



# Concrete Architecture

Group 1



## Scenery and Environment

- Scenery and environment is responsible for the simulated world
- Multiple methods for how the data for the world can be obtained
  - Either locally downloaded or TerraSync
- TerraSync is preferred due to manual download required lots of space



# Original Conceptual Architecture

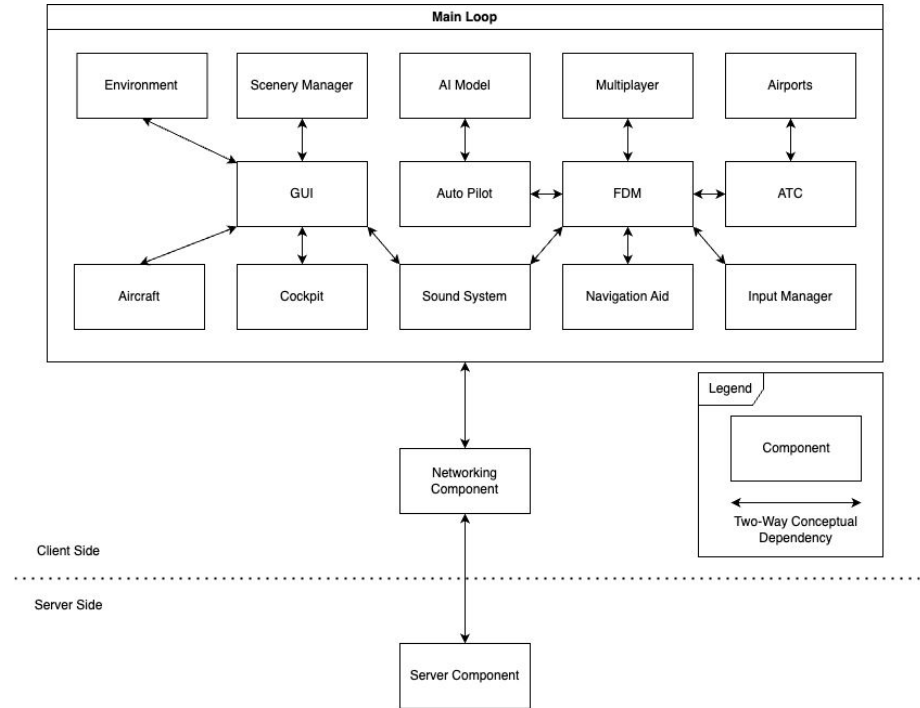
- Original architecture was characterized by an implicit invocation style
- Characterized by 6 main components including runtime infrastructure, I/O Systems, GUI, Simulation Model, Multiplayer System, and Audio/Sound System

# Revised Conceptual Architecture

- Transitioned from an Implicit-Invocation to a Client-Server architectural style to accommodate the multiplayer functionality of FlightGear
- Identified and integrated new components: Autopilot, Airports, Main Loop, Networking Component, and Server Component
- Expanded the conceptual architecture to include 16 components: Air Traffic Control (ATC), Environment, Navigation Aid, AI Model, Input Manager, Scenery Manager, Aircraft, Flight Dynamics Model (FDM), Multiplayer, Sound System, Cockpit, GUI, Auto Pilot, Airports, Networking Component, and Server Component.

# Revised Conceptual Architecture Continued

- Introduced the Main Loop module as the core of the updated architecture, encapsulating client-side components and facilitating game loop dynamics like frame updates and weather modifications
- Integrated additional elements into the Main Loop, such as Aircraft, Environment, Scenery Manager, AI Model, Cockpit, and Server components, previously not defined as standalone entities
- Added a Networking Component for enhanced client-server communication
- Established new connections within the Main Loop to replace functionalities of the removed Runtime Infrastructure component, improving integration and interaction among components

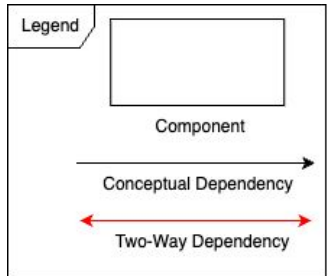
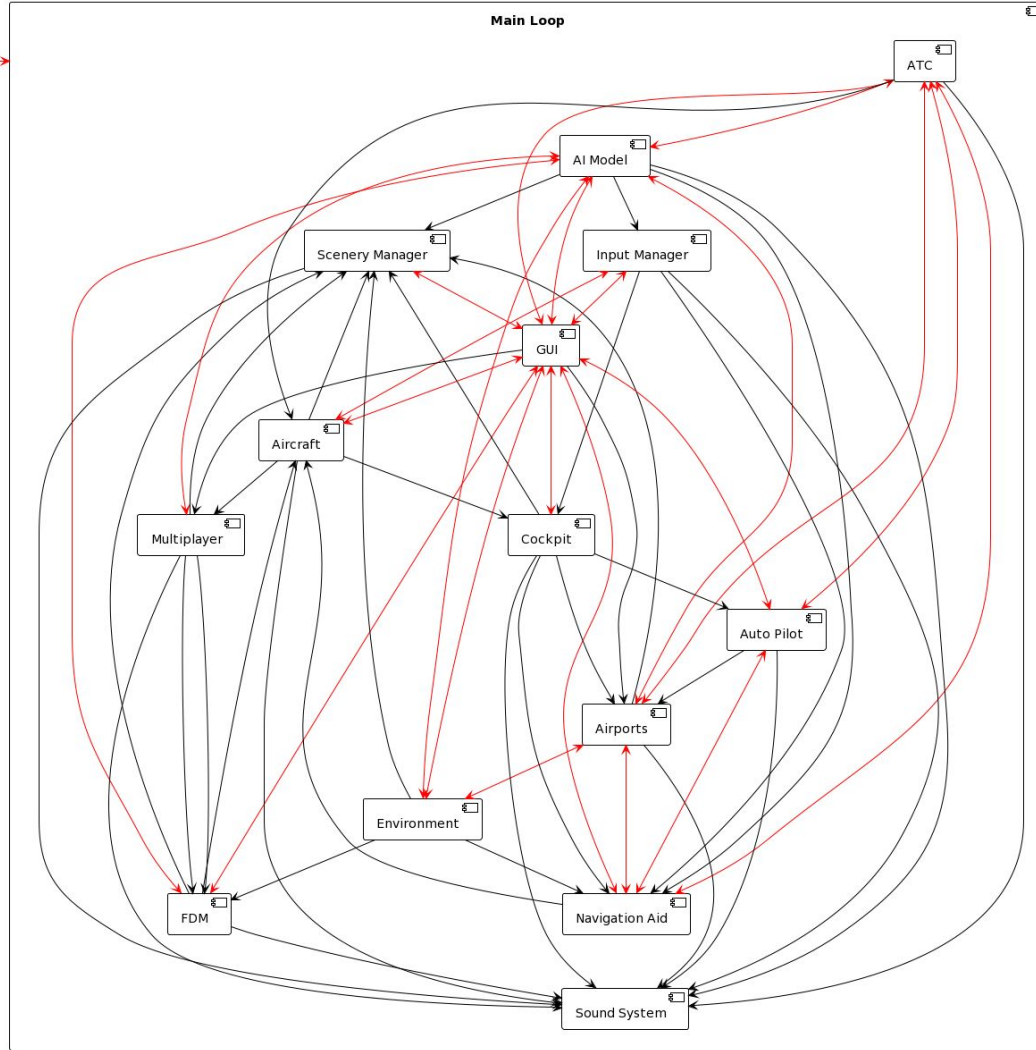
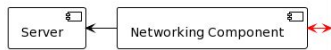




# Concrete Architecture



# Main Loop





# Reflexion Analysis





# All Divergences

*FDM (↔ AI Model , ↔ GUI , → Scenery Manager, → Aircraft)*

*Multiplayer(↔ AI Model, → Scenery Manager)*

*Scenery Manager → Sound System*

*Navigation Aid( ↔ Airports, ↔ ATC, → Aircraft)*

*Airports(↔ Environment, ↔ AI Model, ↔ ATC, → Sound System, → Scenery Manager)*

*Auto Pilot(↔ Navigation Aid, ↔ GUI, ↔ ATC, → Airports, → Sound System)*

*Cockpit(→ Airports, → Auto Pilot, → Sound System, → Navigation Aid,→ Scenery manager)*

*Input Manager(↔ GUI, ↔ Aircraft, → Navigation Aid, → Sound System, → Cockpit)*

*GUI(↔ Navigation Aid,↔ ATC,↔ AI Model,→ Airports,→ Multiplayer)*

*ATC(↔ AI Model,→ Aircraft,→ Sound System)*

*Aircraft(→ Multiplayer,→ Scenery Manager,→ Sound System,→ Cockpit)*

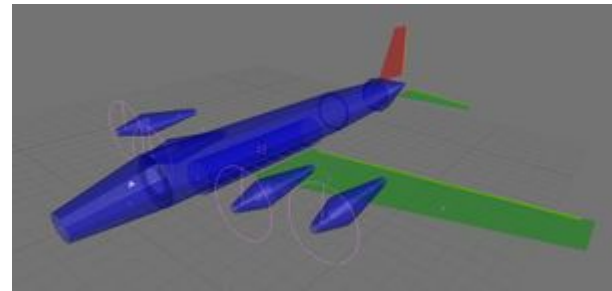
*AI Model(↔Environment,→Sound System,→Scenery Manager,→Input Manager,→ Navigation Aid)*

*Environment (→ FDM, → Scenery Manager, → Navigation Aid)*

*Multiplayer → Sound System*

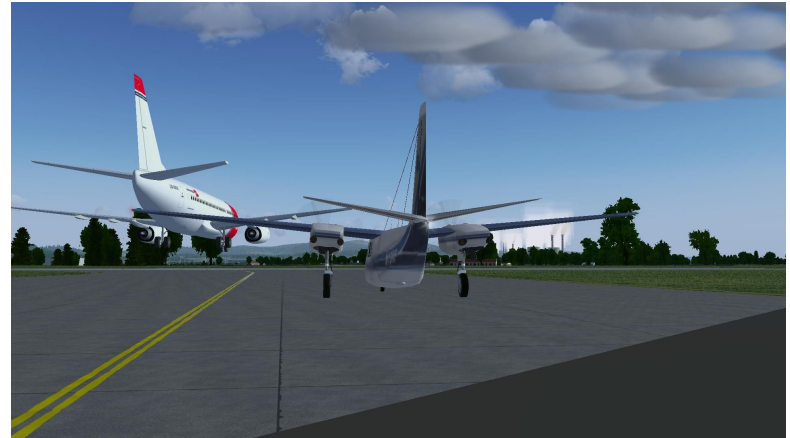
FDM ( $\leftrightarrow$  AI Model ,  $\leftrightarrow$  GUI ,  $\rightarrow$  Scenery Manager,  $\rightarrow$  Aircraft)

- AI model integration simulates aircraft behavior
- GUI displays real time flight and environmental data from FDM
- Scenery Manager enhances realism with dynamic environmental effects
- Aircraft dynamics ensures accurate performance and responsiveness



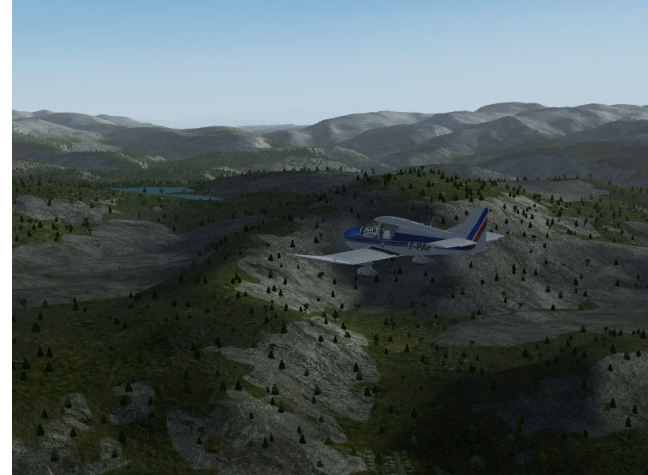
# Multiplayer( $\leftrightarrow$ AI Model, $\rightarrow$ Scenery Manager)

- AI model enriches realism by adding autonomous aircrafts
- Scenery Manager ensures sessions share consistent environment



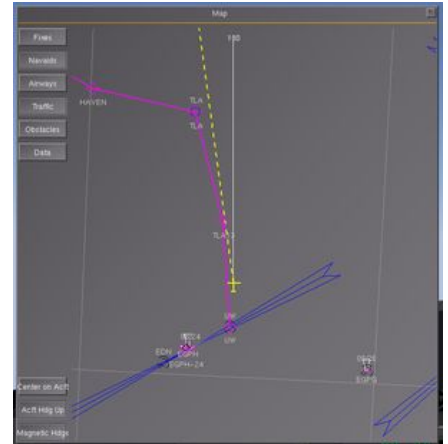
# Scenery Manager → Sound System

- Enhances simulation, linking environment to appropriate sounds
- Matches auditory experience with scenery



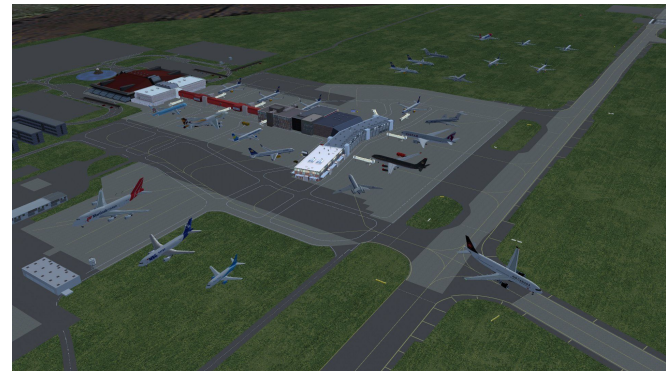
# Navigation Aid( $\leftrightarrow$ Airports, $\leftrightarrow$ ATC, $\rightarrow$ Aircraft)

- The Navigation Aids guide aircraft to Airports and assist ATC in airspace management
- ATC uses Navaids to direct aircraft
- Aircraft relies on onboard instruments to interpret Navaid signals



# Airports( $\leftrightarrow$ Environment, $\leftrightarrow$ AI Model, $\leftrightarrow$ ATC, $\rightarrow$ Sound System, $\rightarrow$ Scenery Manager)

- New Airport dependencies:
  - reflect real world conditions and geography
  - Host AI aircraft operations
  - Interact with ATC for navigational guidance
  - Contribute to soundscape with airport noises
  - Detailed through Scenery Manager for visual realism





## Second Level Subsystem: Scenery and Environment



# Scenery and Environment

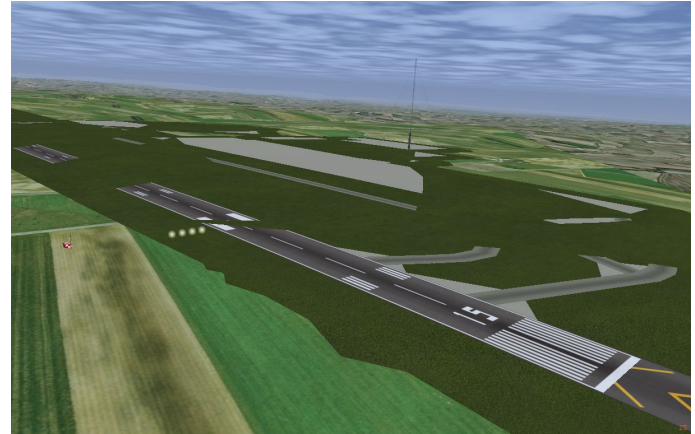
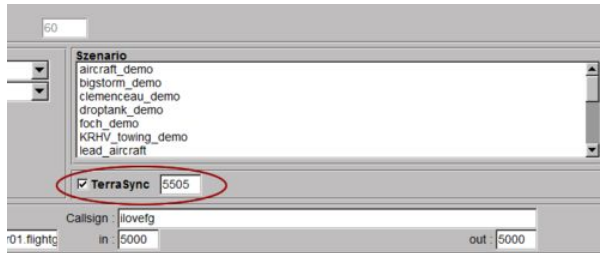
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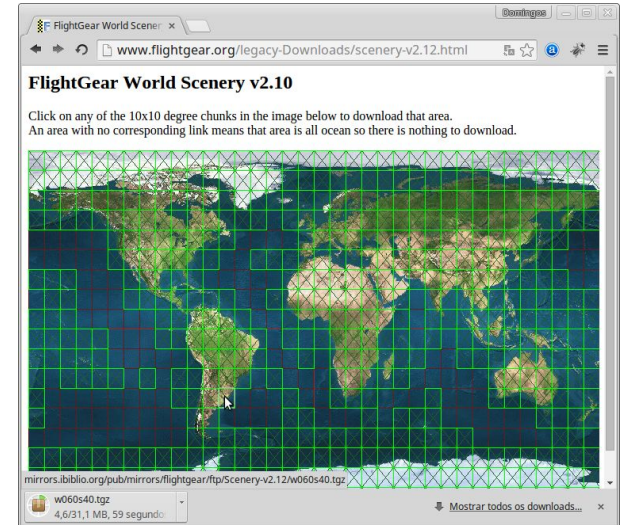
# TerraSync

- Reads your position and direction and downloads the necessary files as you fly around
- Operates in the background downloading files from an HTTP server.
- Info is then sent to TerraGear
- Client-Server architecture subsystem



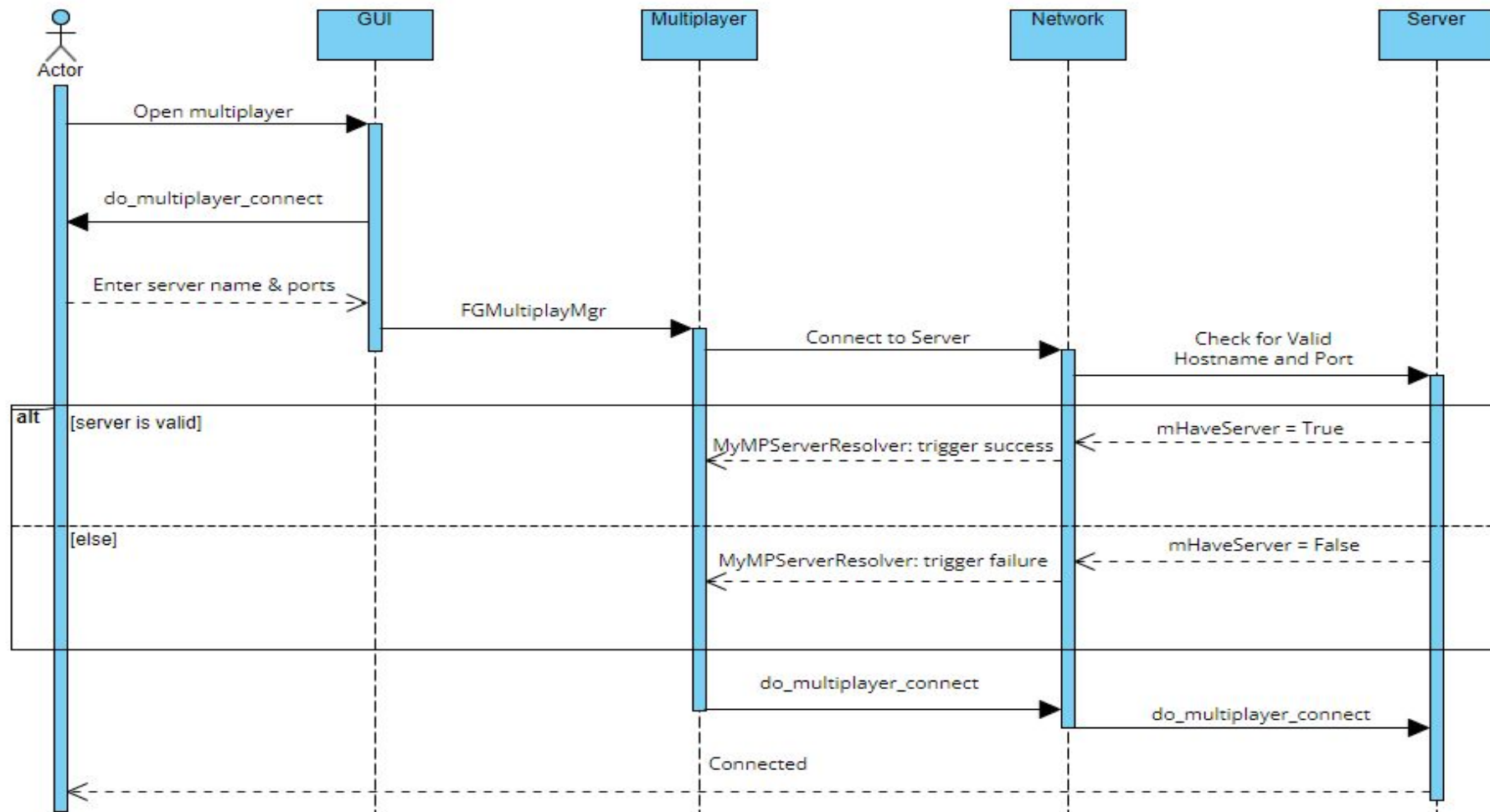
# Scenery and Environment Subsystem

- Divides world into tiles to render necessary areas
- 3D mesh base terrain that objects are rendered overtop
- Environment subsystem handles environment settings set up by environment variables
  - FG\_ROOT: Refers to the base package containing default assets
  - FG\_AIRCRAFT: Specifies additional aircraft directory paths
  - \$FG\_HOME: Indicates main location where user-specific Flightgear data is stored

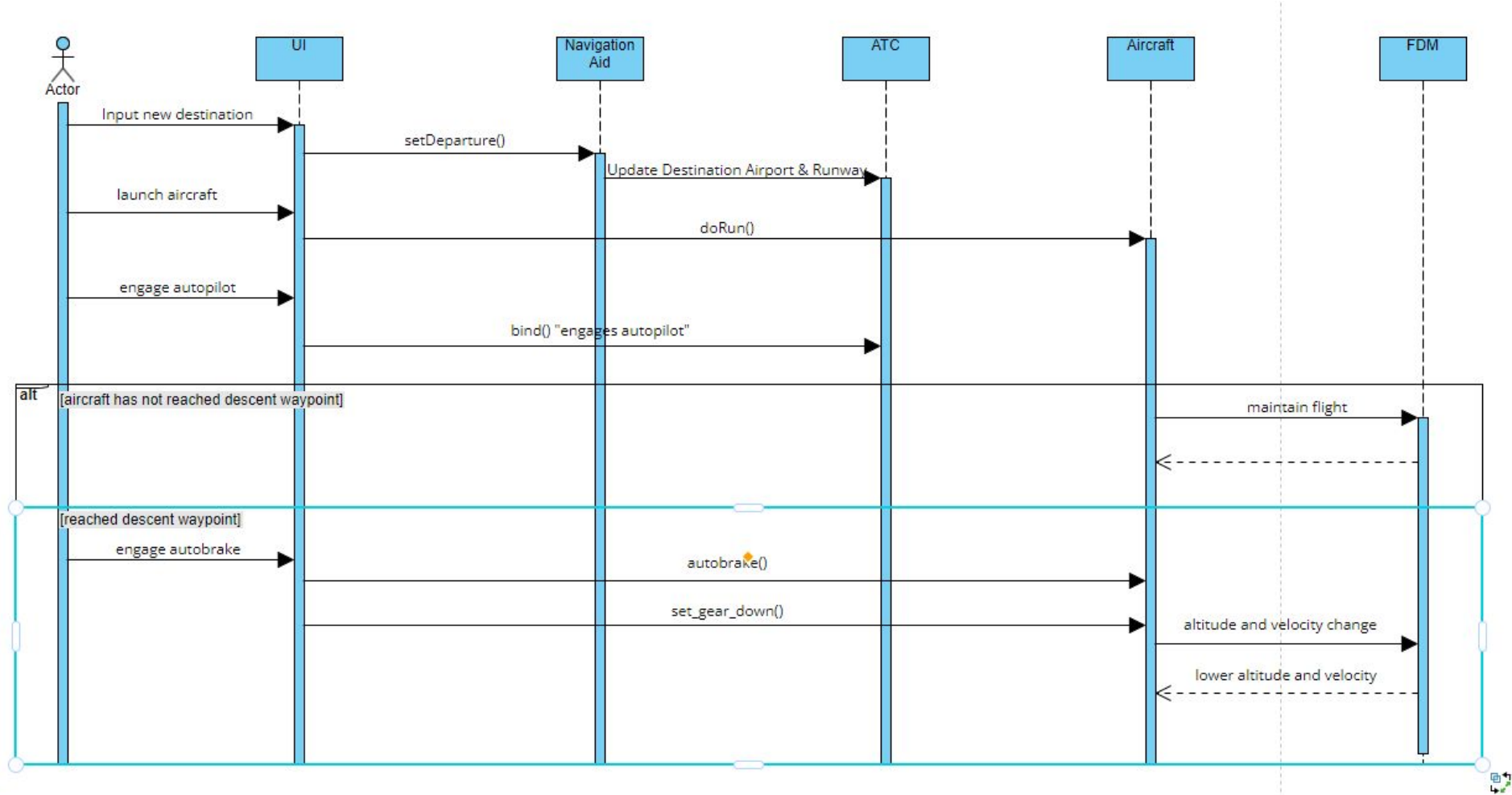


# Use Cases

# Connecting to a multiplayer server



# Auto landing an aircraft





# Conclusions and Lessons Learned



- Transitioning from an Implicit-Invocation to a Client-Server style is critical to the simulator's operational needs, particularly the multiplayer functionality
- Consider not just the individual components of an architecture, but also their relations with the entire system
- Initial conceptual frameworks undergo refinement and adaptation when confronted with practical implementation challenges
- Analytical tools aid in visualizing and understanding complex dependencies and validate architectural decisions made during the design phase
- Flightgear's architectural analysis offers valuable insights into the principles of architectural design and analysis