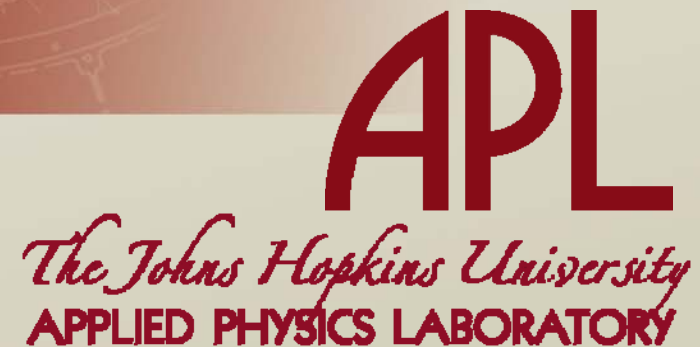


Unclassified

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

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October 26, 2006



Distribution Statement A

Approved for Public Release: Release is Unlimited

Outline

- Purpose
- Problem Description
- UA Regional Airspace Integration Strategy
- Approach
- Why MDSE
- Process
- Importance of Activity Diagrams
- Architecture Artifacts
- Problem Areas Identified
- Findings
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- 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

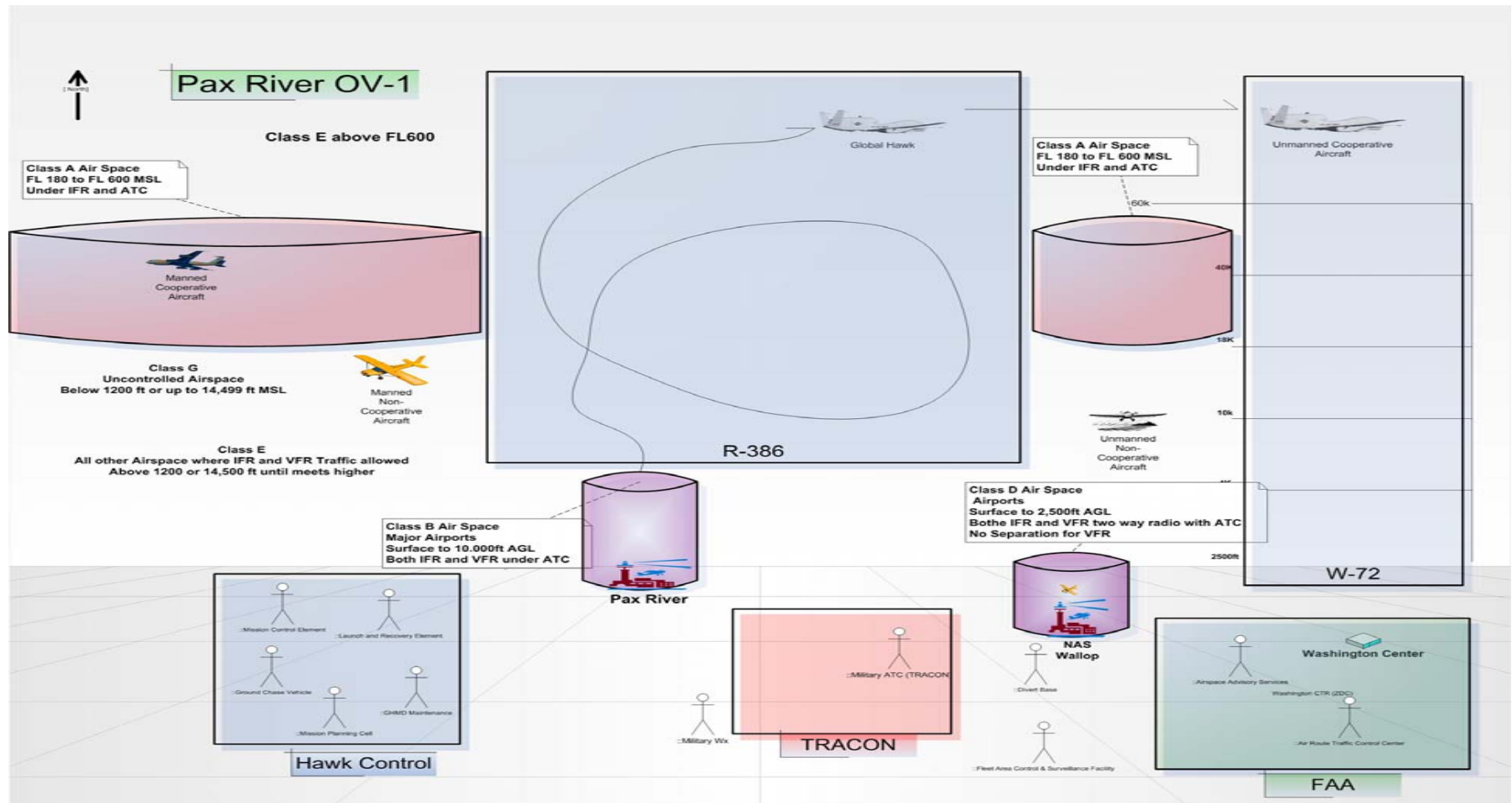
- **Cornerstone of model**
 - Shows sequence of activities
 - Identifies actor responsible for each activity
 - Primary artifact used to communicate with stakeholders
 - Easy to understand (sequential)
- **Helps produce other artifacts**
 - Operational Node Connectivity Diagram
 - Operational Information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

Architecture Artifacts

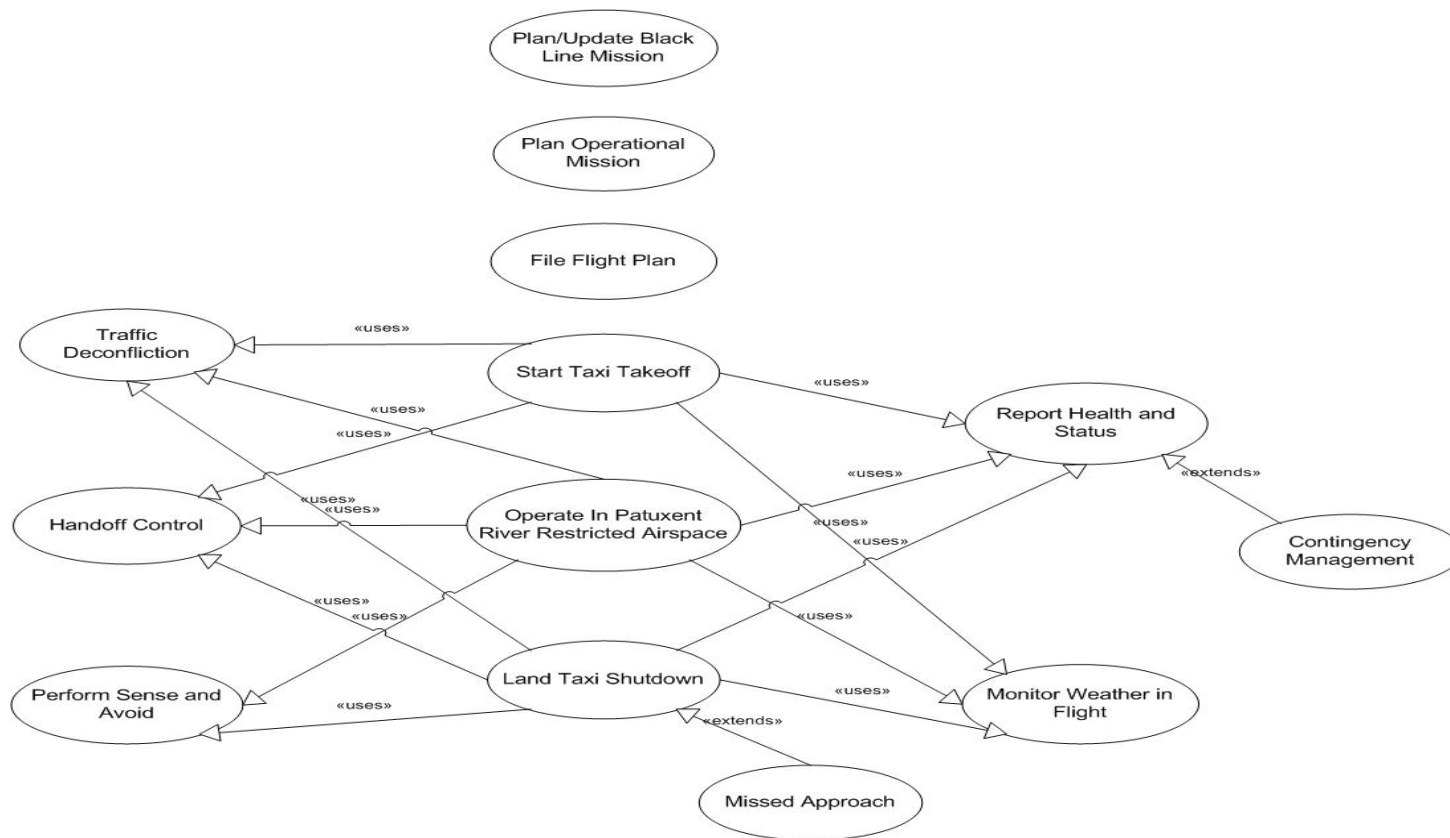
- High-level Operational Concept Graphic (OV-1)
- Use Case Diagrams
- Activity Diagrams (OV-5)
- Operational Node Connectivity Diagram (OV-2)
- Operational Information Exchange Matrix (OV-3)
- Organizational Relationship Chart (OV-4)
- Overview and Summary Information (AV-1)
- Integrated Dictionary (AV-2)

Architecture Artifacts

High Level Operational Concept Graphic



Architecture Artifacts Use Case Relationships



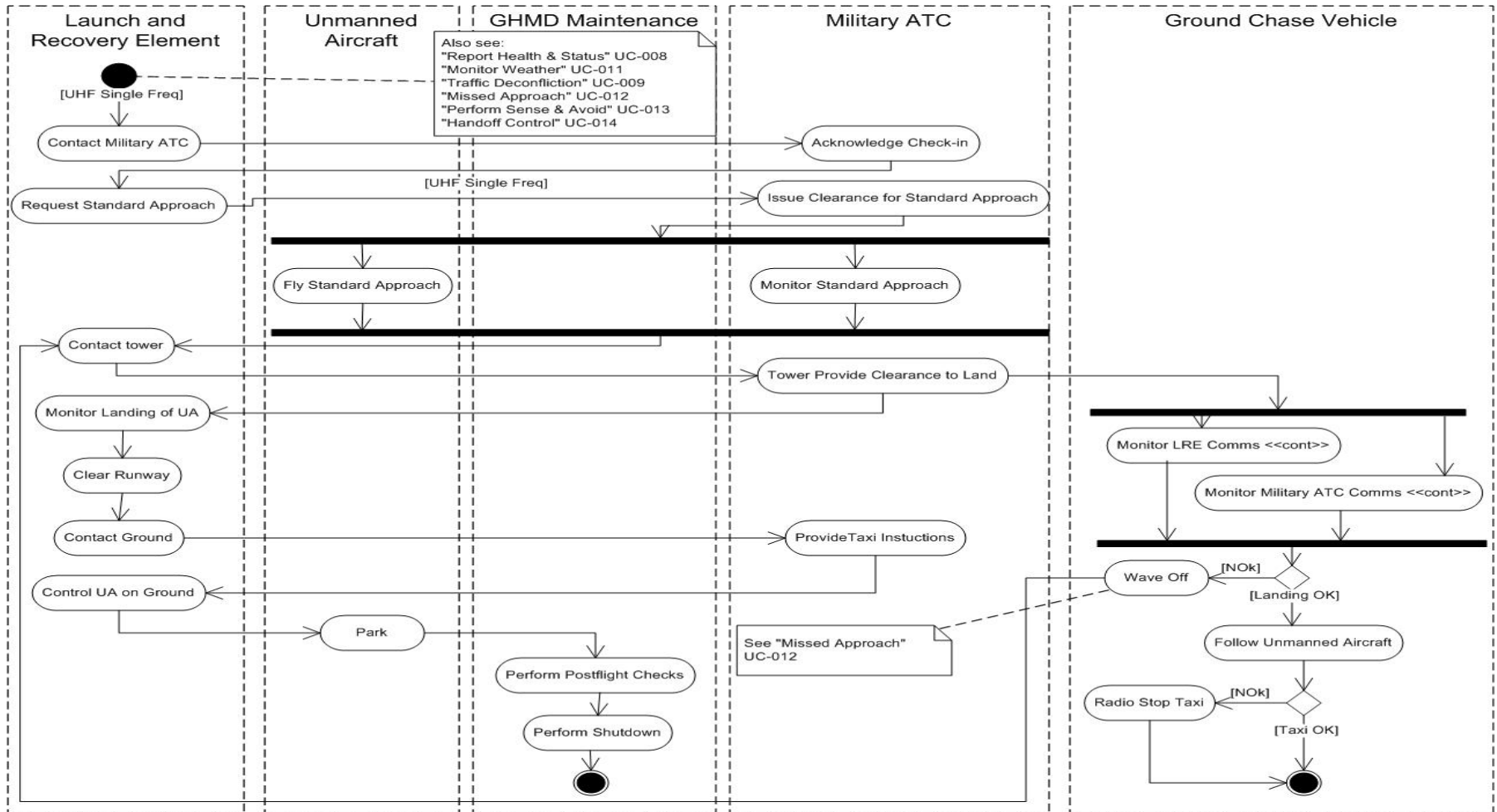
Architecture Artifacts

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



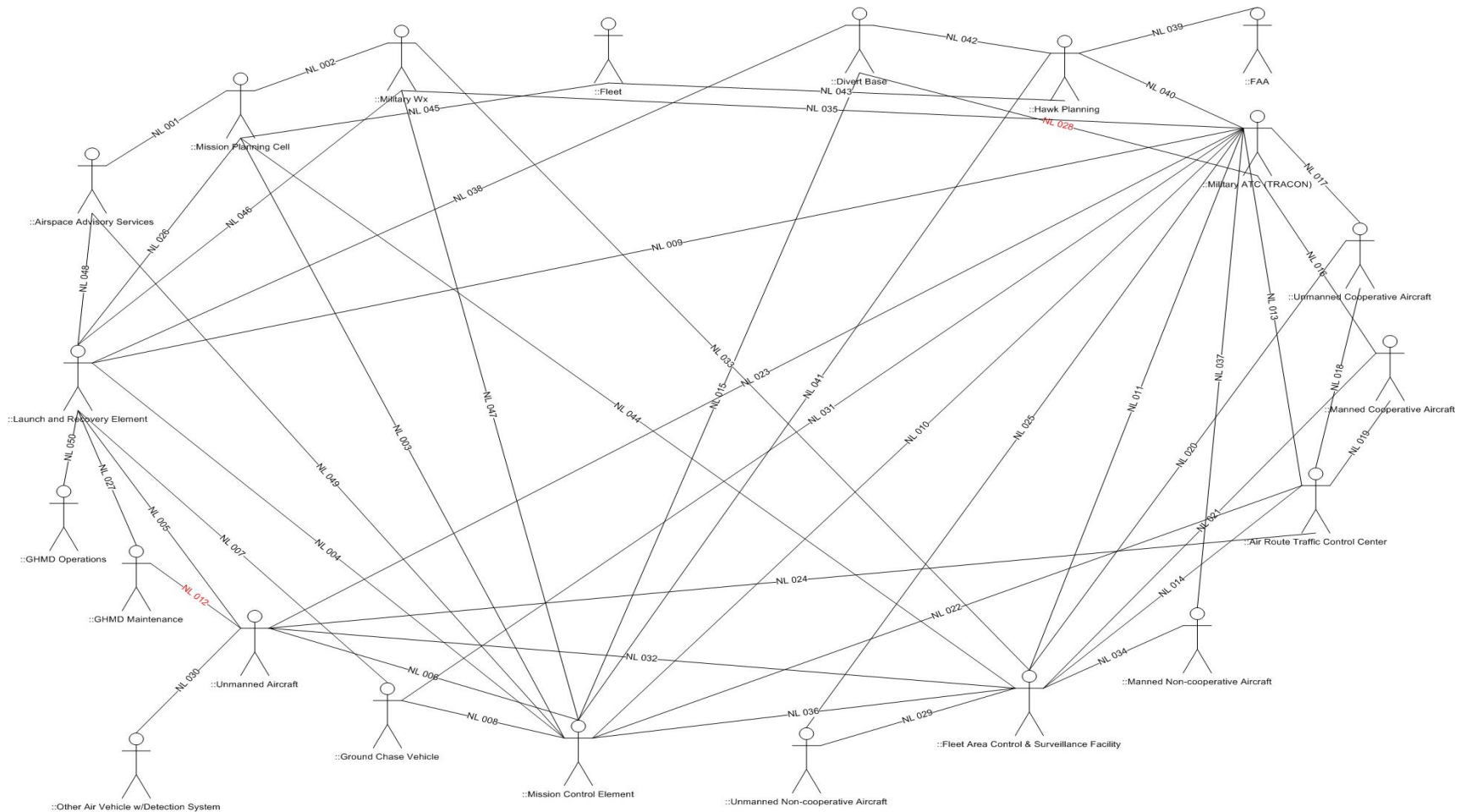
Architecture Artifacts

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



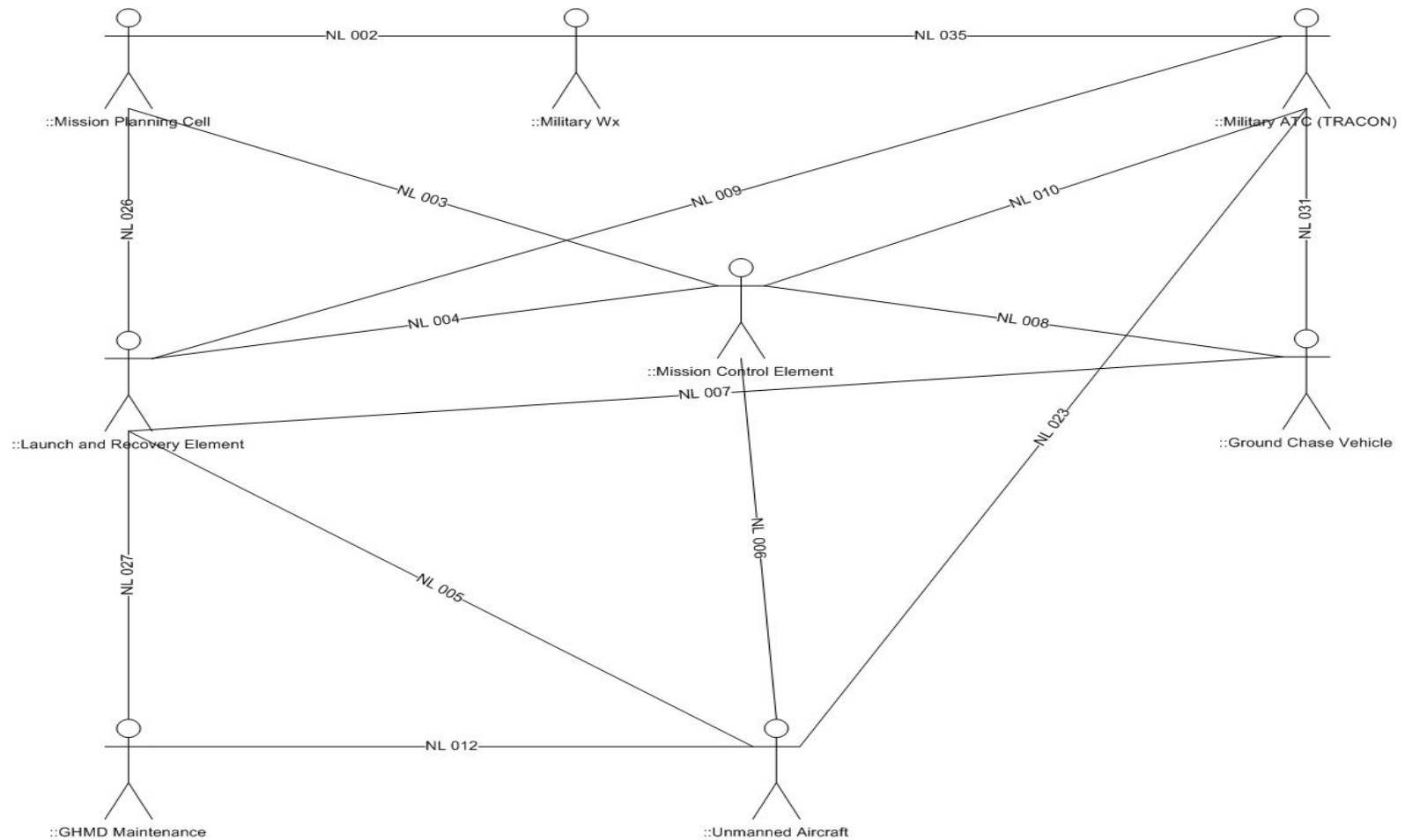
Architecture Artifacts

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