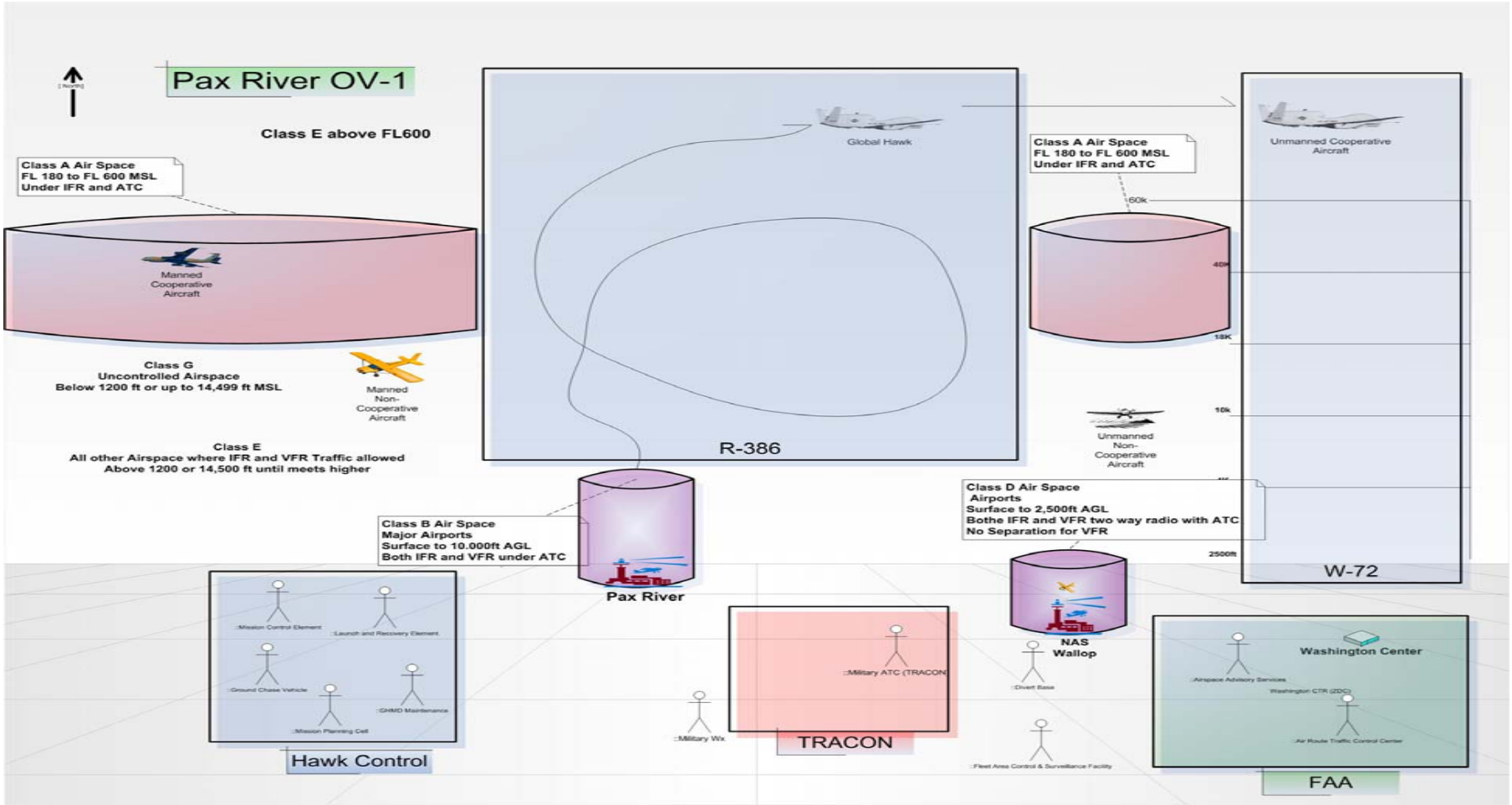
Importance of Activity Diagrams

- 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

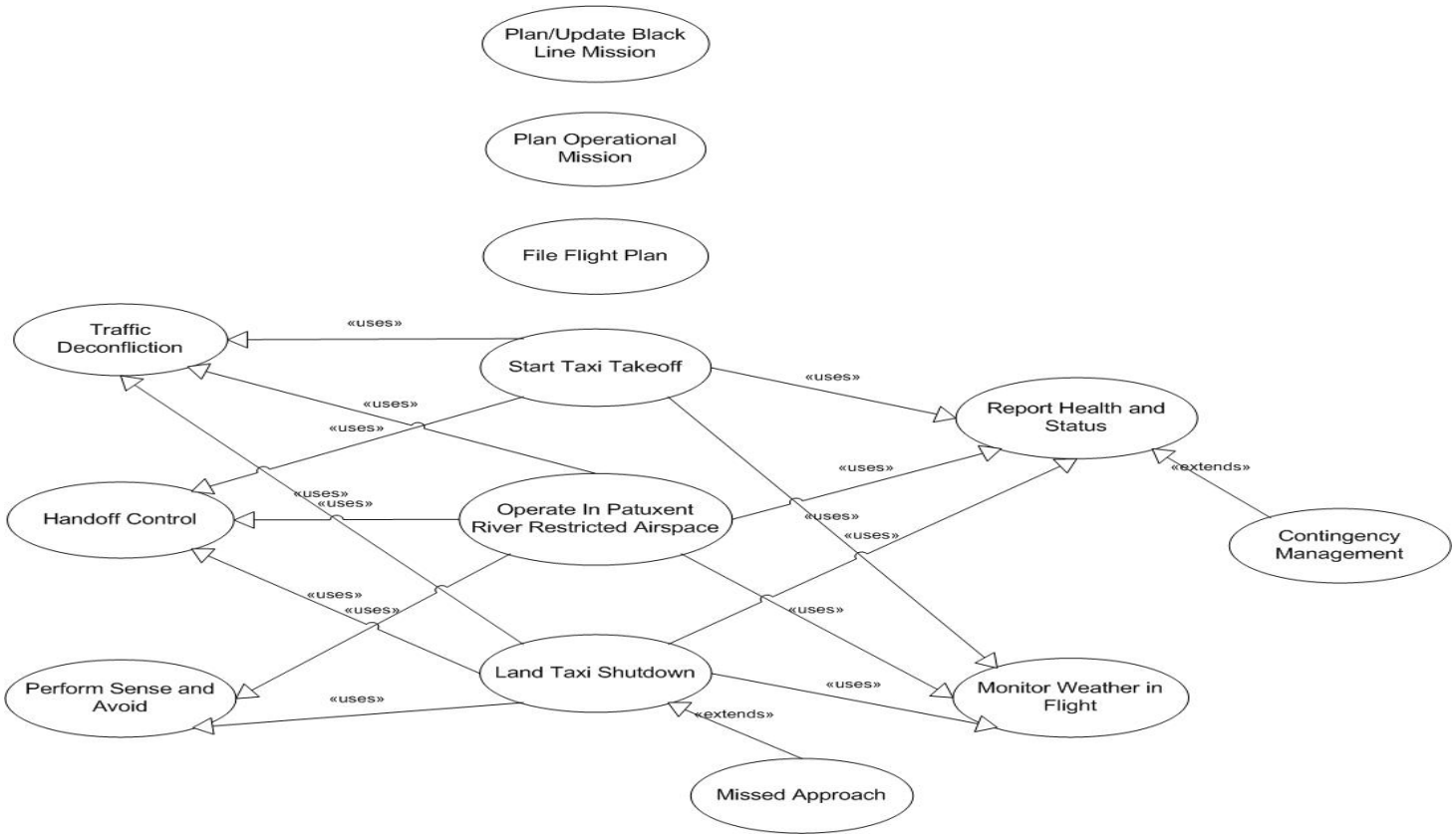
Architecture Artifacts

- 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)

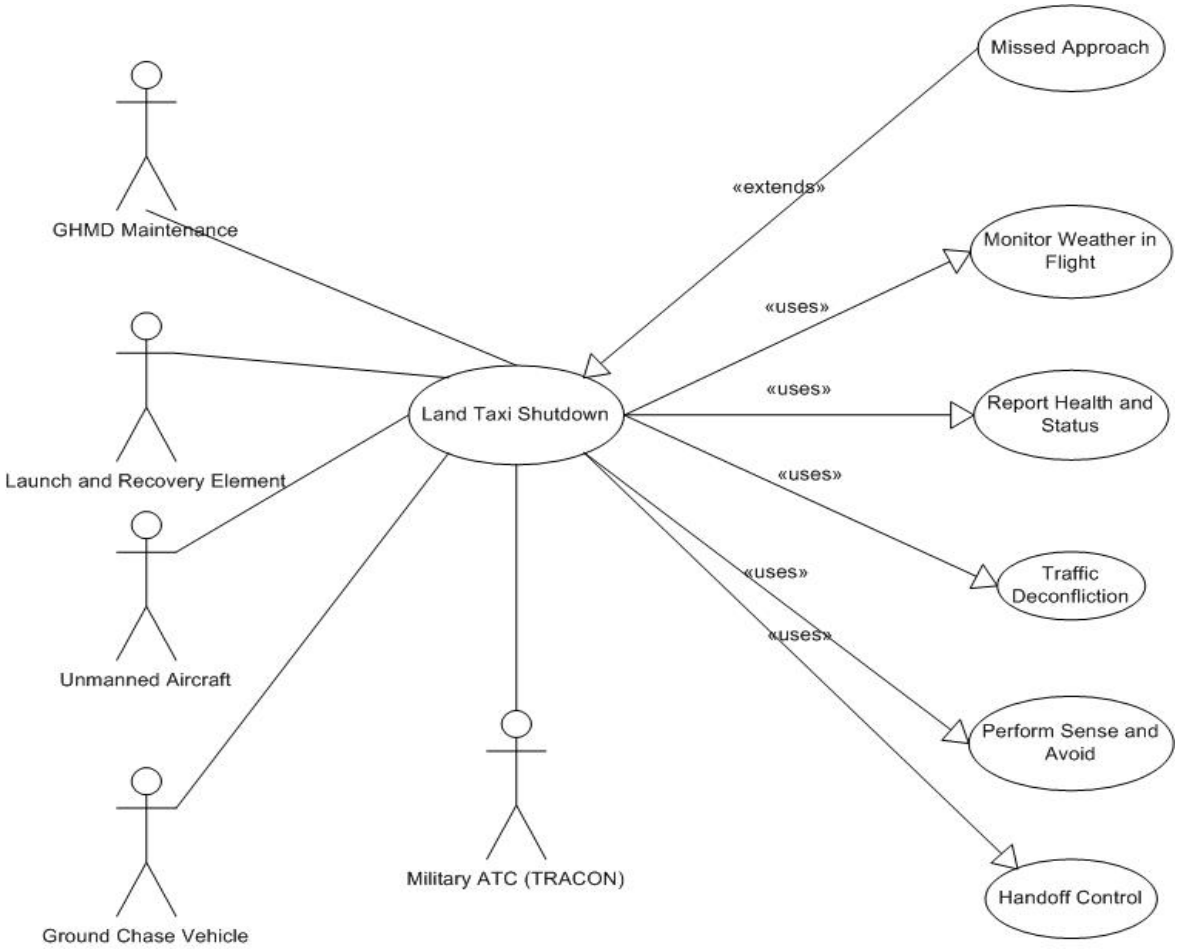
Architecture Artifacts
High Level Operational Concept Graphic



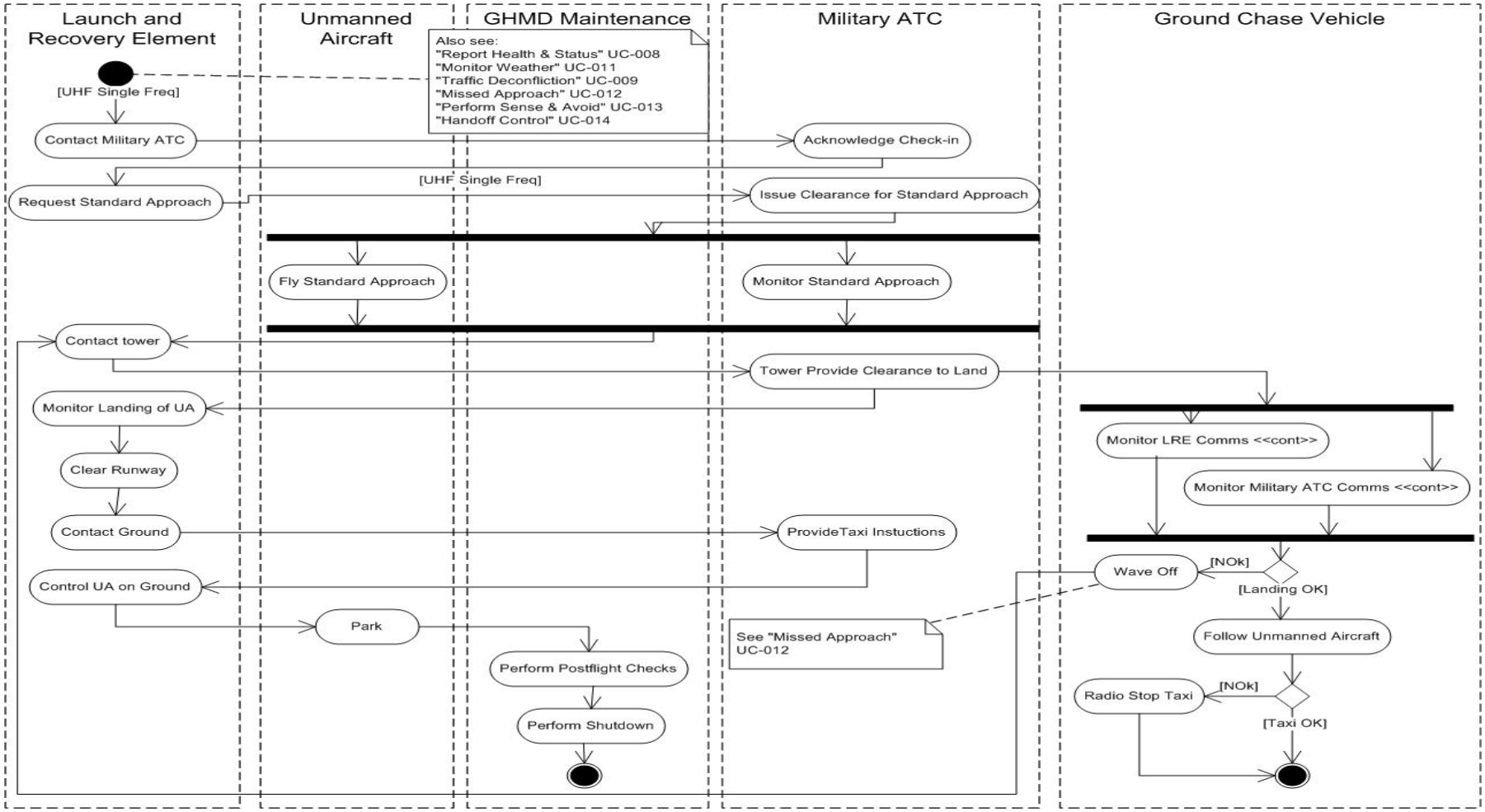
Architecture Artifacts
Use Case Relationships



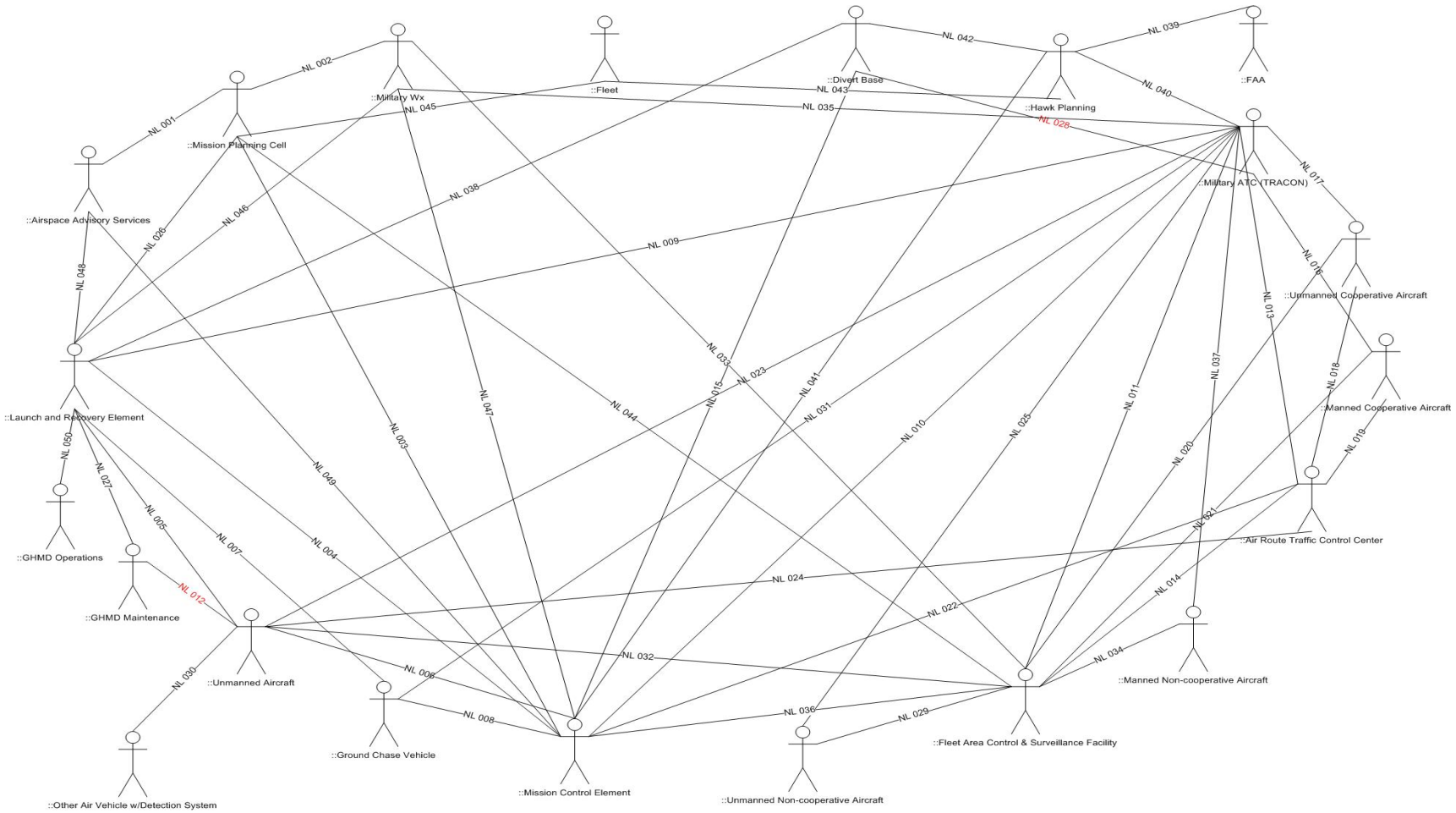
Architecture Artifacts
Land, Taxi, Shutdown Use Case Diagram (1 of 13)



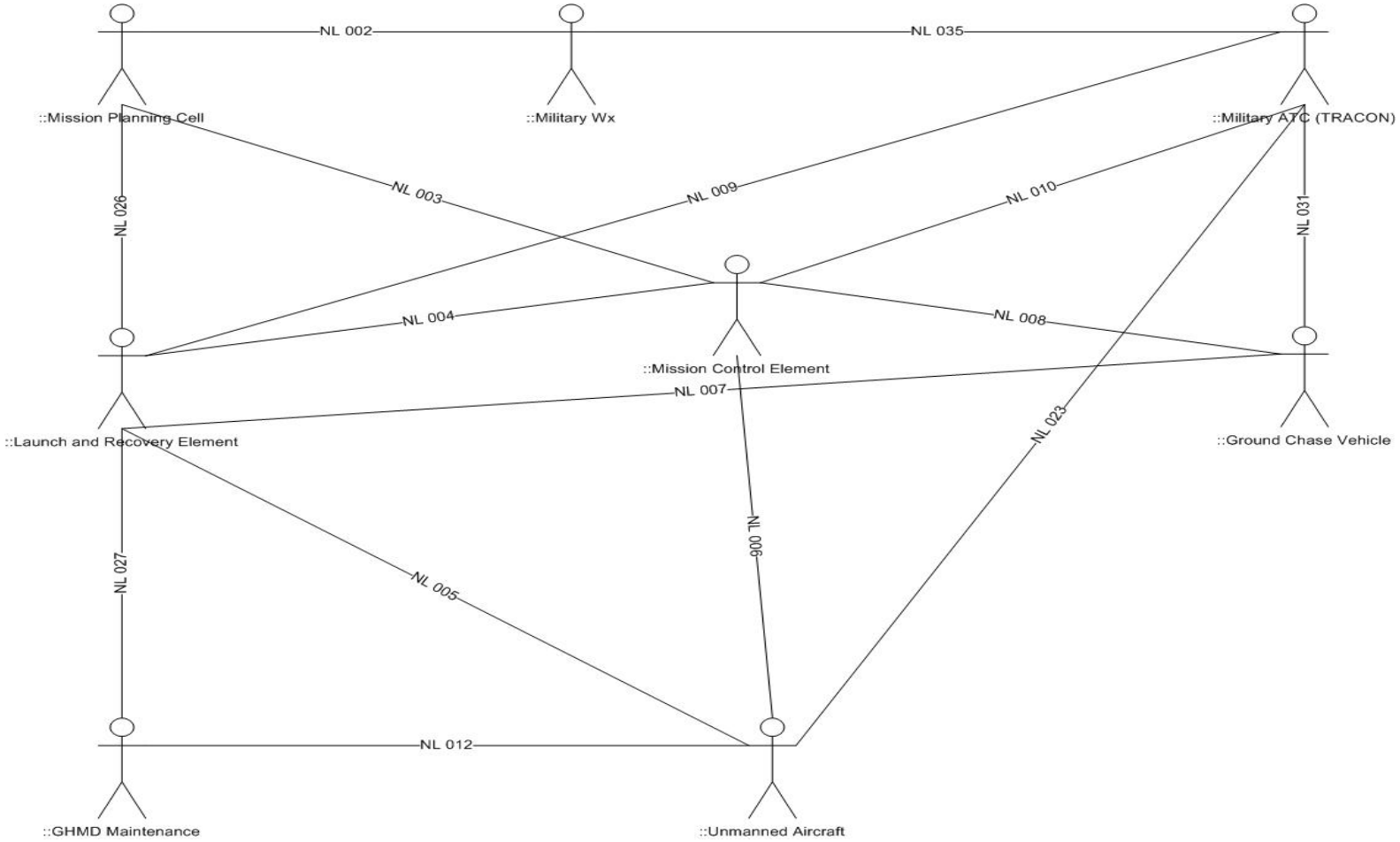
Architecture Artifacts
Land, Taxi, Shutdown Activity Diagram (1 of 13)



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