**ClearPath**

**System Test Plan**

**Version <1.0>**

**11/30/2024**

# Document Control

## Distribution List

The following list of people will receive a copy of this document every time a new version of this document becomes available:

Teaching assistants:

Rajagopal Sugumar

Customer(s):

Dr. Masood Towhidnejad

Project team members:

Michael Yun

Cannon Newbury

Sadeed Khan

Isaac Hewitt

## Change Summary

The following table details changes made between versions of this document:

|  |  |  |  |
| --- | --- | --- | --- |
| **Version** | **Date** | **Modifier** | **Description** |
| 1.0 | 11/26/2024 | Sadeed Khan | Initial document created |
| 1.1 | 11/26/2024 | Sadeed Khan | Template information removed, updated with ClearPath information |
| 1.2 | 11/27/2024 | Sadeed Khan | Continued Working on completing parts of sections 1 and 2 |
| 1.3 | 12/03/2024 | Newbury, Hewitt | Worked on section 2-4 |
| 1.4 | 12/04/2024 | Newbury | Draft of Test Plan complete |

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# Introduction

## Purpose

The purpose of this Test Plan is to outline the testing strategy and procedures for the ClearPath project. This document will detail the organizational responsibilities, the overall approach to testing, the test schedule, and the necessary resources to ensure the successful validation of the system. It will define the scope of testing required to verify that the ClearPath system performs as expected, integrating live traffic data into the simulator and handling incursion scenarios. The document will also provide guidelines for managing any potential issues during the testing phase and the criteria for success. This plan is subject to updates as the project progresses and more detailed requirements emerge.

## Scope

The scope of the ClearPath project focuses on integrating live traffic data into the XPlane simulator in LB131. This integration will include real-time traffic in both the 2D map view and the 3D simulation environment. Additionally, we will develop a plugin that allows users to initiate incursion scenarios, which can be customized based on the number of planes involved and the location of the incursion. These features represent the core scope of the project. Any further customizations, including additional 3D objects or the implementation of bots, fall outside the scope of this initiative.

## System Overview

ClearPath is centered around two main components. The first part is the integration of live traffic with the XPlane simulator in LB131. ClearPath incorporates live traffic as both 3D and 2D objects within the simulated environment, ensuring real-time data is reflected accurately in both the map view and the 3D simulation. This integration allows the simulator to display real-time traffic in a dynamic and interactive way, enhancing the realism of the simulation.

The second part of the system focuses on the development of a plugin that enables users to initiate and customize plane incursion scenarios. Users will be able to adjust parameters such as the number of planes involved and the specific location of the incursion on the taxiway. These scenarios are designed to enhance the training and testing capabilities of the system, allowing users to simulate real-world situations that may occur in air traffic control.

Together, these two components make up the core of the ClearPath system, with future expansions and improvements to be considered as needed.

A diagram of a diagram

Description automatically generated

## Testing Approach Overview

The ClearPath testing strategy involves multilevel testing to ensure all system components and functionalities operate as intended. Key levels include:

* **Unit Testing:** Validate individual modules like API integration and data processing.
* **Integration Testing:** Ensure seamless interaction between components, such as live traffic data integration and motion synchronization.
* **System Testing:** Verify the system’s end-to-end functionality, including real-time traffic visualization and incursion scenarios.
* **Usability Testing:** Confirm the interface is intuitive and accessible.
* **Performance Testing:** Assess system responsiveness under normal and peak conditions.
* **Security Testing:** Ensure secure access and data protection.

## Testing Entrance Criteria

Before testing can begin there must be some criteria and requirements that must be met. The computer connected to the simulator in LB131 must be powered on and connected to WiFi. The XPlane 11 software must be launched and loaded into a flight. The ADS-B database must be functional and transmitting live data

*<< To start system testing, certain requirements must be met for testing readiness. >>*

## Document Overview

This document is split up into sections and subsections. The sections include testing approach, testing environment, types of tests and a testing schedule. After flushing out the background information, there will be specific test cases for ClearPath.

## References

The references used for this document include the software requirements document developed by ClearPath as well as the software design document developed by ClearPath.

# Testing Approach

The testing approach for the ClearPath system involves a structured and phased methodology to validate the system's functionality, usability, performance, and reliability. The approach will include tests that examine individual functions, integrated workflows, and system performance under real-world conditions and stress scenarios. This ensures that the system meets the defined requirements and can handle operational challenges.

#### Types of Testing

#### Unit Testing

* **Objective:** Validate the smallest functional units of the system, such as individual plugins or data integration modules, to ensure they operate as expected.
* **Focus Areas:**

Data parsing and integration with the OpenSky Network API.

Incursion detection logic and thresholds.

**Integration Testing**

* **Objective:** Test the interactions between components to ensure that data flows correctly and functionalities are synchronized.
* **Focus Areas:**

Integration between live traffic data and the XPlane simulator.

Synchronization between the Force Dynamics 401CR motion simulator and the simulation environment.

**System Testing**

* **Objective:** Validate the entire system in the testing environment to ensure all components work together seamlessly.
* **Focus Areas:**

Real-time visualization of aircraft data in both 2D and 3D views.

Customization and execution of incursion scenarios.

**Performance Testing**

* **Objective:** Assess the system’s ability to handle expected and peak workloads without performance degradation.
* **Focus Areas:**

Handling up to 50 live aircraft in a simulated environment.

Real-time updates with a refresh rate of ~1 second.

**Usability Testing**

* **Objective:** Ensure the user interface is intuitive and accessible for both Users and Administrators.
* **Focus Areas:**

Navigation, visual appeal, and error handling.

**Stress Testing**

* **Objective:** Evaluate system behavior under extreme conditions, such as network interruptions or data overload.
* **Focus Areas:**

Recovery from data feed interruptions.

Handling of malformed or incomplete data from the OpenSky API.

## Testing Types

### Usability Testing

### Objective: Ensure the ClearPath user interface is intuitive, visually consistent, and accessible for all users.

* Test navigation, layout consistency, and readability of interface elements.
* Validate that alerts and error messages are clear and actionable.

**Goal:** Confirm users can easily access and interact with simulation controls, scenario settings, and live traffic data.

### Functionality Testing

**Objective:** Ensure each system component meets the functional requirements and business rules defined in the SRS and other project documents.

* Validate that the system correctly integrates live traffic data into the XPlane simulator.
* Test functionality for incursion detection, real-time visualization, and scenario customization.
* Confirm resolution of issues and changes as documented during the project.

Verify the system behaves as expected under all defined operational conditions.

## Testing Suspension Criteria and Resumption Requirements

This section will specify the criteria that will be used to suspend all or a portion of the testing activities on the items associated with this test plan.

### Suspension Criteria

Testing will be suspended if the incidents found will not allow further testing of the system/application under-test. If testing is halted, and changes are made to the hardware, software, or database, it is up to the Testing Manager to determine whether the test plan will be re-executed, or part of the plan will be re-executed.

### Resumption Requirements

Testing will be resumed once all suspension criteria*<< Resumption of testing will be possible when the functionality that caused the suspension of testing has been retested successfully. >>*

## Testing Environment

**Overview:**

Testing will take place in a controlled environment using the XPlane simulator in LB131, configured with the ClearPath system.

**Components:**

* **Hardware:** Force Dynamics 401CR motion simulator, high-performance PC, dual monitors.
* **Software:** XPlane 12, ClearPath plugins, OpenSky API for live data integration.
* **Network:** Stable WiFi or Ethernet connection for live traffic data.

## Testing Assumptions

* All hardware and software components are free from critical defects prior to testing.
* The testing environment in LB131 is fully operational and accessible.
* A stable network connection will be available for real-time traffic integration.
* Test data from the OpenSky Network API is accurate and reliable.

## Testing Risks and Contingencies

* **Risk:** Network interruptions affecting live traffic data integration.
  + **Contingency:** Use offline mock data to simulate traffic scenarios during testing.
* **Risk:** Simulator hardware malfunctions.
  + **Contingency:** Schedule backup testing sessions and perform preliminary hardware checks.
* **Risk:** Delays in team availability due to external commitments.
  + **Contingency:** Develop a flexible testing schedule with buffer time for adjustments.
* **Risk:** Unexpected software bugs halting progress.
  + **Contingency:** Prioritize bug fixes and rerun affected tests as part of the test cycle.
* **Risk:** Incomplete or inaccurate test data from the OpenSky API.
  + **Contingency:** Validate data integrity before testing and document anomalies for further analysis.

## Test Plan

**Table 1: Test Plan**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Test | Status[[1]](#footnote-2) | Date | Notes |
| 001 | Real-Time Traffic Data Integration | Pend | TBD | Test live data integration with OpenSky. |
| 002 | Incursion Detection Alerts | Pend | TBD | Validate alert triggers proximity breaches. |
| 003 | Motion Synchronization with Simulator | Pend | TBD | Confirm Force Dynamics 401CR syncs with aircraft motion. |
| 004 | UI Navigation and Usability | Pend | TBD | Test ease of navigation and readability. |
| 005 | Performance Under Load | Pend | TBD | Assess system handling of 50+ aircraft. |

# Test Schedule



# Traceability Matrix and Defect Tracking

## Traceability Matrix

**Table 2: Traceability Matrix**

****

## Defect Severity Definitions

|  |  |
| --- | --- |
| Critical | The defect causes a catastrophic or severe error that results in major problems and the functionality is rendered unavailable to the user. A manual procedure is impossible to implement, or high effort is required to remedy the defect. Examples of critical defects are as follows:   * System abnormally terminates * Data cannot flow through a business function/lifecycle * Data is corrupted or cannot post to the database |
| Medium | The defect does not seriously impair system function can be categorized as a medium defect. A manual procedure requiring medium effort can be implemented to remedy the defect. Examples of medium defects are as follows:   * Form navigation is incorrect * Field labels are not consistent with global terminology |
| Low | The defect is cosmetic or has little to no impact on system functionality. A manual procedure requiring low effort can be implemented to remedy the defect. Examples of low defects are as follows:   * Repositioning of fields on screens * Text font on reports is incorrect |

# Test Cases

This section outlines the approach to test case development and execution to ensure ClearPath system functionalities and performance meet defined requirements.

* **Guidance for Management and Technical Effort:**
  + Define clear responsibilities for executing and documenting tests.
  + Align testing timelines with project milestones for efficient progress tracking.
* **Test Methods and Outcomes:**
  + Each test will specify inputs, procedures, and expected results, derived from the system requirements and use cases.
  + Anticipated outcomes will confirm functionality, performance, and user experience meet specifications.
* **Nature and Extent of Each Test:**
  + Tests will cover system functions (e.g., live traffic integration, incursion detection), workflows, and performance under various conditions.
  + Usability and interface testing will ensure user accessibility and navigation.
* **Evaluation of Function and Performance:**
  + Functional tests validate that components behave as specified (e.g., data accuracy, alert triggers).
  + Performance tests assess system reliability under load, including real-time updates and incursion scenarios.
* **Documentation:**
  + Each test case will include:
    - Test inputs and preconditions.
    - Step-by-step procedures.
    - Expected outcomes.
    - Results (Pass/Fail) with remarks.

## Test Case <N>

***Objective:***

***Notes:***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 001* | | | | *Current Status: Pending* | | |
| *Test title:* | | | | | | |
| *Testing approach:* | | | | | | |
| *STEP*  *N* | *OPERATOR ACTION*  *Describe the actions taken by the person executing the test procedure. Include the test suite, or the name of the test file (in this case, the contents of the file could be given in the appendix).* | *PURPOSE*  *Describe the reason for the step.* | | | *EXEPCTED RESULTS*  *Describe the expected response of the system being tested to the action specified under OPERATOR ACTION. This should be derived from the SRS and SDD.* | *COMMENTS* |
| *Concluding Remarks:* | | | | | | |
| *Testing Team:* | | | *Date Completed:* | | | |

1. Unwritten, Incomplete, Pass, Fail [↑](#footnote-ref-2)