**ClearPath**

**System Test Plan**

**Version <2.4>**

**4/1/2025**

# 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:

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## 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 |
| 2.0 | 4/1/2025 | Sadeed | Changing test plan to reflect changes to project |
| 2.1 | 4/1/2025 | Newbury, Michael | Change Context Diagram, Edit Test Cases |
| 2.2 | 4/3/2025 | Michael | Editing test cases and fixing traceability matrix |
| 2.3 | 4/8/2025 | Isaac Hewitt | Testing fuctionality and Test Plan updates. |
| 2.4 | 4/10/2025 | Sadeed, Michael | Fixing comments from TA |

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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 along with live weather, and ATC. The document will also provide guidelines for managing any potential issues during the testing phase and the criteria for success.

## 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 implement live weather based on NOAA METAR data with live weather affects in the simulated environment. Finally, we will integrate ATC within the simulator.

## System Overview

ClearPath is centered around three 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 implementation of live weather in the simulator. The weather would show in the pre-flight phase with effects listed at certain altitudes. These effects would then be displayed in the simulator through real effects like wind, cloud coverage and precipitation.

The third and final part of the system focuses on implementing an ATC within the simulator. The ATC allows the pilot to fly a preplanned route providing transmissions with clearance, ground, traffic, etc. Transmissions should auto populate in the Simple ATC text chat box and have audio transmissions audible to the pilot in the simulated environment.

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

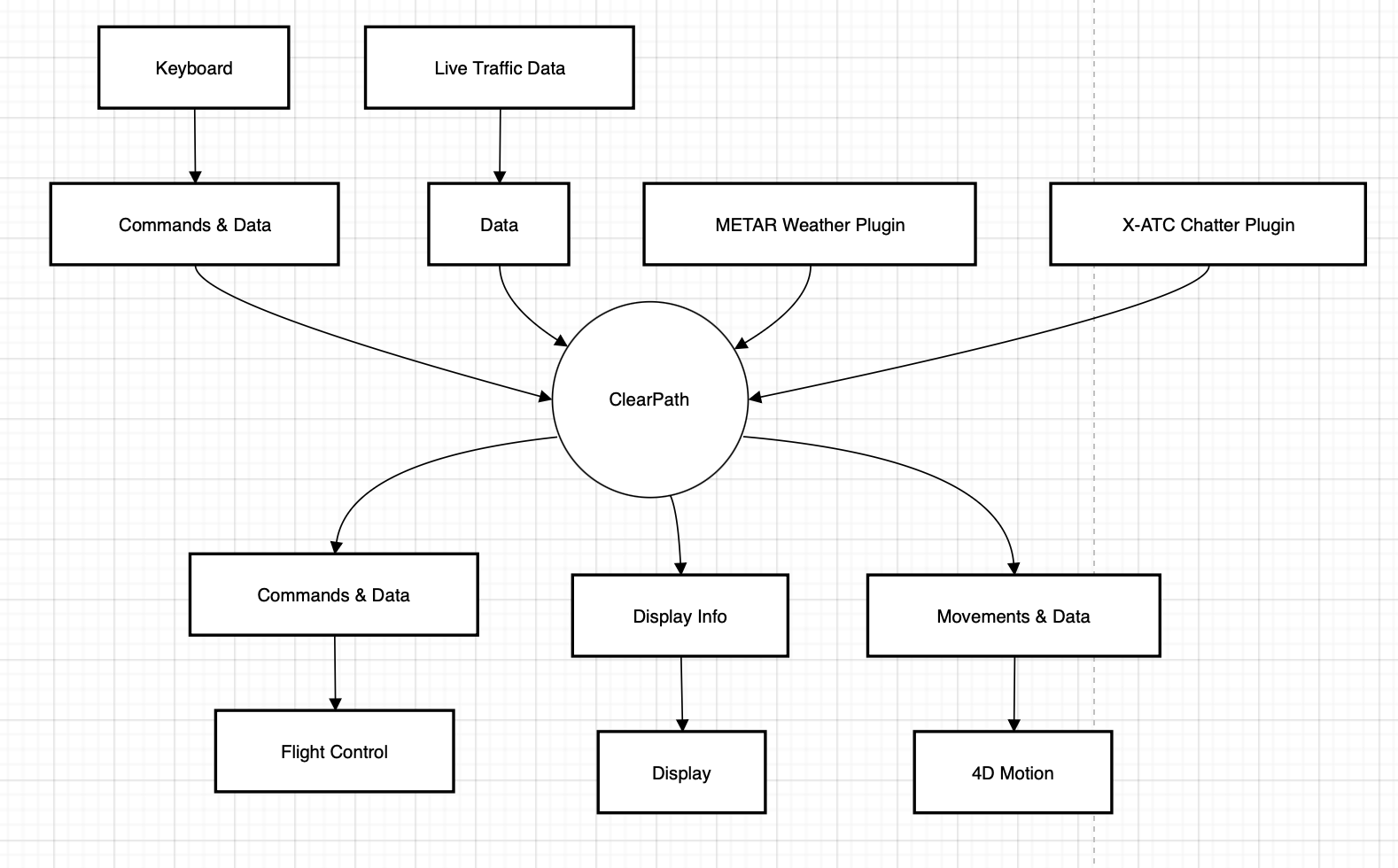


Figure 1 ClearPath Context Diagram

## 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 location based weather accuracy.
* **Usability Testing:** Confirm the interface is intuitive and accessible.
* **Performance Testing:** Assess system responsiveness under normal and peak conditions.

We decided to remove the security testing as we do not have specific secure control over the simulator and environment. Anyone with access to the simulator will have access to ClearPath.

## 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

## 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 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.

METAR Access and integration via NOAA METAR postings. ATC AI integration is based on proper FAA verbiage.

* **Approach:** We validated individual plug-ins by themselves to test if they worked. For live traffic we verified the closest aircraft with open-source data through Flight Radar 24. A industry known mobile app showing aircraft in your area and basic information about them like callsigns and tail numbers. We verified the live weather portion with available METAR information at airports around the world. We chose airports with wind low enough to feel affects when landing, different precipitation, and times of day. Finally, we used publicly available information published by the Aircraft Owners and Pilots Association (AOPA). To verify traffic clearance verbiages and used openly sourced information on when certain calls would be made in different stages of flight.
* **Results:** Our result reflected all expected results. All live traffic matched 50 nearest flights. All weather effects were close to the newest produced METAR information. The live weather is slightly behind than real life, in our testing, depending on the airport, we have the METAR matching or used right before the new one was

**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. Integration with live weather with the XPlane simulator. Integration of ATC with the XPlane simulator.

* **Approach:** We wanted to make sure that all of the plug-ins worked together with one another. We checked to make sure that each plug in would work individually as well as all together.
* **Results:** Our results worked as we intended. All functions worked with one another. It is worth noting that the AI ATC does not take into account live traffic when providing clearances and callouts.

**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.

Real-time visualization of weather in the preflight and simulated views.

Real-time visualization of ATC communications in the Simple ATC chat box and audio queues.

* **Approach:** We want to go through and make sure real-time visualization was present for both 2D and 3D models.
* **Results:** All visualizations and systems functioned as expected. Aircraft injected from OpenSky appeared and moved accurately. METAR-based weather rendered properly, including changing visibility and cloud layers at different altitudes. ATC messages followed logical sequence and appeared in sync with flight operations. No plugin crashes or UI issues were observed during testing.

**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.

Handling real time and up to date METAR data and reflecting it in the simulated environment

Handling real time ATC communications in different stages of flight reflecting the simulated aircraft.

* **Approach:** We spawned the simulator in high-traffic areas, enabled all features, and observed system responsiveness during extended sessions.
* **Results:** System handled full load with no noticeable lag or crashes. Frame rates stayed stable and all features worked without conflict.

**Usability Testing**

* **Objective:** Ensure the user interface is intuitive and accessible for all users
* **Focus Areas:**

Navigation, visual appeal, and error handling

* **Approach:** We interacted with each part of the ClearPath UI, including weather toggles, traffic visibility, and ATC features.
* **Results:** The UI was easy to navigate and visually clear. All controls functioned properly and no major usability issues were reported.

**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.

Handling changing airplane vectors for ATC.

Handling changing weather conditions via METAR Data.

* **Approach:** We disconnected the network during simulation and restarted plugins during flight.
* **Results:** System remained stable. It defaulted to last known conditions and resumed updating once the connection was restored. No crashes occurred.

## 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, live weather systems, ATC communication, 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 live weather information
* Test functionality of ATC communications.
* Confirm resolution of issues and changes as documented during the project.

**Goal:** 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 may resume only after the root cause of suspension has been identified, corrected, and fuctionality affected by the root cause has passed re-evaluation.

## 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: Live weather, ATC Chatter, Live Traffic
* **Network:** Stable WiFi or Ethernet connection for live traffic data, and live weather information.

## 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.
* Test data from ATC is accurate and reliable
* Test data from NOAA METAR information is accurate and reliable.

## Testing Risks and Contingencies

* **Risk:** Network interruptions affecting live traffic and weather data integration.
  + **Contingency:** Wait for network to stabalize to allow for real data integration.
* **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.
* Risk: Incomplete or inaccurate test data from NOAA METAR information.
  + Contingency: Validate data integrity before testing and document anomalies for further analysis.

## Test Plan

**Table 1: Test Plan**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ID** | **Test Title** | **Status** | **Date** | **Notes** |
| 001 | Real-Time Traffic Data Integration | Active | 4/1/2025 | Test live data integration from OpenSky API into XPlane 2D and 3D views |
| 002 | METAR Weather Injection | Active | 4/3/2025 | Test real-time METAR data retrieval and injection into XPlane |
| 003 | Weather Effects Rendering | Active | 4/3/2025 | Validate cloud coverage, wind layers, and precipitation are displayed |
| 004 | ATC Communication - Audio & Text | Active | 4/8/2025 | Confirm ATC messages appear in Simple ATC chat and play over audio |
| 005 | ATC Context Awareness | Active | 4/8/2025 | Validate phase-based and region-appropriate ATC messages |
| 006 | UI Navigation and Usability | Active | 4/8/2025 | Test user interface flow, accessibility, and layout consistency |
| 007 | System Performance Under Load | Active | 4/1/2025 | Simulate 50+ aircraft, full weather data, and ATC to test stability |
| 008 | Weather Fallback and Recovery | Pending | 4/10/2025 | Disconnect METAR feed and test weather system response and recovery |
| 009 | ATC Chatter Fallback and Recovery | Pending | 4/10/2025 | Disconnect ATC plugin and validate safe system behavior and alert |
| 010 | Visual Weather Preview Accuracy | Pending | 4/3/2025 | Compare preflight weather preview with actual in-sim rendering |

# Test Schedule

|  |  |  |
| --- | --- | --- |
| **Week** | **Dates** | **Planned Activities** |
| **Week 1** | Apr 1 – Apr 4 | Set up test environment and simulator- Begin testing core features:   * Live Traffic Data Integration (TC-001) * METAR Weather Injection (TC-002) * Weather Effects Rendering (TC-003) |
| **Week 2** | Apr 7 – Apr 11 | Continue functionality testing:   * ATC Communication (TC-004) * ATC Context Awareness (TC-005) * UI Usability (TC-006) * Performance Under Load (TC-007) * Buffer day for re-tests |
| **Week 3** | Apr 14 – Apr 18 | Edge case and failure scenario testing:   * Weather Fallback & Recovery (TC-008) * ATC Chatter Fallback (TC-009) * Visual Weather Preview Accuracy (TC-010) * Exploratory testing and catch-up |
| **Week 4** | Apr 21 – Apr 24 | * Documentation Finalization * Internal Review & Fixes * Regression Testing |

# Traceability Matrix and Defect Tracking

## Traceability Matrix

**Table 2: Traceability Matrix**

|  |  |  |  |
| --- | --- | --- | --- |
| **Requirement ID** | **Requirement Description** | **Test Case ID** | **Verification Method** |
| REQ-01 | The system shall integrate real-time live traffic data from the OpenSky Network | TC-001 | System Test |
| REQ-02 | The system shall display real-time aircraft on the 2D and 3D simulator interfaces | TC-001 | Visual Confirmation |
| REQ-03 | The system shall integrate live METAR weather data from NOAA | TC-002 | System + Unit Test |
| REQ-04 | The system shall apply METAR data to simulate in-sim weather effects | TC-002 | Environmental Testing |
| REQ-05 | The system shall simulate wind, cloud coverage, and precipitation based on METAR | TC-002 | Functional Test |
| REQ-06 | The system shall integrate ATC audio and text communications | TC-003 | Integration Test |
| REQ-07 | The ATC system shall play appropriate audio based on flight phase and aircraft location | TC-003 | Functional + Scenario Test |
| REQ-07.1 | The system shall allow user interaction with ATC via Simple ATC chat box | TC-003 | Usability Test |
| REQ-07.2 | Allow user interaction with ATC via Simple ATC chat box | TC-004 | Usability Test |
| REQ-07.3 | UI must be intuitive and responsive | TC-006 | Usability Evaluation |
| REQ-08 | The power switch shall be an easily accessible toggle switch. | TC-007 | Functional Test |
| REQ-09 | The motion control system shall use standard connectors (RJ45 for network, USB for peripheral connections). | TC-008 | Functional Test |
| REQ-10 | The system shall interface with the OpenSky Network API to receive real-time flight data. | TC-001 | Functional Test |
| REQ-11 | The system shall ensure that data is inputted through the OpenSky Network API and integrated into the X-Plane 11 environment. | TC-001 | System Test |
| REQ-12 | The system shall use TCP/IP protocol for communication between the OpenSky Network API and the simulation environment. | TC-001 | Failure Recovery Test |
| REQ-13 | The system shall implement a secure connection (HTTPS). | TC-001 | Security Test |
| REQ-14 | The ClearPath System shall provide one User class. | TC-006 | Functional Test |
| REQ-15 | All users should have access to the program fully, no user should be restricted. | TC-006 | Usability Test |
| REQ-16 | The system shall model real-world objects (Aircraft, Taxiways, ATC). | TC-001 | Visual Confirmation |
| REQ-17 | Each aircraft object shall have attributes updated from real-time data. | TC-001 | Functional Test |
| REQ-18 | Incursion detection shall identify proximity breaches. | TC-001 | Functional Test |
| REQ-19 | Aircraft objects updated in real time from OpenSky. | TC-001 | Functional Test |
| REQ-21 | Notify user on data feed loss and retry every 30s. | TC-008 | Failure Recovery Test |
| REQ-24 | Connect to OpenSky and ADSB-Fi APIs for real-time data. | TC-001 | Functional Test |
| REQ-25 | Update aircraft positions and headings to match real-time. | TC-001 | Functional Test |
| REQ-26 | Display aircraft in 3D with accurate altitude/speed/heading. | TC-001 | Functional Test |
| REQ-27 | Render aircraft changes in real time. | TC-001 | Functional Test |
| REQ-30 | Validate traffic data before updating sim. | TC-010 | Functional & Visual Comparison Testing |
| REQ-31 | Revert to last valid state if anomalies found. | TC-008 | Failure & Recovery Testing |
| REQ-32 | Process and render position updates. | TC-001 | Functional Test |
| REQ-33 | Interpolate position data for smooth movement. | TC-001 | Functional Test |
| REQ-36 | Handle overflow errors by queuing data. | TC-009 | Failure & Recovery Testing |
| REQ-37 | Notify user and show last known positions on connection loss. | TC-008 | Failure & Recovery Testing |
| REQ-39 | Attempt reconnect every 30s and notify user. | TC-008 | Failure & Recovery Testing |
| REQ-40 | Display default aircraft/runway positions from config. | TC-001 | Functional Test |
| REQ-42 | Support single user interacting with controls. | TC-006 | Usability Test |
| REQ-43 | Real-time updates every 1 second. | TC-001 | Functional Test |
| REQ-44 | Handle up to 50 aircraft with <2s delay. | TC-007 | Performance Testing |
| REQ-48 | Revert to safe state after crash/data loss. | TC-008 | Failure & Recovery Testing |
| REQ-49 | 100% availability when XPlane starts. | TC-010 | Stress & Performance Testing |
| REQ-51 | Log access to controls with timestamps and roles. | TC-007 | Functional Test |
| REQ-53 | Modular software design. | TC-007 | Design Review |
| REQ-54 | Documentation for all modules. | TC-007 | Documentation Review |
| REQ-55 | Cross-platform language implementation. | TC-007 | Compatibility Test |
| REQ-57 | No extra hardware required; works with current setup. | TC-006 | Usability Test |
| REQ-58 | Compliance with OpenSky API standards. | TC-001 | Compliance Test |
| REQ-60 | Store live event data in database with defined fields. | TC-006 | Database Test |
| REQ-65 | Support Interactive Mode simulation. | TC-006 | Functional Test |
| REQ-65.1 | Require user in simulator chair. | TC-006 | Usability Test |
| REQ-65.2 | Require seatbelt and door closed. | TC-006 | Usability Test |
| REQ-65.3 | Require motion controls enabled. | TC-006 | Usability Test |
| REQ-65.4 | Require XPlane 11 to be started. | TC-006 | System Test |
| REQ-65.5 | Begin motion when sim is running. | TC-006 | Functional Test |
| REQ-68 | Restore last database state after shutdown. | TC-008 | Functional Test |

## Defect Severity Definitions

|  |  |
| --- | --- |
| Critical | The defect causes a severe failure, halting core functionality or rendering the simulator unusable. Immediate resolution is required.   * System crash or freeze during simulation * Live data (traffic, METAR, or ATC) fails to load or apply * Weather or ATC systems fail to initialize * Audio fails completely during ATC communication |
| Medium | The defect affects specific features but does not stop the simulator from running. A workaround may be possible.   * METAR data loads but weather effects do not fully apply * ATC text populates, but audio is delayed or out of sync * Inconsistent aircraft visibility between 2D and 3D views * Display formatting issues affecting readability |
| Low | Cosmetic or minor issues that do not impact functionality. Fixes can be deferred.   * UI spacing or alignment errors * Minor delays in weather transitions * Incorrect font, colors, or labels in debug mode * Minor clipping or non-blocking visual glitches |

# 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, Live weather detection, accurate ATC call/response), 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, such as the real-time updates for traffic and METAR.
* **Documentation:**
  + Each test case will include:
    - Test inputs and preconditions.
    - Step-by-step procedures.
    - Expected outcomes.
    - Results (Pass/Fail) with remarks.

## Test Case 1

***Objective:*** *Validate that real-time aircraft data from the OpenSky Network is successfully integrated into the XPlane simulator and visible in both 2D and 3D views.*

***Notes:*** *Ensure OpenSky API is connected, and aircraft are spawning in real-time.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 001* | | | | *Current Status: Completed* | | |
| *Test title: Real-Time Traffic Data Integration* | | | | | | |
| *Testing approach: Functional & Integration Testing* | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXEPCTED RESULTS** | **COMMENTS** |
| 1 | Launch XPlane and ensure the ClearPath plugin is running | Ensure project simulator starts and runs | | | XPlane launches, loads plugin, and can load into the map. | *No problems completing* |
| 2 | Enable live traffic via OpenSky plugin | Ensure toggling of plugin | | | Live traffic via OpenSky can be toggled on and off | *No problems completing* |
| 3 | Open 2D map view in XPlane | Find nearby planes and avoid live traffic | | | Map opens, is able to inspect other planes, and move the users plane. | *No problems completing* |
| 4 | View external 3D camera angles | View real time flights of live aircraft | | | Real time flights spawn in as visible 3d live objects. | *No problems completing* |
| 5 | Compare OpenSky web tracker with simulator | Ensure data is up to date | | | OpenSky matches simulator within 5 minutes | *No problems completing* |
| *Concluding Remarks: Worked as expected* | | | | | | |
| *Testing Team: SK, MY, CN, IH* | | | *Date Completed: 04/10/2025* | | | |

## Test Case 2

***Objective:*** *Verify that METAR data is retrieved from NOAA and properly injected into XPlane.*

***Notes:*** *Use a known METAR station with current weather.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 002* | | | | *Current Status: Completed* | | |
| *Test title: METAR Weather Injection* | | | | | | |
| *Testing approach: Unit & System Testing* | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXPECTED RESULTS** | **COMMENTS** |
| 1 | Launch XPlane and access ClearPath weather interface | Set up environment | | | Weather UI is accessible | *No problems completing* |
| 2 | Enable METAR live weather mode | Begin pulling real-time METAR | | | Weather data loads from NOAA | *No problems completing* |
| 3 | Select a specific ICAO airport | Test localized weather accuracy | | | METAR report is parsed and displayed | *No problems completing* |
| 4 | Cross-check with METAR website | Validate external source | | | METAR string matches simulator conditions | *No problems completing* |
| 5 | Log output for METAR feed | Confirm proper parsing | | | JSON or text output matches METAR structure | *No problems completing* |
| *Concluding Remarks: Pass if weather data from NOAA is pulled and visible in ClearPath/XPlane.* | | | | | | |
| *Testing Team: SK, MY, IH, CN* | | | *Date Completed: 04/10/25* | | | |

## Test Case 3

***Objective:*** *Confirm that wind, clouds, and precipitation effects from METAR data are rendered accurately in XPlane.*

***Notes:*** *Use METAR with changing conditions (e.g., rain, broken clouds).*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 003* | | | | *Current Status: Completed* | | |
| *Test title: Weather Effects Rendering* | | | | | | |
| *Testing approach: Functional Testing* | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXPECTED RESULTS** | **COMMENTS** |
| 1 | Load airport with active METAR conditions | Initiate visual test | | | Sim loads correct location | *No problems completing* |
| 2 | Observe sky and environment | View rendered weather | | | Cloud coverage and wind reflect METAR | *No problems completing* |
| 3 | Fly aircraft to multiple altitudes | Check altitude-based weather effects | | | Wind direction/speed and clouds change correctly | *No problems completing* |
| 4 | Log precipitation if any | Check visual rain/snow | | | Particle effects and sound appear | *No problems completing* |
| 5 | Confirm temperature/visibility effects | Test realism | | | Fog and low visibility match METAR | *No problems completing* |
| *Concluding Remarks: Pass if visible and physical effects reflect the METAR data.* | | | | | | |
| *Testing Team: SK, CN* | | | *Date Completed: 04/10/25* | | | |

## Test Case 4

***Objective:*** *Verify that ATC text and audio communications are integrated into the simulator via the ATC Chatter plugin.*

***Notes:*** *Ensure X-ATC Chatter plugin is installed and configured.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 004* | | | | *Current Status: Completed* | | |
| *Test title: ATC Communication – Audio & Text* | | | | | | |
| *Testing approach: Integration & Usability Testing* | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXPECTED RESULTS** | **COMMENTS** |
| 1 | Enable X-ATC Chatter plugin | Begin ATC module | | | Audio/text plugin loads correctly | *No problems completing* |
| 2 | Begin taxi and departure sequence | Trigger ground/clearance chatter | | | ATC messages appear contextually | *No problems completing* |
| 3 | Observe Simple ATC chat window | Verify text logs | | | Text matches audio output | *No problems completing* |
| 4 | Fly through departure, cruise, and approach | Check full-flight support | | | Audio updates across all phases | *No problems completing* |
| 5 | Listen for frequency changes | Verify transitions | | | Messages change with location/phase | *No problems completing* |
| *Concluding Remarks: Pass if audio and text ATC data plays consistently during flight.* | | | | | | |
| *Testing Team: CN, SK, MY* | | | *Date Completed: 04/10/25* | | | |

## Test Case 5

***Objective:*** *Test the system’s ability to deliver context-aware ATC chatter based on aircraft location and flight phase.*

***Notes:*** *Fly a route with takeoff, cruise, and approach segments.*

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| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 005* | | | | *Current Status: Active* | | |
| *Test title: ATC Context Awareness* | | | | | | |
| *Testing approach:* Scenario-Based Testing | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXPECTED RESULTS** | **COMMENTS** |
| 1 | Select a cross-country VFR flight plan | Create full-flight scenario | | | Plan defines ground to landing phase | *No problems completing* |
| 2 | Start at ramp and contact ATC | Begin simulation | | | Ground/tower messages play | *No problems completing* |
| 3 | Depart and climb | Confirm enroute handoff | | | ATC switches to center/approach | *No problems completing* |
| 4 | Begin descent and approach | Test descent phase ATC | | | Instructions for approach play | *No problems completing* |
| 5 | Land and taxi to gate | End scenario | | | Ground/taxi chatter resumes | *No problems completing* |
| *Concluding Remarks: Pass if ATC chatter accurately matches location and flight phase.* | | | | | | |
| *Testing Team: CN, SK, MY* | | | *Date Completed: 04/10/25* | | | |

## Test Case 6

***Objective:*** *Evaluate the user interface for ease of use, clarity, and accessibility during simulator operation.*

***Notes:*** *Focus on ClearPath plugin controls and any in-sim overlays or menus.*

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| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 006* | | | | *Current Status: Active* | | |
| *Test title: UI Navigation and Usability* | | | | | | |
| *Testing approach: Usability Testing* | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXEPCTED RESULTS** | **COMMENTS** |
| 1 | Launch simulator and access ClearPath UI | Assess load and layout | | | Interface loads cleanly with readable elements | *PASS* |
| 2 | Navigate through weather, ATC, and traffic modules | Evaluate menu structure | | | Buttons are logically grouped and labeled | *PASS* |
| 3 | Trigger in-sim messages or warnings | Check visibility and formatting | | | Alerts are clear, color-coded, and non-intrusive | *PASS* |
| 4 | Attempt basic user actions (toggle traffic, adjust weather source, mute ATC) | Test responsiveness | | | System updates promptly and reflects changes | *PASS* |
| 5 | Log any issues with accessibility or readability | Gather usability feedback | | | No obstructive UI elements or misaligned text | *PASS* |
| *Concluding Remarks: Pass if users can intuitively navigate and operate all ClearPath UI elements.* | | | | | | |
| *Testing Team: SK, MY, IH, CN* | | | *Date Completed: 04/10/25* | | | |

## Test Case 7

***Objective:*** *Assess system performance under full-load conditions, simulating a high number of aircraft and active weather/ATC modules.*

***Notes:*** *Use a known high-traffic area and force 50+ aircraft.*

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| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 007* | | | | *Current Status: Active* | | |
| *Test title: System Performance Under Load* | | | | | | |
| *Testing approach: Stress & Performance Testing* | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXEPCTED RESULTS** | **COMMENTS** |
| 1 | Load airport with heavy traffic (e.g., KATL, KLAX) | Simulate high load | | | 50+ aircraft populate in-sim | *PASS* |
| 2 | Enable real-time METAR weather | Add environmental complexity | | | Weather updates live without stalling | *PASS* |
| 3 | Enable ATC Chatter plugin | Layer in audio/text load | | | Audio/text transmission plays smoothly | *PASS* |
| 4 | Monitor system FPS and latency | Evaluate performance | | | FPS remains above 25, no freezing | *PASS* |
| 5 | Run for 15–30 minutes | Check for memory or CPU spikes | | | No significant degradation or instability | *PASS* |
| *Concluding Remarks: Pass if simulator remains stable and functional under peak load.* | | | | | | |
| *Testing Team: SK, MY, IH, CN* | | | *Date Completed: 04/10/25* | | | |

## Test Case 8

***Objective:*** *Test the system’s behavior when the METAR feed is interrupted or unavailable.*

***Notes:*** *Disconnect WiFi or disable NOAA temporarily.*

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| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 008* | | | | *Current Status: Pending* | | |
| *Test title: Weather Fallback and Recovery* | | | | | | |
| *Testing approach:  Failure & Recovery Testing* | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXEPCTED RESULTS** | **COMMENTS** |
| 1 | Begin with METAR feed active | Establish baseline | | | Weather updates reflect METAR accurately | *PASS* |
| 2 | Disconnect internet or NOAA source | Simulate failure | | | System recognizes loss of feed | *PASS* |
| 3 | Observe weather rendering in sim | Assess fallback logic | | | Simulator retains last known conditions | *PASS* |
| 4 | Reconnect to METAR source | Test recovery | | | New weather data updates resume automatically | *PASS* |
| 5 | Log any system or UI errors | Check error handling | | | Errors logged and presented clearly | *PASS* |
| *Concluding Remarks: Pass if system gracefully handles disconnection and resumes weather injection.* | | | | | | |
| *Testing Team: SK, MY, IH, CN* | | | *Date Completed: 04/10/25* | | | |

## Test Case 9

***Objective:*** *Validate how the system handles failure or interruption of the ATC Chatter plugin.*

***Notes:*** *Force disable or kill plugin process mid-simulation.*

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| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 009* | | | | *Current Status: Active* | | |
| *Test title: ATC Chatter Fallback and Recovery* | | | | | | |
| *Testing approach: Failure & Recovery Testing* | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXEPCTED RESULTS** | **COMMENTS** |
| 1 | Begin flight with ATC chatter enabled | Establish baseline | | | Audio and text function normally | *PASS* |
| 2 | Kill plugin or disable ATC manually | Simulate failure | | | Audio/text stops without crashing sim | *PASS* |
| 3 | Observe system behavior | Ensure stability | | | Simulator remains operational | *PASS* |
| 4 | Re-enable ATC plugin | Check recovery behavior | | | ATC resumes without restart | *PASS* |
| 5 | Log UI or error messages | Ensure visibility | | | User is notified of ATC interruption | *PASS* |
| *Concluding Remarks: Pass if simulator continues running and ATC chatter resumes properly after recovery.* | | | | | | |
| *Testing Team: SK, MY, IH, CN* | | | *Date Completed: 04/10/25* | | | |

## Test Case 10

***Objective:*** *Ensure the pre-flight weather preview shown in the ClearPath UI accurately reflects the actual rendered in-sim weather.*

***Notes:*** *Use METAR data with distinctive weather patterns.*

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| --- | --- | --- | --- | --- | --- | --- |
| *Test No.: 010* | | | | *Current Status: Active* | | |
| *Test title: Visual Weather Preview Accuracy* | | | | | | |
| *Testing approach: Functional & Visual Comparison Testing* | | | | | | |
| **STEP** | **OPERATOR ACTION** | **PURPOSE** | | | **EXEPCTED RESULTS** | **COMMENTS** |
| 1 | Open ClearPath pre-flight weather UI | Review forecast/preview | | | Weather conditions (wind, clouds, temp) displayed | *PASS* |
| 2 | Start the simulation at selected airport | Verify in-sim conditions | | | In-sim weather matches preflight preview | *PASS* |
| 3 | Cross-check with live METAR report | Ensure data alignment | | | Preview aligns with NOAA report | *PASS* |
| 4 | Change METAR source (if supported) | Test multi-source behavior | | | New preview reflects updated input | *PASS* |
| 5 | Log any mismatches or sync delays | Track display accuracy | | | System updates within acceptable latency | *PASS* |
| *Concluding Remarks: Pass if in-sim weather is consistent with what is shown in the preview and source METAR.* | | | | | | |
| *Testing Team: SK, MY, IH, CN* | | | *Date Completed: 04/10/25* | | | |