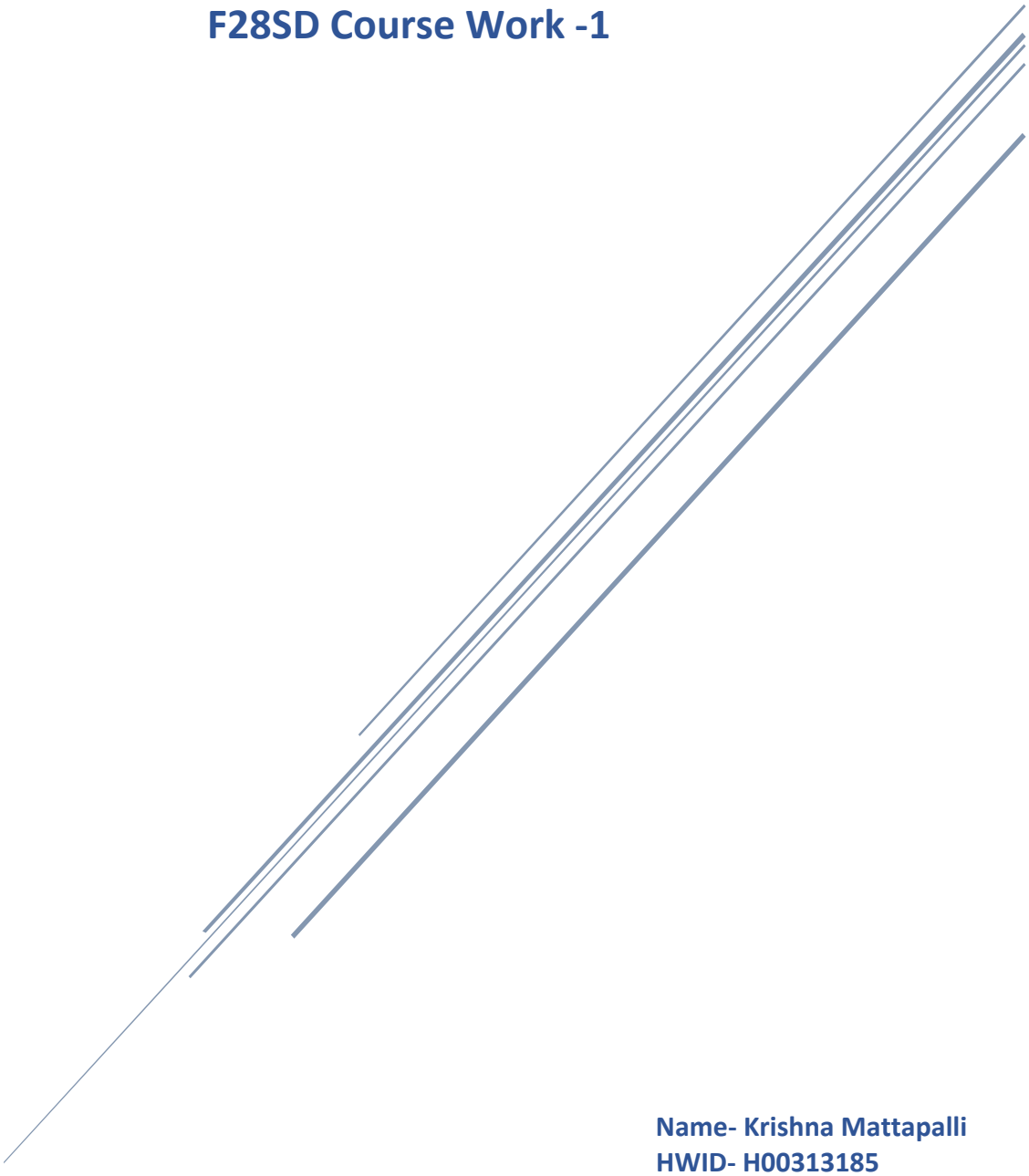
Air Traffic Control System
Portfolio Report

Software Design
F28SD Course Work -1



Name- Krishna Mattapalli
HWID- H00313185

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INTRODUCTION

This report is a portfolio of the Air Traffic Control System (ATC), I designed a software-intensive system to support the ATC activities at the airport. Aviation is a major industry and ATC plays a vital role in assuring safety, promoting efficiency of air travel. This report is divided into nine deliverables.

D1- Assumptions on ATC, statements should be true but no need any proofs.

D2- Functional requirements described as a specification of performance between output and input.

Non Functional requirements specify criteria that can be used to decide the performance of a system, rather than explicit behaviours.

D3- Use Cases is a list of actions or event steps typically describing the communication between a role and a system to reach a goal.

D4- Class-Responsibility-Collaborator is a class represents a group of alike objects, responsibility is something that a class knows and partner is another class that a class that interacts with to fill its responsibilities.

D5- Class Diagrams is a type of static structure diagram that represents the structure of a system showing the system's classes, attributes, operations and relationship among objects.

D6- Sequence Diagrams shows object intercommunications arranged in time sequence.

D7- Activity Diagrams is a flowchart to represent the flow from one *activity* to a different *activity*. The *activity* can be defined as an action of the system.

D8- State Machine Diagrams require that the system illustrated is made of a finite number of states; sometimes, this is indeed the case, while at other times this is a reasonable idea.

D9 - Is a short statement describes the strengths and limitations of UML.

D1-Assumptions

- Cylinder of airspace approximately 25 miles in dimeter and 10 miles high is Control Zone (CZ).
- Approach controller (APC) is responsible from approximately 3 miles from runway.
- Approach Controller (APC) responsible for aircraft as they enter CZ (approximately 3 miles) from the runway.
- AIC is responsible on final approach (approximately 3 miles from the runway).
- Aircraft which are out of TMA is not responsible for air traffic controllers base.
- Electronic FPS (eFPS) is easy to use, much better than paper FPS.
- Command messaging system (CMS) made communications much stronger between pilots-to-controllers and controllers-to-controllers.
- When CMS fails, they can use radio and landline communication.
- AIC and APC cannot manage eFPS without associated software system.
- eFPS cannot access by GMC software system.
- Touch screen display (tablet pc) made work easy for viewing and changing information.
- Without generating FP aircraft cannot enter controlled airspace.
- Pilot FP can be only validated through external pilot's database (PDB).
- When pilot forgets to communicate with GMC, they won't get permission to outbound.
- When aircraft is not in contact with APC, it can't get directional information and glide path for the runway.
- If CZ is busy, then aircraft will be holding the stock until slot become available.

- Handover may be delayed between APC and AIC its CZ is busy.

- If aircrafts take too long to clear the runway, aircraft is established on the glide path at approximately 600 feet above the ground.

- Depending on busy airport, the APC may choose to place the aircraft in a holding stack or direct it back onto the glide path for another attempt of landing.

D2-Functional Requirements

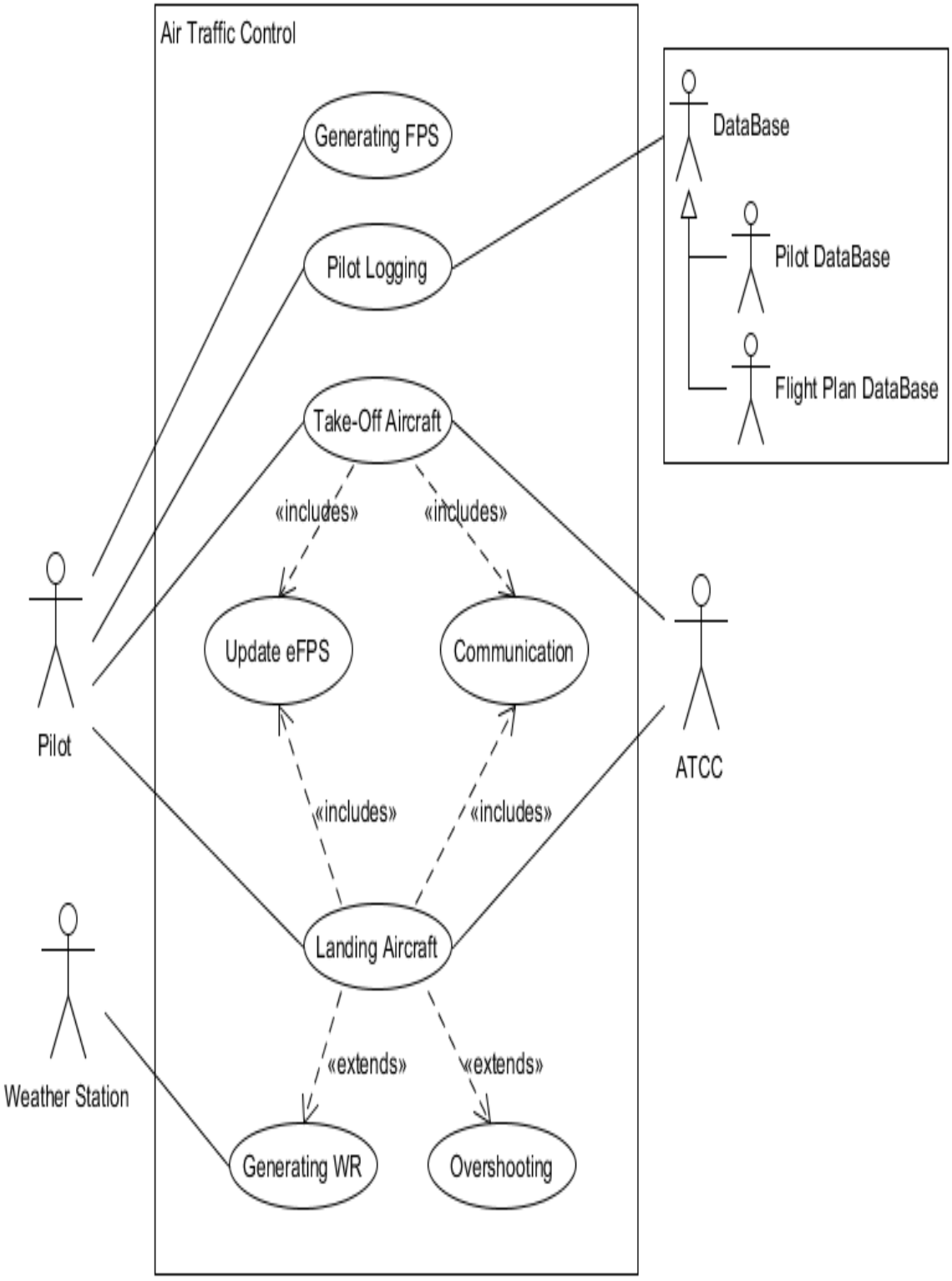
ID	Description	Priority
FR1	Air Controller (AIC) responsible for all aircraft enter the runway to take off.	S
FR2	Ground Movement Controller (GMC) responsible for all aircrafts movements within airport taxiway system and allocating gates.	S
FR3	All communications should be through command messaging system (CMS).	M
FR4	eFPS should include aircraft type, call sign, altitude and gate number.	M
FR5	Once FP is completed it is archived to another external database (FPDB).	M
FR6	FP should be generated before aircraft enter controlled airspace.	M
FR7	ATC system to include a Flight Plan Logging (FPL).	S
FR8	FP details of the pilot should be validated through the external pilot database (PDB).	M
FR9	ATCC controller sends aircrafts eFPS to the APC system.	S
FR10	ATCC instructs aircraft to make contact with APC.	C
FR11	When aircraft enters the CZ, APC provides pilot with Weather Report (WR) for final approach.	M
FR12	At final approach APC passes control to AIC.	S
FR13	Aircrafts are routed to a holding stack until a landing slot is available, when CZ is busy.	S
FR14	Before aircraft touch down, AIC requests a gate number from GMC.	M
FR15	Aircrafts are occasionally instructed to overshoot.	M
FR16	When overshoot undertaken then AIC hands aircraft back to APC.	S
FR17	Once inbound process is completed then eFPS is archived.	M
FR18	GMC software system records of aircraft call sign, gate number.	C
FR19	AIC then sends a copy the eFPS to the ATCC.	S
FR20	GMC will push back aircraft to the gate and taxi to a holding point.	M
FR21	Departure gate is provided automatically by GMC system.	S
FR22	At holding point the AIC takes over direct control of aircraft.	S

D2-Non-Functional Requirements

1. Maintaining safe separation between aircraft and guiding into final approach.
2. Keeping relevant aircraft information up to date on flight progress strips.
3. All communications can be through radio, landline as secondary.
4. ATC system is concerned with management of eFPSs as aircraft outbound and inbound at airport.
5. Inbound and outbound of eFPS have to record airspeed, expected time of arrival and departure, actual time of arrival and departure and rout information.
6. GMC has no access to eFPSs.
7. A controller changes information on an eFPS vie a scribe, just like tablet (pc).
8. eFPS is classified into pending, active and archived.
9. APC has additional heading holding stack.
10. FPL system will allow pilots to log their FPs electronically.
11. FP also records the names and licence numbers of the pilots.
12. AIC and APC are presented with eFPS information is via touch screen display.
13. AIC and APC eFPS are managed by AIC system and APC system respectively.

14. eFPS is generated automatically by the FPL system and sent to AIC system.
15. It should appear a pending flight once an eFPS has been sent from FPC system within AIC system.
16. When aircraft is ready for departure, the pilot communicate their readiness to the GMC via CMS.
17. GMS communicates to AIC via CMS.
18. When AIC is ready, it instructs GMC to push aircraft back from the gate and taxi to a holding point.
19. AIC instructs the pilot to taxi to the end of the runway, where final clearance is given for take-off.
20. Inbound aircraft handover between ATCC controller and APC involves both CMS and eFPS.
21. ATCC will contact APC trough CMS.
22. APC provides directional information to enable to locate the glide path for the runway.
23. APC provides WR to pilot, communicated electronically.
24. WRs are transmitted electronically from airport Weather Station (WS).
25. WR includes wind speed and direction as well as visibility.
26. WR is generated automatically by WS system and sent every 15 minutes to APC system.
27. When WR has significantly changed the pilot are provided with an update.
28. When aircraft touches down, AIC logs the ATA and advises the pilot of their allocated gate.
29. ATC system will replace paper-based FPS with electronic FPS (eFps).
30. Both AIC and APC systems maintain eFPS.
31. GMC has a software system to assist work.
32. Airspace around an airport is called Control Zone (CZ).
33. Outside CZ is terminal manoeuvring area (TMA).
34. Controllers are responsible for aircraft within CZ.
35. ATC system will be concerned with the management of eFPS.

D3-USE CASES


Air Traffic Control
Generating FPS
Pilot Logging
Take-Off Aircraft
«includes»
«includes»
Update eFPS
Communication
«includes»
«includes»
Landing Aircraft
«extends»
«extends»
Generating WR
Overshooting
Pilot
Weather Station
ATCC
DataBase
Pilot DataBase
Flight Plan DataBase

Use Case: Generating of FPS
ID: *1*
Goal: To generate FPS
Primary actor: Pilot
Secondary actor(s): *None*
Preconditions: *1. FP must be submitted before entering controlled airspace*
Postconditions: 1. Submission successful 2. FPS is generated
Main flow: *1. Before pre-flight checks* *2. Pilot will submit FP within airport* *3. FPS is generated*
Alternative flows: None

Use Case: Pilot Logging
ID: *2*
Goal: To finish logging process
Primary actor: Pilot
Secondary actor(s): *DataBase*
Preconditions: *1. Submit FP before entering controlled airspace*
Postconditions: 1. pilot logging successful
Main flow: *1. Pilot will log FPs electronically* *2. FP records name and licence number of the pilot* *3. Details are validated via external Pilot database (PDB)*
Alternative flows: None

Use Case: Take-Off Aircraft
ID: ***3***
Goal: ***Take-off aircraft***
Primary actor: **Pilot**
Secondary actor(s): **ATCC**
Preconditions: ***1. FP is generated before entering controlled airspace***
Postconditions: ***1. eFPS is archived***
Main flow: ***1. Departure gate is provided automatically by GMC system*** ***2. eFPS is generated automatically by FPL system*** ***3. FPL is sent to AIC system*** ***4. Once eFPS has be sent from FPL system it appears as pending flight within AIC system*** ***5. Once aircraft is ready to departure, pilot communicate their readiness to the GMC*** ***Include (Communication)*** ***6. GMC communicates to the AIC*** ***Include (Communication)*** ***7. AIC instructs the GMC to push back from their gate and taxi to a holding point*** ***8. On holding point, the AIC take over direct control of aircraft*** ***9. Departure slot will be arrived*** ***10. AIC instructs the pilot to taxi to the end of the runway*** ***11. Final clearance is given for take-off*** ***12. After airborne, AIC records the ATD on eFPS*** ***13. AIC sends a message to the pilot requesting to contact ATCC*** ***14. AIC sends a copy of eFPS to the ATCC*** ***15. Include (Update eFPS)***
Alternative flows: **None**

Use Case: *Communication*
ID: ***4***
Goal: **Pilots and controllers to communicate effectively**
Primary actor: **Pilot**
Secondary actor(s): **ATCC**
Preconditions: ***1. Check CMS is in good condition or not.*** **2. Check pre-defined message**
Postconditions: **1. Communicated successfully**
Main flow: ***1. Pilot-and- controller communicate via CMS*** ***2. controller-and- controller communicate via CMS***
Alternative flows: ***1. Communication fails between Pilot-and- controller*** ***a. Pilot-and-controller use radio to communicate*** ***2. Communication fails between Controller-and- controller*** ***a. Controller-and-controller use landline to* Communicate**

Use Case: Update eFPS
ID: **5**
Goal: **To make *eFPS as archived***
Primary actor: **Pilot**
Secondary actor(s): ***ATCC***
Preconditions: **None**
Postconditions: **None**
Main flow: **1. eFPS sent from FPS status is pending** **2. when CZ is free status is active** ***3. Take-Off or Landing is successfully*** ***4. AIC tags their copy of the eFPS as archived***
Alternative flows: **2. when CZ is busy** **a. Aircraft routed to holding stack** **b. Until slot becomes available**

Use Case: Landing Aircraft
ID: 6
Goal: Landing aircraft
Primary actor: Pilot
Secondary actor(s): *ATCC*
Preconditions: *1. Check whether report*
Postconditions: *1. eFPS is archived*
Main flow: *1. ATCC controller sends aircrafts eFPS to the APC system* *2. It appears as a pending eFPS and alerts APC to the aircraft* *3. ATCC controller instructs the aircraft to make contact with APC* *Include (Communication)* *4. APC provides directional information to enable to locate the glide path for runway* *5. In Control Zone (CZ), the APC provides the pilot with a WR in final approach* *6. Extension point:* Weather Report *Include (Communication)* *7. In final approach APC passes control to AIC* *Include (Communication)* *8. Before touching down, AIC requests a gate number from GMC* *9. Logged on the eFPS by controller* *10. Aircraft touches down then AIC logs the ATA* *11. Advises the pilot of their allocated gate* *12. Extension point:* Overshooting *13. When overshoot undertaken then AIC hands the aircraft back to APC* *14. Include (Update eFPS)*
Alternative flows: 6. Weather report has significantly changed 1. Pilots are provided with update *7. When handover delayed* *1. Aircraft is routed to holding stack* *2. Until a landing slot becomes available* *12. Aircraft takes too long to clear the runway* *1. Decisions are taken when aircraft is established on the glide path* *2. Approximately 600 feet above the ground*

13. *If airport is busy*
    1. *APC may choose to place aircraft in holding stack*
    2. *Direct it back onto glide path for another attempt at landing*

Extension Use Case: Generating WR
ID: 7
Goal: To generate Weather Report
Primary actor: Weather Station
Secondary actor(s): ATCC, Pilot
Segment Preconditions: *None*
Segment Postconditions: 1. *WR sent or not*
Segment flow: Weather Report 1. *WRs are generated automatically by WS system* 2. *WS system (WS) sends to weather station* 3. *Weather Station sends WRs electronically to APC for every 15 minutes* 4. *APC sends WRs to pilot in final approach*

Extension Use Case: Overshooting
ID: 8
Goal: Overshooting aircraft
Primary actor: Pilot
Secondary actor(s): ATCC
Segment Preconditions: 1. *Aircraft takes long to clear the runway*
Segment Postconditions: 1. *Aircraft overshoot*
Segment flow: Overshooting 1. *When aircraft established glide path* 2. *Approximately 600 feet above the ground* 3. *Aircrafts are occasionally in structed to overshoot*

Requirements/use case tractability table

FR\UC	UC1	UC2	UC3	UC4	UC5	UC6	UC7	UC8
FR1			✖					
FR2			✖			✖		
FR3				✖				
FR4	✖							
FR5		✖						
FR6	✖							
FR7			✖			✖		
FR8		✖						
FR9						✖		
FR10			✖			✖		
FR11							✖	
FR12						✖		
FR13								✖
FR14						✖		
FR15								✖
FR16								✖
FR17					✖			
FR18			✖			✖		
FR19					✖			
FR20			✖					
FR21			✖					
FR22			✖					

D4-Class-Responsibility-Collaborator

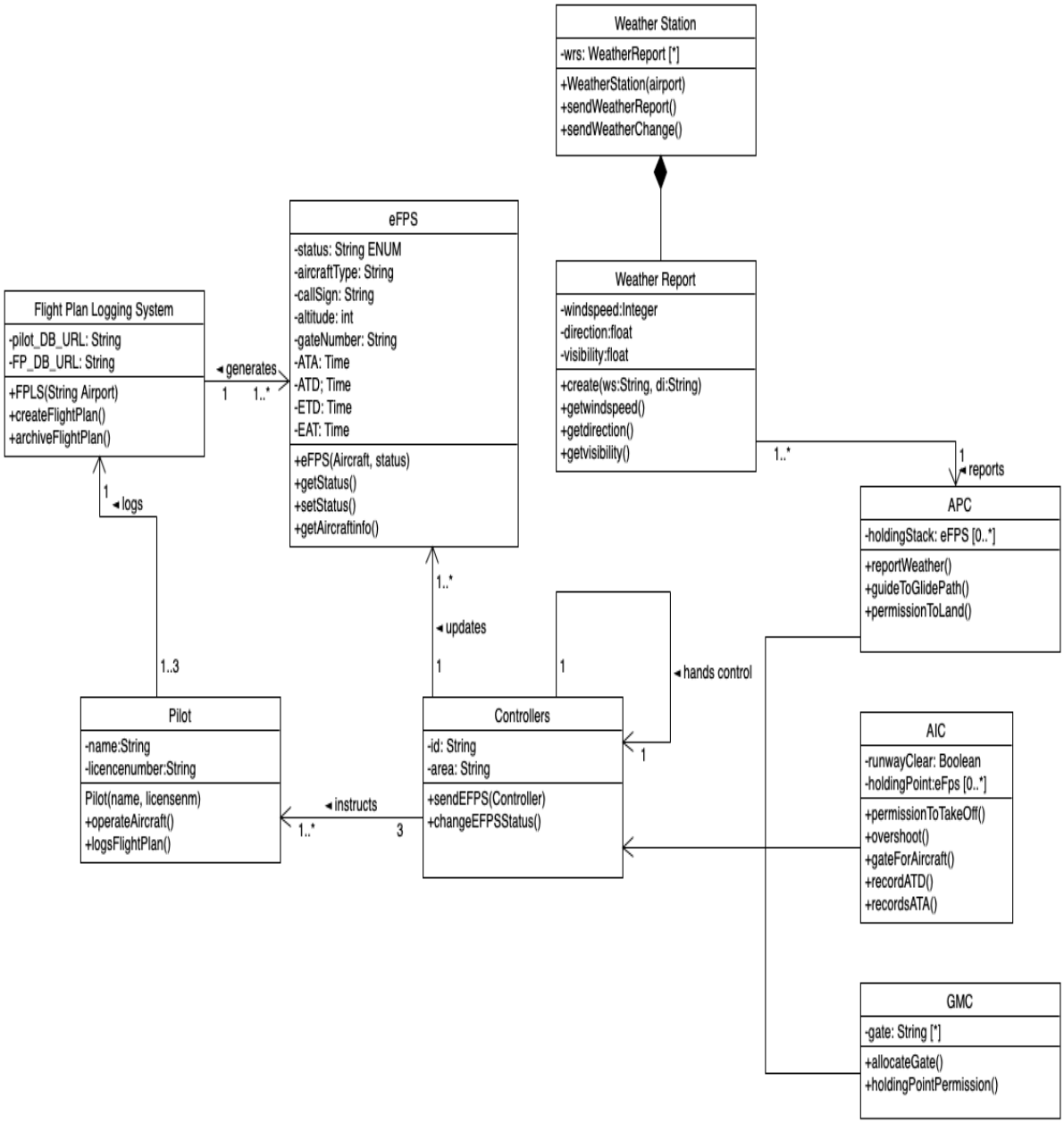
Class: eFPS	
Responsibilities	Collaborators
Records Expected Time of Arrival (ETA)	Aircraft
Records Actual Time of Arrival (ATA)	Aircraft
Records Expected Time of Departure (ETD)	Aircraft
Records Actual Time of Departure (ATD)	Aircraft
Status as pending	AIC
Status as active	AIC
Status as archived	AIC
Status as holding	APC

Class: Approach Controller (APC)	
Responsibilities	Collaborators
Aircraft as they enter the CZ, approximately 3 miles from the runway	Pilot
Maintaining a safe separation between aircraft	Aircraft
Guiding aircrafts onto the final approach	Aircraft
Keeping relevant aircraft information up to data on flight progress strips	eFPS

Passing weather report to aircraft on approach	Weather Station
Aircraft holding stack	Airport
Another attempt at landing	Airport
eFPS of AIC and APC is managed	AIC
To alert aircraft	ATCC
Directional information	Aircraft
Glide path for the runway	Aircraft
Provides Weather Report (WR)	Weather Station (WS)
In final approach, passing control to AIC	AIC

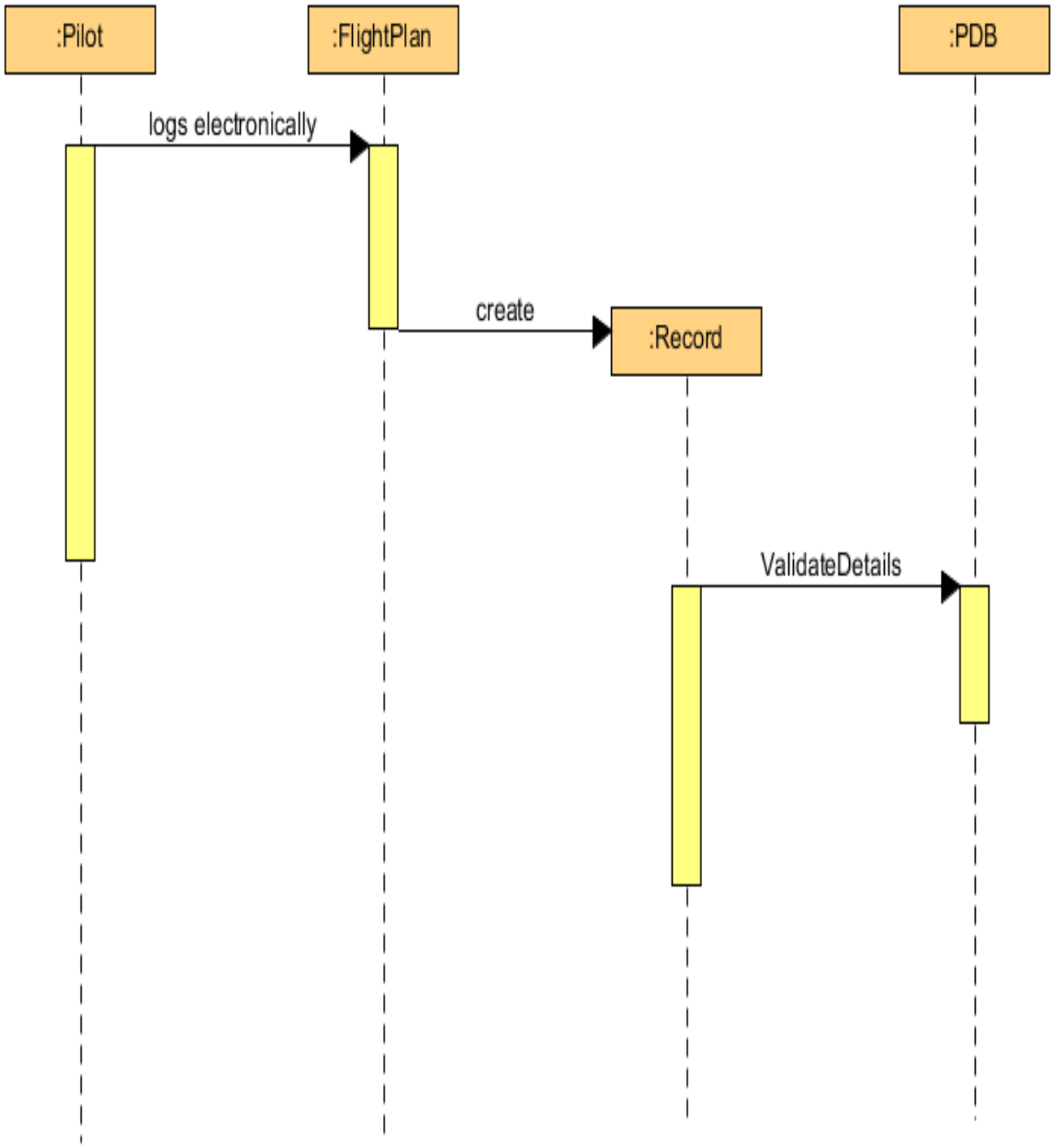
Class: Communication	
Responsibilities	Collaborators
Communication between pilot-and-controller	Command Messaging System (CMS)
Communication between controller-and-controller	Command Messaging System (CMS)
Communicate effectively between pilots and controllers using pre-defined messages	Command Messaging System (CMS)
Secondary mode of communication between pilot-and-controller	Radio
Secondary mode of communication between controller-and-controller	Landline

D5-Class Diagrams

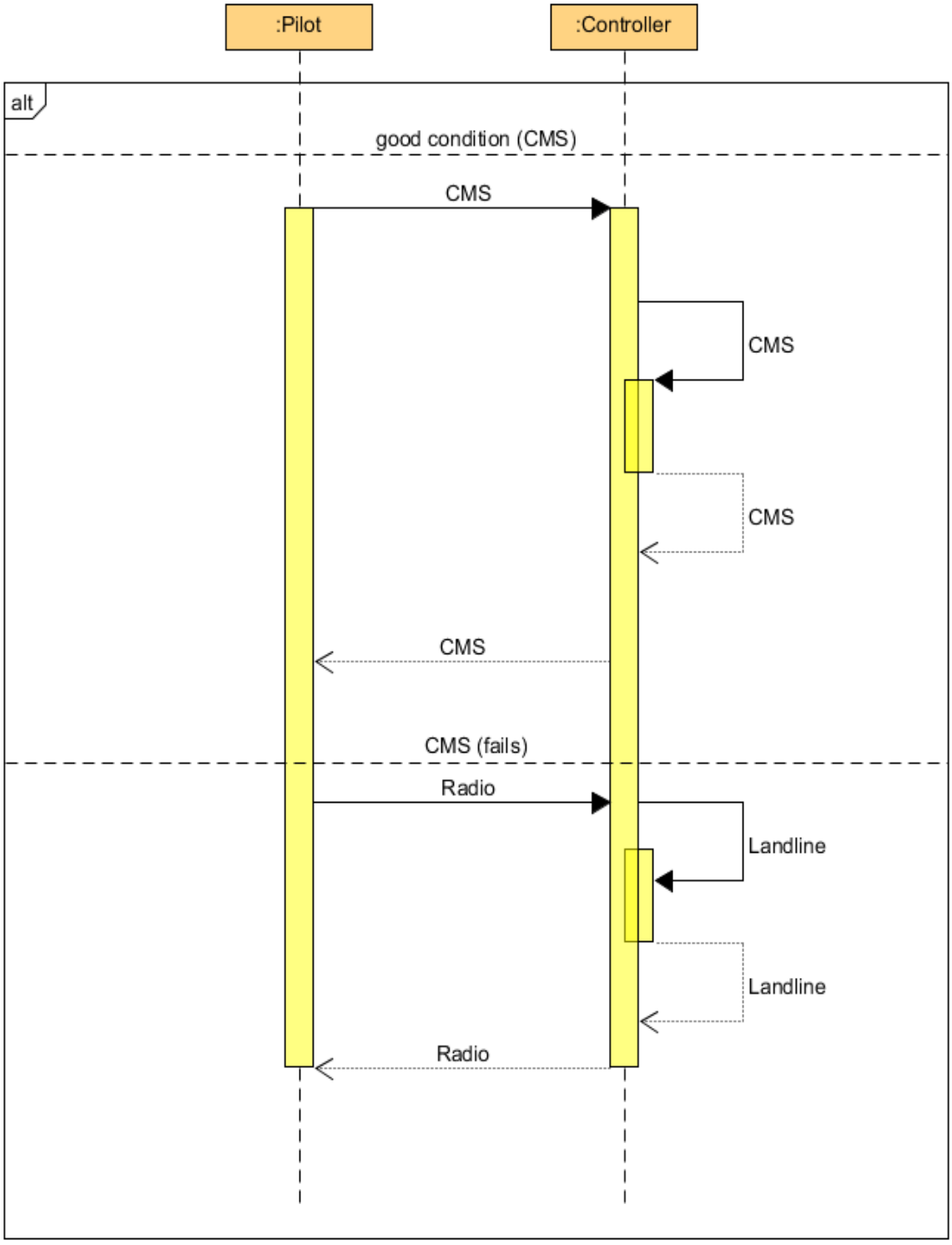


D6-Sequence Diagrams

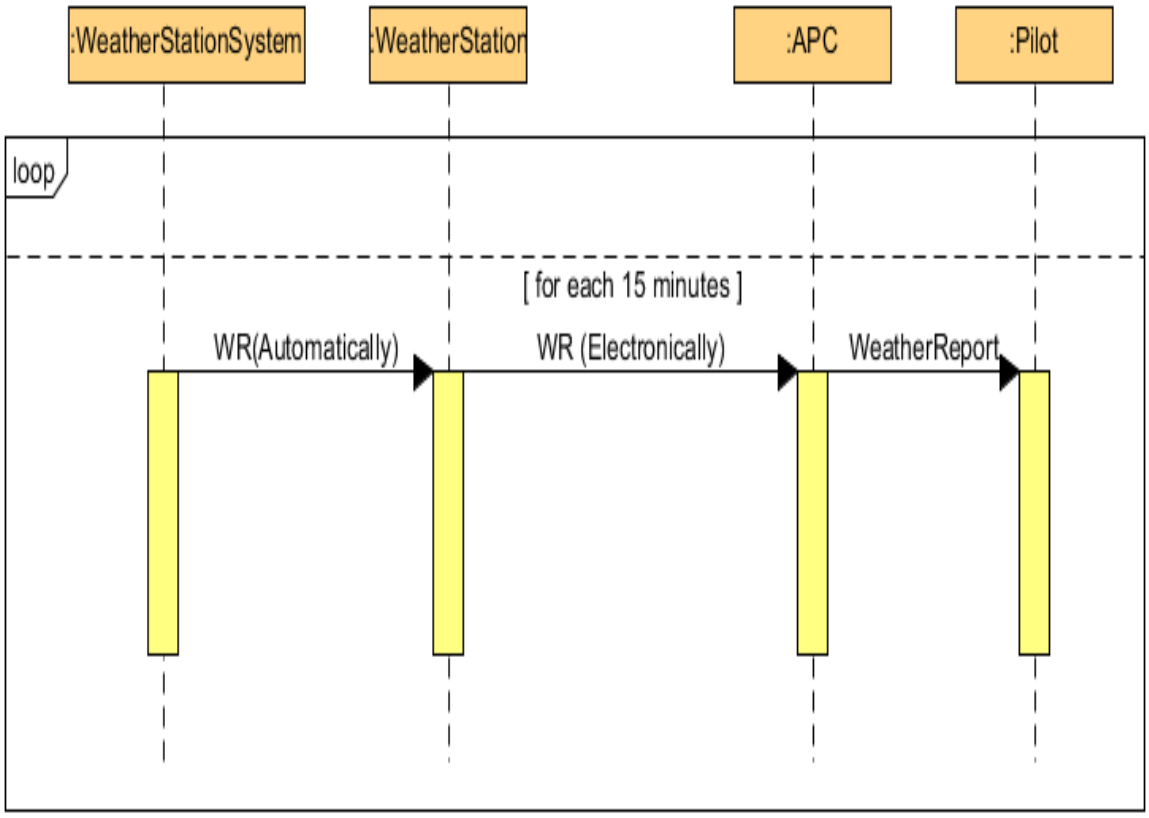
Pilot Logging



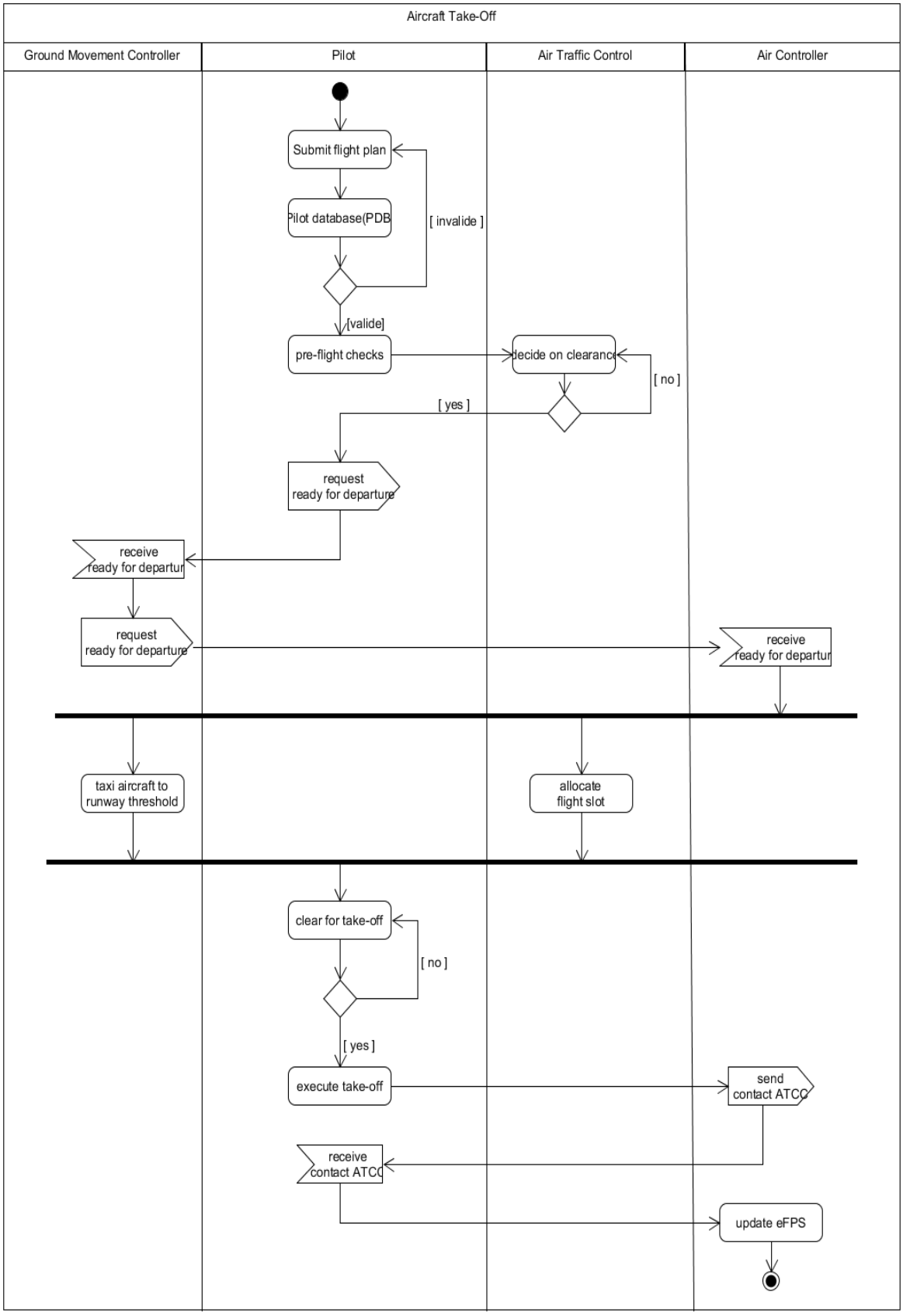
Communication



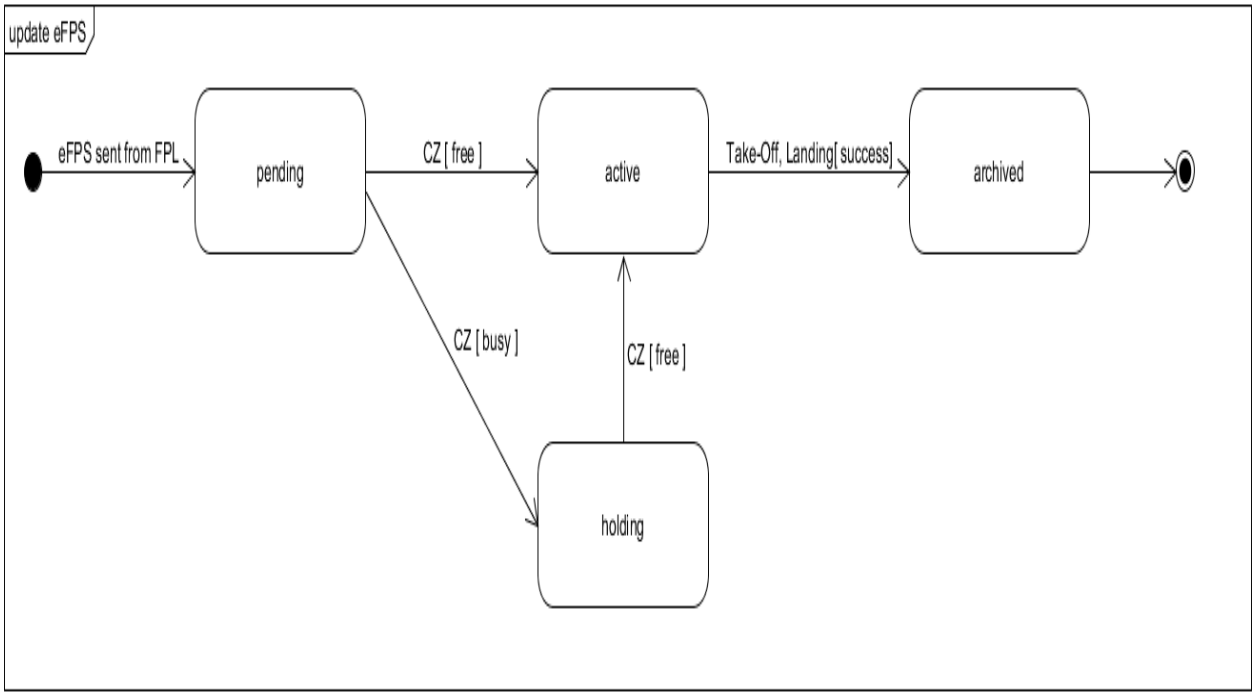
Generating WR



D7-Activity Diagram



D8-State Machine Diagram



D9- Strengths and limitations of UML

UML is a highly appreciated and accepted platform for software design. It is a regular system among software developers.

We can customize your modelling components and interplays in a UML diagram especially to suit the domain or technologies you are exercising.

UML is a rich and inclusive language that can be used to create not just object-oriented software engineering, but statement formation and management, business processes too.

UML tools range from free open-source software. These tools cover many areas exceeding just drawing diagrams.

UML can create code from the design, use design patterns, mine elements, reverse engineer code, and perform influence and complexity analysis.

Don't need a UML diagram to describe your designs. You can have the same result and conclusion with informal, box-and-line diagrams designed in PowerPoint, Visio and whiteboard.