F-35 Aircraft System

Team 2
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1. Introduction

The F-35 Aircraft System that we have decided to cover is an Event-Driven Architecture that has many stakeholders ranging from the military, the defense contractors, as well as some taxpayers and/or citizens that value such a sophisticated system, and are eager to see a successful completion of the technology. For any clarification on this document, you may contact either: Esau Cuevas erc150130@utdallas.edu, Jerusalem Yohannes jty150030@utdallas.edu, Jose Varela jav150730@utdallas.edu.

Since different components work and react to each other's responses, it makes sense to create an architecture that implements an Event-Driven Architecture. This type of architecture pattern promotes the production, detection, consumption of, and reaction to events, and so since the hardware and software subsystems of a Fighter Control System are as loosely coupled as can be, they still work together and make decisions per external stimuli.

This document was created March 9, 2017. It is the first phase to a bigger architecture design plan that will be presented on April 7 & 8. It is intended to educate peers about a design that is created by reverse engineering an F-35 Fighter Aircraft System; we do this by using what we have learned throughout our collegiate career, and coming up with an overview of the system that best fits the functions and components of the F-35.

Many views will be shown later in this document; the Logical View can be found on Section 4, Dynamic View in Section 5, Process View in Section 6, Development View in Section 7, and Physical View in Section 8. The Logic View will show the static structure of the system, such as the UML class diagrams, and it will show the components of the system along with their interfaces and how they connect with each other. The Dynamic View shows how the system will respond to stimuli from the environment, and how the components will interact with the use of a sequence diagram. The Process View shows how the components of the systems are assigned to threads of control, while they Physical View shows how the components are allocated on the physical nodes. Lastly, the Development View shows the structure of the code, and how logical components are assigned to code pieces.

References

[KRU41]: The "4+1" view model of software architecture, Philippe Kruchten, November 1995, http://www3.software.ibm.com/ibmdl/pub/software/rational/web/whitepapers/2003/Pbk4p1.pdf
[EDA]: Programming Without a Call Stack - Event-Driven Architectures, Gregor Hohpe, October 2003, http://www.enterpriseintegrationpatterns.com/docs/EDA.pdf
[ASD]: Agile Software Development, David Cohen, Mikael Lindvall, and Patricia Costa, January 2003, https://www.csiac.org/wp-content/uploads/2016/02/Agile-Software-Development-SOAR-2.pdf

2. System Overview

a. Context

The F-35 system is meant to provide many capabilities as a multirole fighter that deal with national defense such as air superiority, stealth, information gathering, and information sharing. It is created by Lockheed Martin, and is to be used by many militaries around the world, including the U.S. military.

There are three variations of the F-35 aircraft, and in extension, their software system but with little deviation from one another. The three variations are the F-35A (conventional takeoff and landing, US Air Force), the F-35B (Short takeoff/vertical landing, USMC), and the F-35C (for aircraft carries, US Navy).

The 5th-generation fighter has a unique software system that has over 8 million lines of code, 4x more than the next most. The system aims to offer direct support to the forces on the ground, share its data (such as enemy location) to its commanders/coalition, while retaining its conventional warfighting capabilities that is enhanced by its superior stealth technology, among many more functionalities.

The customers (12 global countries in total) will benefit by having the most technological and superior fighter jet in their air force fleet that is sure to benefit their military. The enterprise (Lockheed Martin) behind the F-35 will most certainly benefit by having many customers and contracts aiming to buy its technology for several decades that the U.S Defense Department expects to spend $391 billion to develop and buy 2,443 of the F-35 warplanes.

There are many features that the system has that justifies its cost, and thus offset the criticism of its high budget. To list a few, the aircraft has sensor-fusion which enables pilots to draw information from all of their on-board sensors to create a single integrated picture of the battlefield, provides a 360 degree view of the environment to its pilot's helmet visor from its Distributed Aperture System, enables aircraft to share information securely and fast to other legacy aircraft, share data and battlefield information to forces back on the ground or to base, and many more functionalities of the system that makes use of its 8 million lines of code.

b. Functional / Service Categories

Category Name	Category Description
Flight Control	targeting, data viewing, flight information, providing night vision
Mission Systems	Display system information, communicate system information, collect data, share data,
Pilot Support System	Services that react to pilot commands and display state(s) of aircraft

3. Actors & Goals

a. Functional Categories

Identify functional categories (i.e. Customer Management) and a brief category description of the category's purpose.

Category Name	Category Description
flight sensors	target aiming by exchanging data information
mission systems	information communication using software operating system
pilot support system	Services that react to pilot commands and display state(s) of aircraft

b. Actors and Actor Goals

Pilot

Goal	Description
Communicate vocally	Helmet provides radio to communicate with other pilots, and any other entities such as HQ
See 360 degree environment	Infrared cameras placed all around aircraft to provide pilot with ability to look through airframe to his surroundings, called the Distributed Aperture System (DAS).
See state of the aircraft	All the information pilots need to complete their missions – airspeed, heading, altitude, targeting information and warnings – is projected on the helmet's visor, rather than on a traditional Heads-up Display.
Ability to see in the night	Infrared cameras through DAS gives pilot night vision
Autopilot	System controls trajectory of aircraft without "hands on" pilot control
Avoid ground collision	System avoids ground collision through Automatic Ground Collision Avoidance System (Auto-GSAC) that controls trajectory of aircraft if it is heading towards an unsafe state

HQ

Goal	Description
Gather Intelligence	System sends information from aircraft to operation center to coordinate strategies
Get aircraft state	System uses sensors to gather state of aircraft and communicates it back to HQ
Communicate with pilot	System provides radio for vocal communication between pilot and HQ
Share resources to aircraft	System shares intel to coordinate strategies with aircraft, and ultimately presents it to pilot e.g. geographical coordinates

Maintenance

Goal	Description
Safety of the Pilot	Diagnosis and repair of mechanical and electrical problems
Maintenance	Replacing and repairing of aircraft parts
Performance	Improving the performance of the aircraft

c. Scenario Descriptions

Scenario descriptions are presented in per-student documents that follow the outline given in the template document 00 Scenario Definition Template.docx. Each student is to present their scenarios in a separate copy of this template document. Each document is to be attached to this document when submitting for grading.

d. Functional Formal Requirements

ID	Requirement Text
MS01	The system shall be able to make an estimate of potential casualties. For instance, in a known battlefield such as Aleppo or Mosul, many civilians have left. However, there are those who have stayed behind. Gathering data from intelligence and reports, the system shall make an estimate of potential civilian and or enemy casualties.
PSS02	The system shall display estimate of potential civilian and/or enemy casualties to the pilot's helmet. Prior to a mission, the system shall make an estimated casualty count, as well as post-mission, and send the information to command
MS03	The system shall make an estimated success probability of the mission beforehand. For example, if entering enemy territory, the range to the target should be known, the number of surface-to-air batteries, as well as the enemy's mobilization time to counter, etc. All this should be accounted for in the processing of the system in determining the success probability of the mission.
PSS04	The system shall give updates to the pilot on the status of his or her fighter squad, and/or ground friendly forces. The updates shall be displayed on the fighter's helmet.

e. Non-Functional Requirements

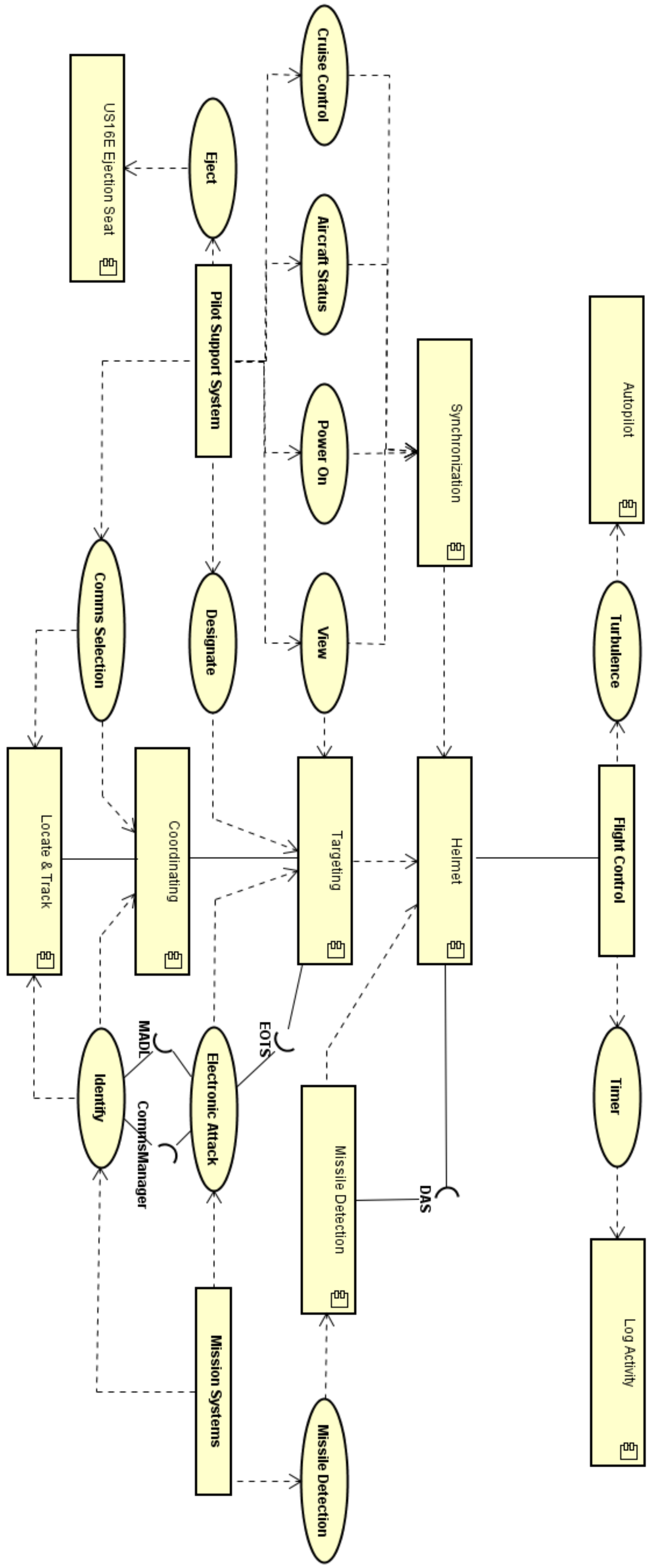
ID	Requirement Text
NFR01	The Multifunction Advanced Data Link (MADL) should allow pilots to communicate information securely and situational awareness with each other, at a high-data-rate without revealing the pilot's location to opposing forces
NFR02	the core processor should be capable of 400 billion operations per second
NFR03	the flight navigation system should be able reliable 99.99% of the operating time
NFR04	the fighter aircraft system should have the utmost security as possible as to not be hacked or stolen
NFR05	the mission systems should be operable and error-ridden 99.99% of the time
NFR06	The design of the aircraft should help enhance its stealth capabilities that is one of its core features
NFR07	The information sharing should be instantaneous to commanders whether at sea, air, or ground.
NFR08	The processing of the pilot's commands whether to fire off weapons or release external fuel tanks should be instantaneous and successful 99.99%
NFR09	The sensors placed on the aircraft should have minimal drag effect
NFR10	The system should be maintainable, and serviceable

f. Open Issues and Risks

Risk ID	Requirement Text
OpenIssues01	The costs of the system and practically the F-35 threaten its successful agreements. However, although costs are still high, there has been a reduction in cost which has satisfied many customers.
OpenIssues02	There are many US citizens and taxpayers that have an issue with the exorbitant cost amount of the F-35 that the US government has agreed to. Many issues are the amount of spending the US commits each year on Defense.
OpenIssues03	There are complaints about the F-35's difficulty in sustaining energy in close-in maneuvering combat ("dog-fighting"). The energy needed to turn and accelerate is substantial and could leave the aircraft vulnerable.
Risk01	There could be individuals or countries that aim to steal the designs of the sophisticated software, dethroning the US military to equal footing. Security and secrecy is then needed to protect the enterprise's technology as well as for national security

4. Logical View

Component Diagram:



a. Overview

1. Helmet Component

This component will represent many services needed to support the pilot, mission, and aircraft. This component represents the main GUI for the F-35. The helmet is connected and associated with many systems such as the Departure Aperture System, Electro-Optical Targeting System, and general views such as night vision and the 360-degree view of the pilot's surroundings. This component is an essential feature to the F-35.

2. Autopilot Component

This component represents the services needed to maintain a logistics of information of the aircraft in air set by the pilot. Many services include the stability of the aircraft and the synchronization of information of the F-35's status information, as well as the Collision Detection (DAS) feature, all that is shared with the pilot and system. The Autopilot is a shared component between the Flight Control and Pilot Support System.

3. Ejection Seat Component

This component represents the services that will be needed in the event of the ejection seat US16E (Martin-Baker) to support the pilot. Many functions include the back-up oxygen supply activation, Neck Protection Device inflation, IFF/Emergency location triggered, and many more.

4. Log Activity Component

This component represents the services that maintains information of the aircraft, specifically its parts information that includes its time of use or lack thereof. The component can then make recommendations on parts to change and order for.

5. Synchronization

This component represents the services needed to communicate up-to-date information about the aircraft or mission plans to either the pilot or the base. It is important to get recent information to respond or assert plans correctly, and this service provides the interfaces needed by the system to communicate that information.

6. Coordinating Component

This component represents the services needed to allow the pilot and aircraft to communicate with other aircrafts. This system relies on security during its communication with aircrafts and control centers for situational awareness, and receive information vital in coordinating attacks, or information relating to maneuvering. This component also interacts with other components to gather the intelligence, and the ability to communicate that intelligence.

7. Targeting Component

This component represents the services that are needed to provide pilots with air-to-air and air-to-ground targeting capabilities by the F-35's Electro-Optical Targeting System (EOTS). It represents the different services that allow aircrews to identify areas of interest, perform reconnaissance, and deliver laser- and GPS-guided weapons.

8. Locate & Track Component

This represents the services required to first, locate an enemy target, and then track it. This component will derive from the Mission Systems subsystem, which mostly deals with the additional features that make up the F-35. This component is not inclusive; it also works with the Communications component that allows information that was located to be sent back to the base.

9. Missile Detection ComponentLog

This component represents the services that deal with the detection and tracking of missiles by using the Distributed Aperture System (DAS). Upon detection of missiles or aircrafts, it can share this information with the pilot.

10. SecurePersistence Component

This component represents services that provide access to sensitive information such information about the mission.

11. App Persistence Component

This component represents services that provide access to remaining non-sensitive information maintained by the system such as information about the aircraft.

b. Tactics

1. Availability Tactics

Ranking: Critical

A main function of the system is to ensure that each of the sub-systems/components are working because any fault could be detrimental to the overall system. We can accomplish this by using the Heartbeat method for Fault Detection, where the important components periodically send an "I am alive" signal to its agent, and with the agent signaling a fault when the component stops its signaling.

The Process Monitoring Fault Prevention tactic is another tactic that can be implemented into the SensorManager which appears throughout the system. One of the services that the monitoring agent may look for is unusual vibrations in the different hardware devices which can signal that there may be a mechanical problem. This monitoring agent can then log a request using our LogActivity component which has a service that can signal to any base the aircraft will be landing at to have the faulty component replaced.

One specific component that is important to a pilot's mission is using radar to detect where enemies are located. Just how the F-35 can use electronic radars to jam opposing forces' radars, they can do the same to us. A way to avoid this is with the use of multiple radars which can be compared with each other. The system shall then incorporate the voting fault recovery tactic to determine the correct cause for inconsistencies between radars, and so for example if there are a total of three radars, with two showing the same output and the third showing something different, then the one whose output deviates from its peers is faulted.

2. Modifiability Tactics

Ranking: Important

This system design will employ the event-driven architecture tactic. There will be less waiting because of this, since components derive from an internal/external event, and react accordingly instead of having the system wait on an input from a user. The system is separated into 3 main subsystems, which attempt to reduce coupling as much as possible while enabling high performance and a highly scalable system. See Log00.

An important category for modifiability is to reduce coupling between components to minimize the impact of introducing new services. We do this by limiting the amount of interaction components have with each other, and more so interact with a control center per their subsystem. There are instances where components may interact with each other, and so the use of interfaces is a way to prevent rippling changes due to a system modification. Another way of minimizing the cost/effort of making changes is by maintaining high cohesion. You will see these cohesive components focused on their intended usage and easy to understand, and thus easier to change with new behaviors.

Also, by shielding the database at HQ with the implementation details of the aircraft's LogActivity service through a Client-Server tactic, changes can be made to the system without having much effect to the database which stores all aircraft activity, and new services can be added in the future. The system also uses the Data Access Object (DAO) tactic to decouple the database schema from the rest of the system's design and implementation while getting personnel information.

3. Performance Tactics

Ranking: Important

Because this system does not get overwhelmed with information since the number of actors interacting with it are minimal, performance is mainly based on how independent the components are. Since components are specific to a certain function, those services in the component tend to stay within the component. Limitations on resources is a big factor that affects performance, but since I/O services are not a factor in our system, resources are not scarce.

On the other hand, there are some components that interact with neighboring components, such as to keep a log of aircraft information and then can order necessary parts. This component can use the Pipes & Filter tactic to implement a queue of parts that are needed. This tactic will allow the accumulation of logged information which will then get written in batches to the database in HQ. This will put less stress on the system so that it is not constantly under stress, rather, it can send batches during times when it is under less stress.

4. Security Tactics

Ranking: Critical

Security is mainly completed through the Multifunction Advanced Data Link. To complete missions in denied airspace, pilots need a way to share information securely, without revealing their location to enemy forces. With this MADL, pilots are provided to connect with other planes and automatically share situational awareness data. The MADL is a high-data-rate, directional communications link that allows for secure transmission of coordinated tactics and engagement.

Also, another security tactic that is used is by having pilots authenticate themselves before they can operate the aircraft. This will prevent unauthorized users from trespassing into the system and not allow them to operate the vehicle or gather any information stored within the system.

Other security tactics involve the system providing mechanisms to make the pilot physically more secure. An example of this is the ejection seat which can be seen in the component diagrams. The ejection seat provides many services to the pilot that can range from the service that adjusts the thrusters to stabilize the seat, to the tracking service that would signal friendly forces the location of the ejected pilot.

5. Testability Tactics

Ranking: Important

The F-35 is the most sophisticated advanced jet in the world. There are different variations of the F-35, with each variation building upon the previous one. With that, regression testing is a very important aspect of the system during the lifecycle. Regression testing are designed to uncover faults in components that were once working correctly, and so with each variation of the aircraft, there must be further testing to ensure that the components continue working correctly by itself and as it is integrated with the overall system. This is important to capture any ripple effects in response to any alterations.

As for the sensors and radars that work together to be combined in sensor/data fusion for the pilot, each of these services can be tested separately to verify the correct functionality in isolation, but then is even more important to apply integration testing afterwards. This sensor and data fusion is very impactful as well for the usability of the system per the pilot.

A last tactic that can be used is Record/Playback for the helmet/dashboard interface. This tactic can be used to record all the different interfaces that are displayed, and then monitor what happens with all the ways that the pilot interacts with them.

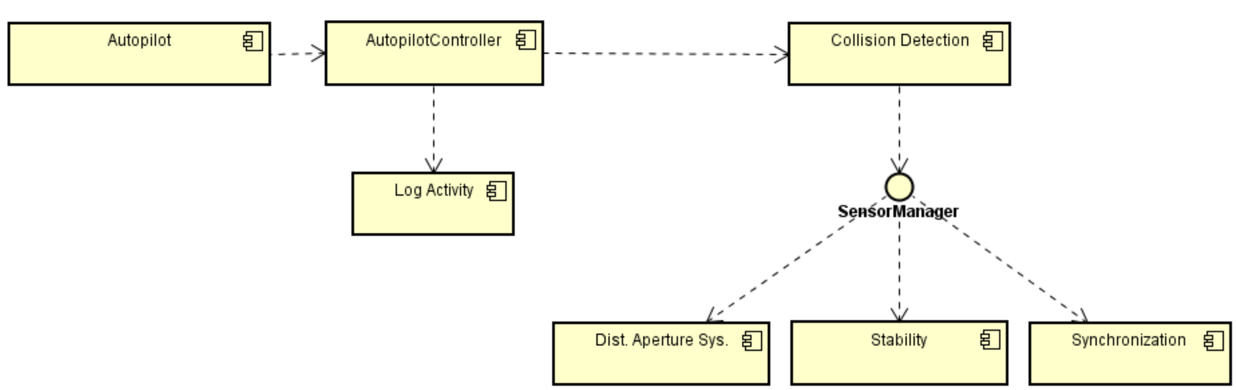
6. Usability Tactics

Ranking: Trivial

The pilot is limited in how he or she interacts with the system, with the main components it interacts with is the dashboard and the helmet. The data and sensor fusion mentioned earlier is very helpful in this aspect; it enables the pilots to efficiently draw on information from all its sensors to create a combined view of their surroundings, internally and externally. The usability of the overall system is not meant to be used by the common masses, it is designed specifically for highly trained fighter pilots, and so the usability of the system should relate to how easily a trained pilot can accomplish tasks, rather than the common man.

The dashboard is a component that is meant to be as convenient to the pilot as it can possibly be. It has a touch screen display that the pilot can select and adjust windows to however is most comfortable or most beneficial to himself, or herself. Also, the helmet contains elements to enhance the pilot's experience and make his or her task as convenient as possible. For example, after the pilots choose their target, the helmet can present the pilots with warnings and triggers displaying where the enemy is located even if the target is not in direct view to them.

c. Components



Autopilot: This service represents the hardware component required to initiate the autopilot service. The system then knows that the autopilot function is required.

AutopilotController: This represents the controller which directs unsafe behavior to the pilot.

Log Activity: This represents the service interfaces used to log aircraft status levels. Services include query methods that allow the update of aircraft status.

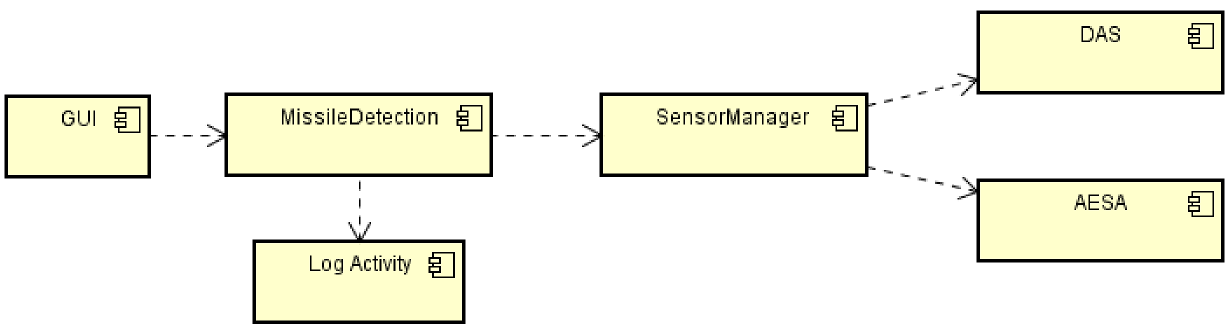
Collision Detection: This provides the service interfaces needed to manage collision information. Services include calculations determining unsafe aircraft routes.

SensorManager: This provides the interfaces needed by the Collision Detection services the information gathered by the DAS, Stability, and Synchronization components.

Dist. Aperture Sys: This provides the interfaces required to implement the 360 degree, spherical situational awareness system. The services gather information from six electro-optical sensors, and provide situational awareness which the SensorManager uses.

Stability: This provides the interfaces required to stabilize the aircraft in flight. It may include services that the calculate adjustments per gyroscope readings and such.

Synchronization: This service provides the interfaces used to manage up-to-date information about the aircraft to the pilot. It is a component itself that can be seen in greater detail in its own component diagram.



GUI: This represents the screen needed to implement the interface between the pilot and the missile detection services.

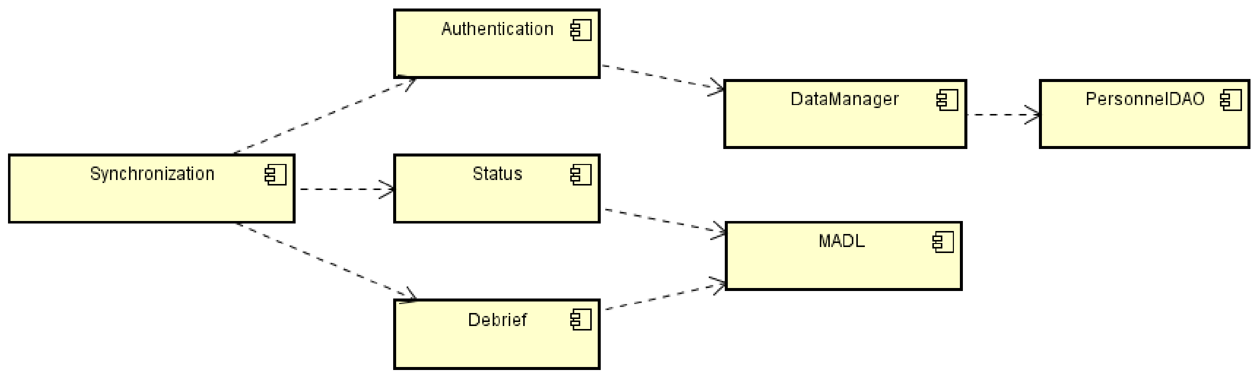
MissileDetection: This represents the service interfaces needed to verify and direct threats to the pilot.

Log Activity: This represents the service interfaces used to log aircraft status levels. Services include query methods that allow for the update of aircraft status.

SensorManager: This represents the service interfaces needed to manage sensor information. Services include directing information to the MissileDetection services.

DAS: This represents the service interfaces needed to provide 360-degree situational awareness. Services include locating targets, but not as strong as AESA.

AESA: This represents the service interfaces needed to provide situational awareness. Services include locating long range targets, including missiles.



Synchronization: This represents the service interfaces used to update aircraft status information, along with mission information.

Authentication: This service provides the interfaces needed by the system to authenticate a pilot's identity.

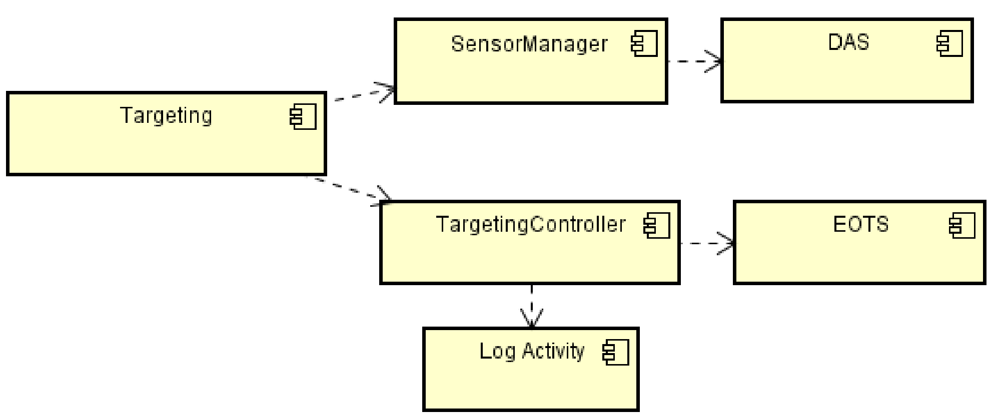
DataManager: This represents the interface used to retrieve pilot information.

PersonnelDAO: This service is an implementation of the Data Access Object design pattern and provides interfaces needed by the system to Retrieve pilot and related information.

Status: This represents the interfaces used to transmit underlying aircraft status information to the pilot.

Debrief: This represents the interfaces used to transmit mission information from the base to the pilot/aircraft.

MADL: This service provides the interfaces needed by the system to establish fast switching narrow directional communications data links between aircrafts.



Targeting: This represents the service interfaces needed to monitor and integrate both the awareness and targeting components.

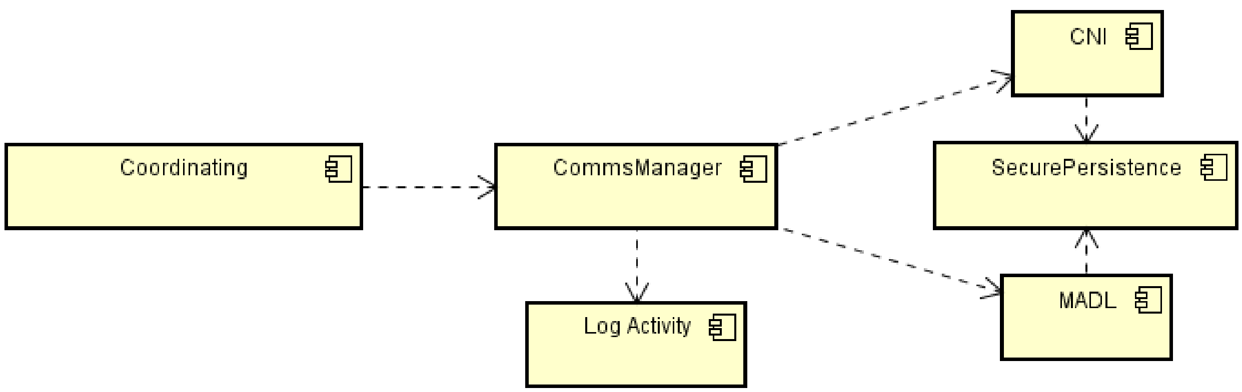
SensorManager: This represents the service interfaces needed to manage sensor information. Services include directing information to the Targeting services.

DAS: This represents the service interfaces needed to provide 360-degree situational awareness. Services include locating targets, but not as strong as AESA.

Targeting Controller: This represents the service interfaces needed to integrate the EOTS with the aircraft's central computer.

EOTS: This represents the service interfaces used by the system to perform reconnaissance and deliver guided weapons.

Log Activity: This represents the service interfaces used to log aircraft status levels, and any information found about the environment. Services include query methods that allow for the updating and creation of status information.



Coordinating: This service provides the interface to communicate with other F-35 and legacy aircrafts. The system shares information over a secure datalink with other aircraft and control centers for situational awareness.

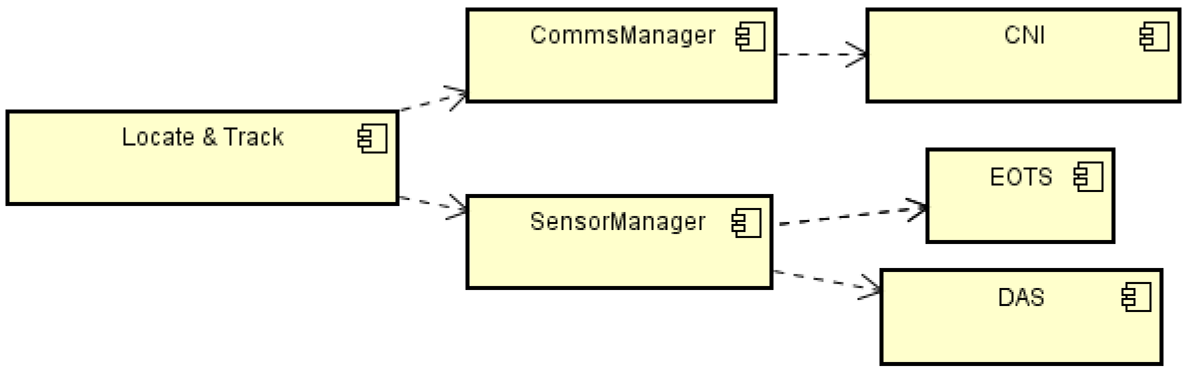
CommsManager: This represents the service interfaces needed to integrate the CNI and MADL with the aircraft's main computer.

CNI: This represents the service interfaces that provide a reliable and efficient delivery of voice and data, and intercom audio communication between pilot and ground crew.

SecurePersistence: This system provides the service interfaces needed by the system to secure data meant to be coordinated between pilot-to-pilot, or base-to-pilot and vice versa.

MADL: This service provides the interfaces needed by the system to establish fast switching narrow directional communications data links between aircrafts.

Log Activity: This represents the service interfaces used to log aircraft status levels. Services include query methods that allow for the update of aircraft status.



Locate & Track: This represents the service interfaces needed to integrate the communication and tracking of entities.

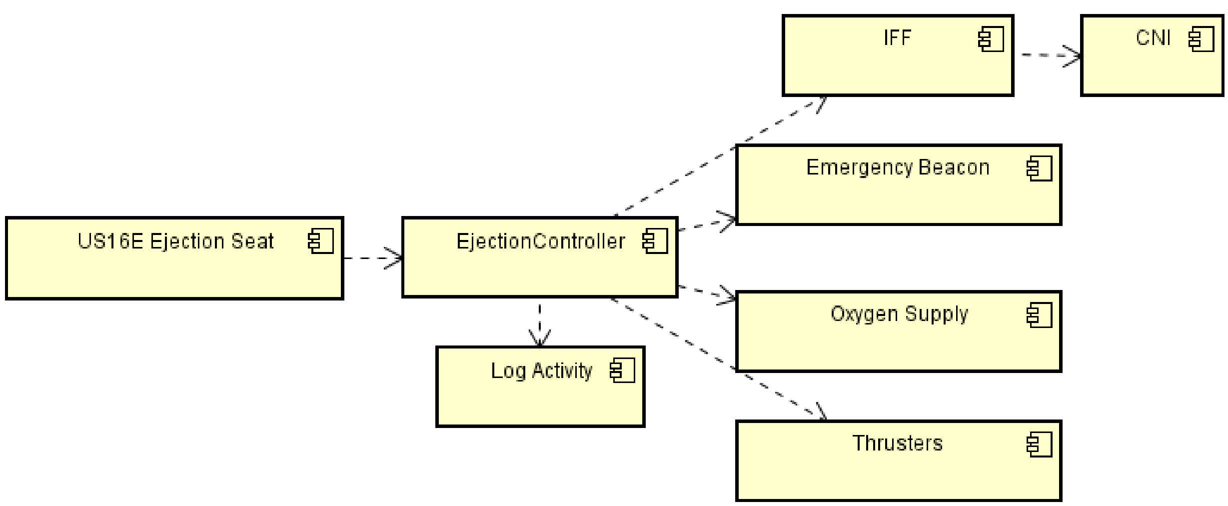
CommsManager: This represents the service interfaces needed to integrate the CNI with the aircraft's main computer.

CNI: This represents the service interfaces that provide a reliable and efficient delivery of voice and data, and intercom audio communication between pilot and ground crew.

SensorManager: This represents the service interfaces needed to integrate the EOTS and DAS with the aircraft's main computer.

EOTS: This represents the service interfaces used by the system to identify areas of interest and perform reconnaissance.

DAS: This represents the service interfaces needed to provide 360-degree situational awareness. Services include locating targets surrounding the aircraft.



US16E Ejection Seat: This represents the service interfaces that allow the pilot to eject the seat system in case of emergency. This ejection system act as a parachute and land on the ground.

EjectionController: This represents the service interfaces needed to trigger each of the ejection services. Services may include triggering an oxygen supply.

IFF: This represents the service interfaces needed to integrate the CNI to the aircraft's main computer. Services include identifying friend or foe.

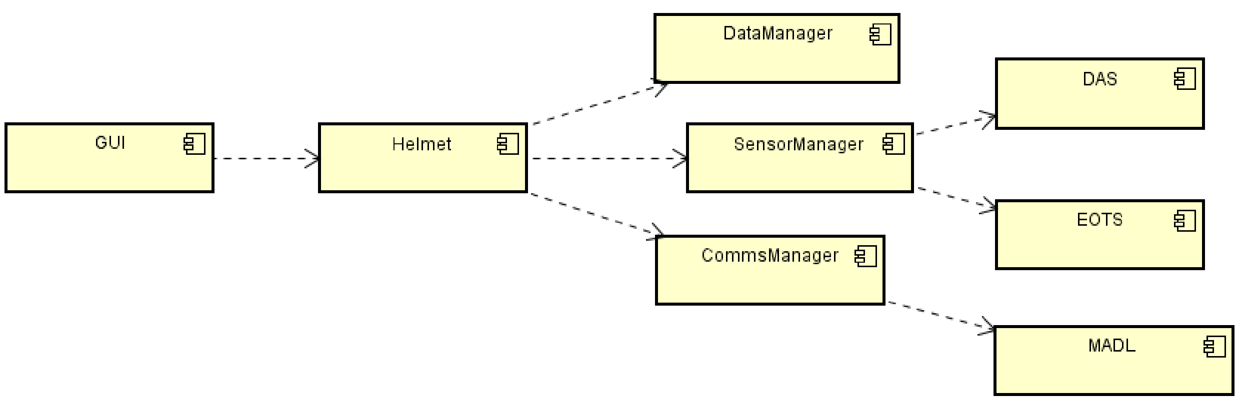
CNI: This represents the service interfaces that provide a reliable and efficient delivery of voice and data, and intercom audio communication between pilot and ground crew.

Emergency Beacon: This represents the services needed to communicate with friendly targets. Services include describing pilot's location after ejection.

Oxygen Supply: This represents the service interfaces that provide oxygen to the pilot through the helmet.

Thrusters: This represents the service interfaces needed to calculate the stability. Services include reading the gyroscope and adjusting thrusters accordingly.

Log Activity: This represents the service interfaces used to log aircraft status levels. Services include query methods that allow for the update of aircraft status.



GUI: This represents the services the screen needs to implement the interface between the pilot and all the functionalities the helmet provides.

Helmet: This represents the service interfaces needed to coordinate the information gathered from different functionalities, these services can include displaying aircraft status.

DataManager: This represents the service interfaces needed to gather aircraft status information.

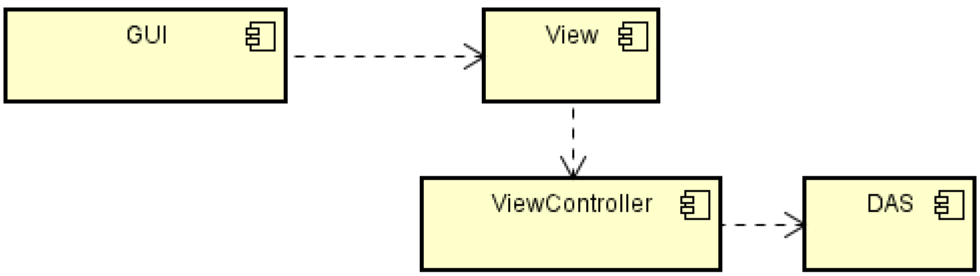
SensorManager: This represents the service interfaces needed to integrate the EOTS and DAS with the aircraft's main computer.

DAS: This represents the service interfaces needed to provide 360-degree situational awareness. Services include locating targets surrounding the aircraft. Services may include the displaying of a 360 view around the aircraft with the use of infrared sensors.

EOTS: This represents the service interfaces used by the system to identify areas of interest and perform reconnaissance.

CommsManager: This represents the service interfaces needed to integrate the MADL with the aircraft's main computer.

MADL: This service provides the interfaces needed by the system to establish fast switching narrow directional communications data links between aircrafts.



GUI: This represents the services the screen needs to implement the interface between the pilot and the night vision service.

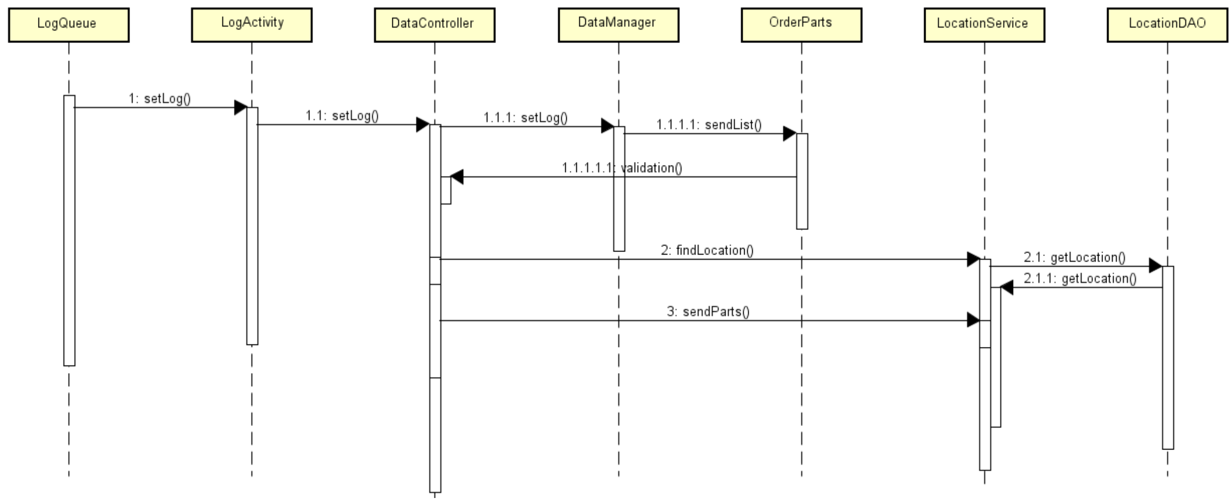
View: This represents the service interfaces needed to trigger the night vision service from the ViewController.

ViewController: This represents the service interfaces needed to integrate the DAS with the aircraft's main computer.

DAS: This represents the service interfaces needed to provide 360-degree situational awareness. Services include locating targets surrounding the aircraft. Services may include the displaying of a 360 view around the aircraft with the use of infrared sensors.

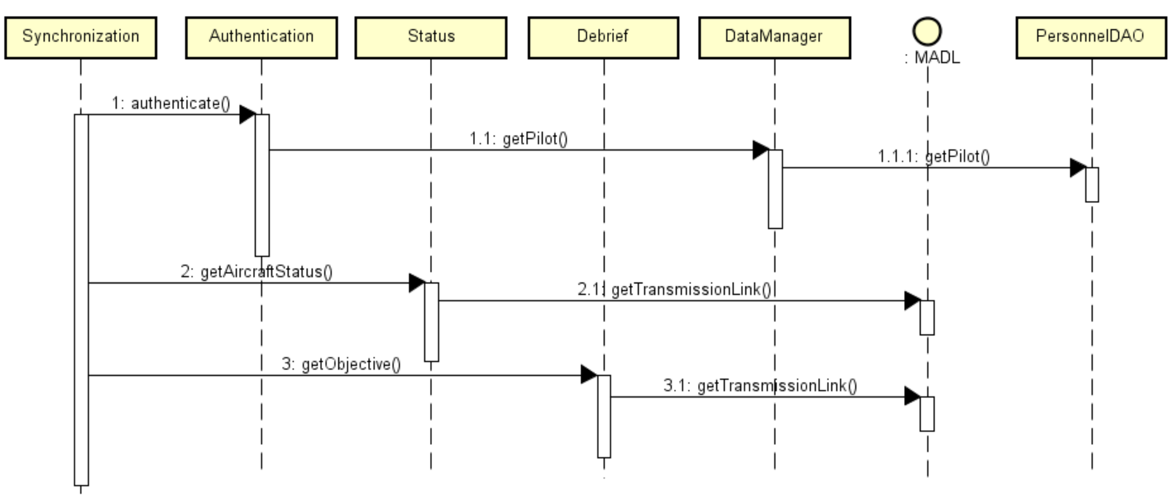
5. Dynamic View [Phase 2]

1. Log Activity Sequence Diagram



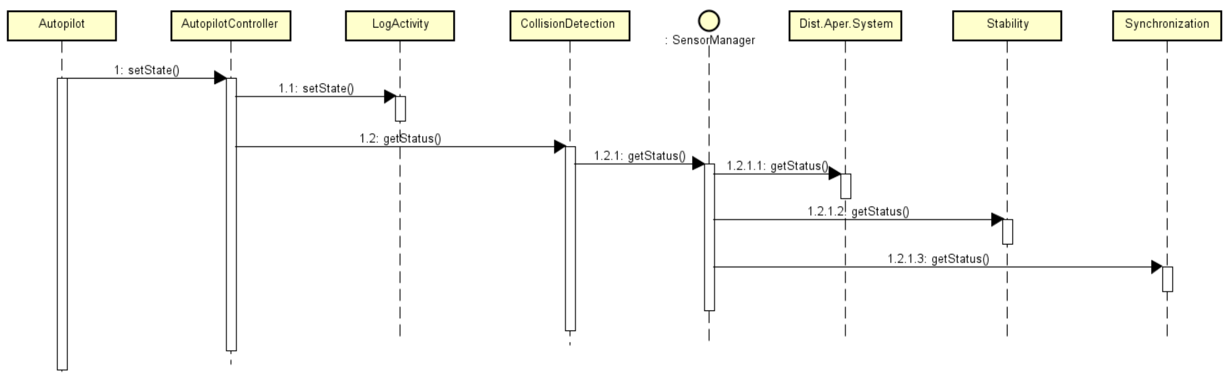
This sequence diagram describes the functionalities that goes into logging that activity of the aircraft, specifically its parts. The logs arrive in and gets written in batches (batch-processing), and this logQueue is the buffer that holds them until it gets processed. The logActivity class gets these batches and passes them to the DataController, that then writes it to DataManager. Simultaneously while the logs are saved and sent to the OrderParts component, the LocationService does it function in retrieving the flight logs of the F-35 (of its current and future locations). When the logs are validated (meaning that it has been successfully processed) and location is known, is when the DataController can then send the parts to where it is then needed.

2. Synchronization Sequence Diagram



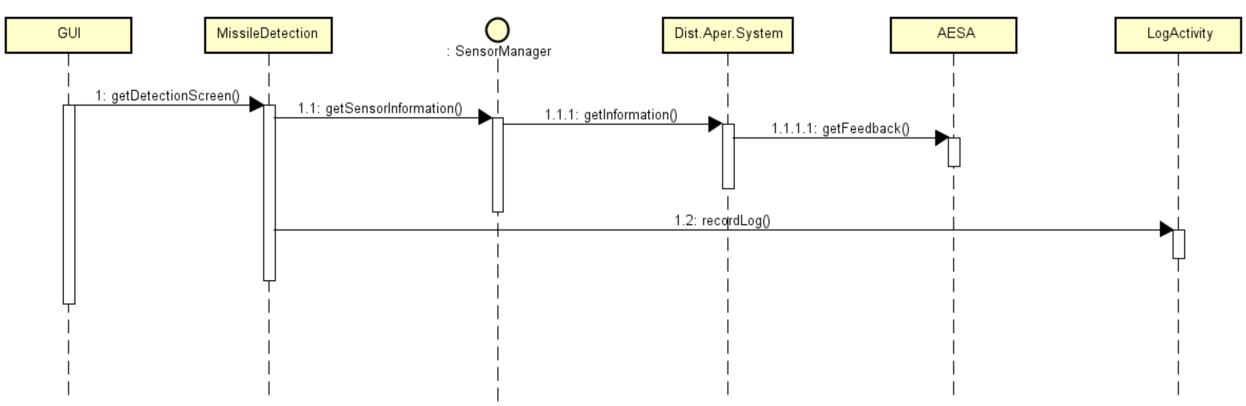
This sequence diagram describes what goes into the initial “start-up” when the pilot enters the aircraft and starts the systems. The synchronization sequence first starts out by authenticating the pilot, by going to DataManager, that then retrieves the appropriate information from the PersonnelDAO. Simultaneously, the aircraft status is retrieved from the Status component, that gets the Navigation information from the MADL (Multifunction Advanced Data Link). The mission debrief to is an important part of Synchronization, that is retrieved from the MADL.

3. Autopilot Sequence Diagram



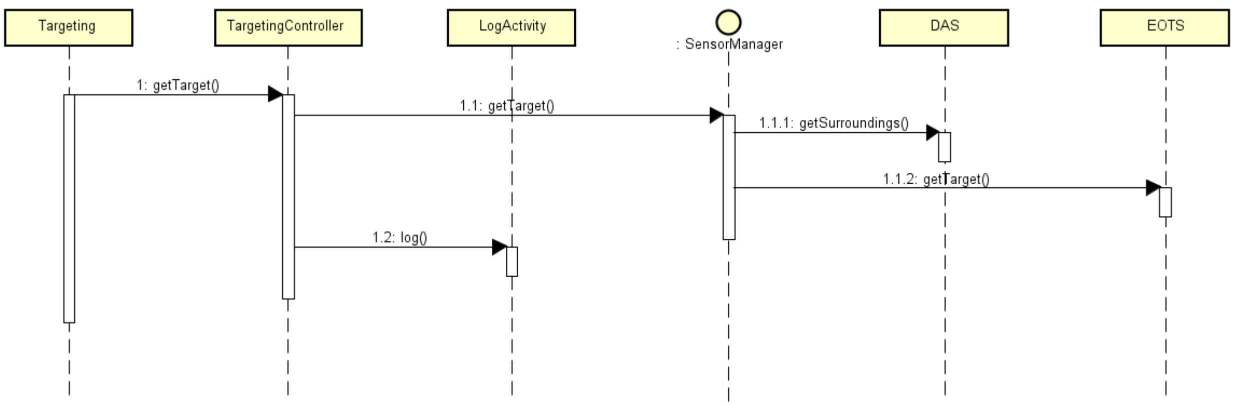
This sequence diagram describes the Automated pilot class, in setting the controls and retrieving status from its on-board sensors as well as coordinating with other classes. First, in this sequence diagram, the current state is saved (hypothetically according to the human pilot’s commands), to the pilots’ own levels of altitude, speed, etc. Concurrently, it will pass the information to the LogActivity class, as well as to the CollisionDetection. From there, it will access the SensorManager interface that will then retrieve the status from all its systems and classes, such as the Distributed Aperture System that includes the functionality of spherical awareness.

4. Missile Detection Sequence Diagram



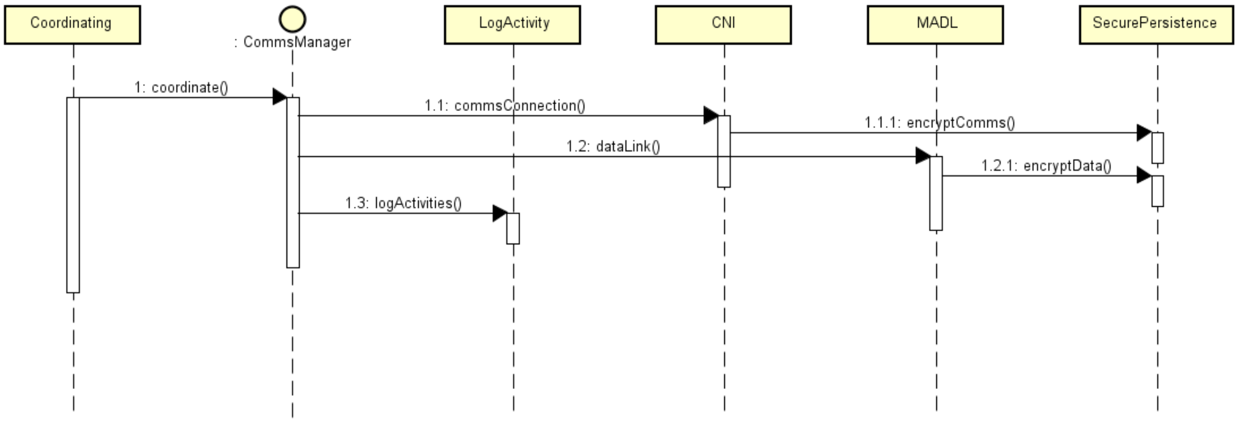
This sequence diagram describes the actions that goes into the Missile Detection function that displays to the pilots' helmet and dashboard. This is a reactionary sequence in response to a missile. Thus, when a missile first appears, whether a 100 miles or 800 miles away, it can be immediately detected by the AESA (Active Electronic Scanned Array), and the information will be recorded and logged to the LogActivity class. These functions combined with the DAS send real-time information to the SensorManager, that then compacts and transition the information to the MissileDetection class, that then sends it to the pilots' helmet and dashboard (GUI).

5. Targeting Sequence Diagram



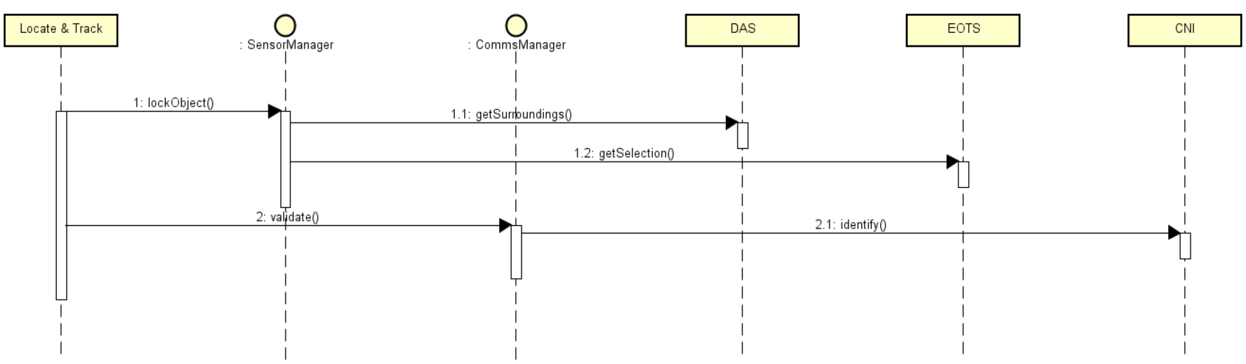
This sequence diagram describes the actions of selecting a target in the range of the F-35, specifically the pilot designating which target and in extension, the steps that the F-35 systems do to deliver that request. First, transitioning from the Long range Tracking sequence diagram, as will be explained later, the Targeting class takes over in the series of steps in achieving mission success. When the opposing airborne targets have located and tracked, the pilot can then select which foe to target and lock on. The TargetingController will access the SensorManager interface, that then retrieves the following functions from the DAS (imagery, to route the dashboard), and the targets(to route to the dashboard as well). This information (of the number of airborne targets and where, is logged and sent to the LogActivity class). From there on, the pilot themselves can then choose what to do next.

6. Coordinating Sequence Diagram



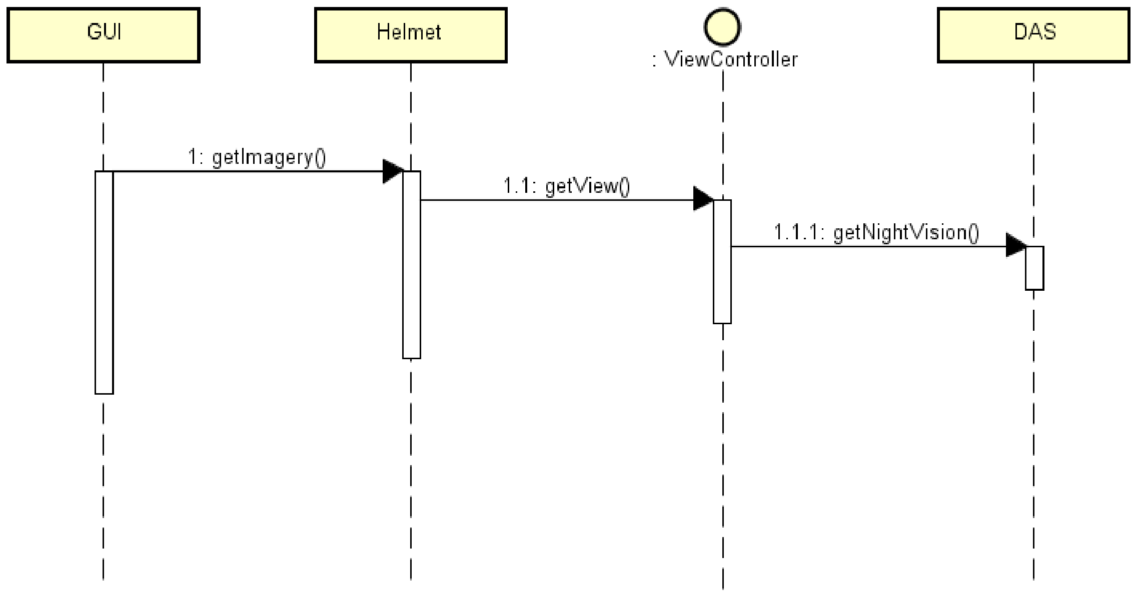
This sequence diagram describes the coordination that goes between the F-35 and its friendlies (specifically their squadron). First, after the pilot chooses to establish communication, the CommsManager will handle that request. The CommsManager will establish the links for comms and data, to the CNI (Communication, Navigation, Identification) system and the MADL, respectively. However, establishing and transmitting these links need to be secure, and so the links will by encrypted with the SecurePersistence class

7. Locate & Track



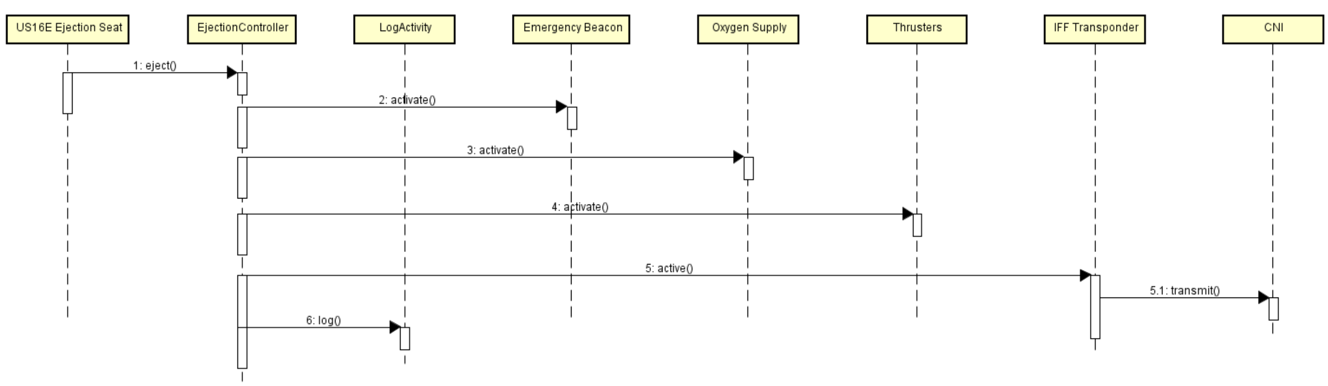
This sequence diagram describes the Locate and tracking function, whether on ground, sea, or air (missile, or jet). For this sequence, the object that will be located and tracked, will be an opposing jet. The jet first comes into the operational range and while simultaneously detected by the EOTS the SensorManager interface will retrieve the surroundings and update the imagery from the DAS to the dashboard. The friend-or-foe identify will then be handled afterwards by the CNI component.

8. Night Vision Sequence Diagram



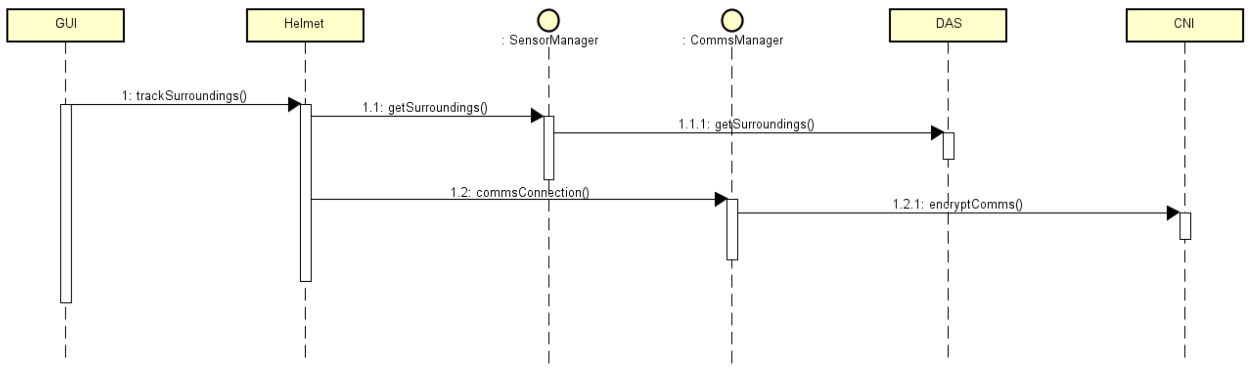
This sequence diagram describes the request of the pilot selecting night vision being executed in the system. To get night vision, the imagery must be retrieved from the DAS, that can only be accessed through the ViewController. When the following request is handled and retrieved, it is routed to the pilots' helmet mounted display.

9. Ejection Sequence Diagram



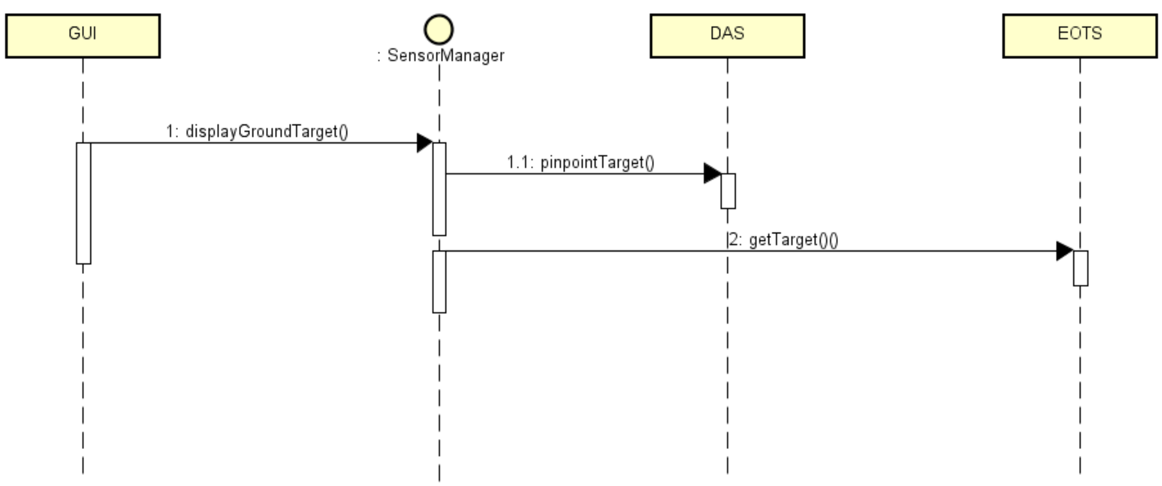
This sequence diagram describes the ejection activities. There are a lot that actually goes into this one component, into the pilot ejecting from their F-35. This sequence diagram focuses mainly on the US16E ejection seat. When the ejection is initiated, the EjectionControler activates the following EmergencyBeacon, Oxygen Supply, and thrusters. One prominent function is the IFF Transponder (Identify Friend or Foe) that transmit signals under the CNI component. The following information of the pilots' location (emergency beacon) is logged.

10. Situational Awareness Sequence Diagram



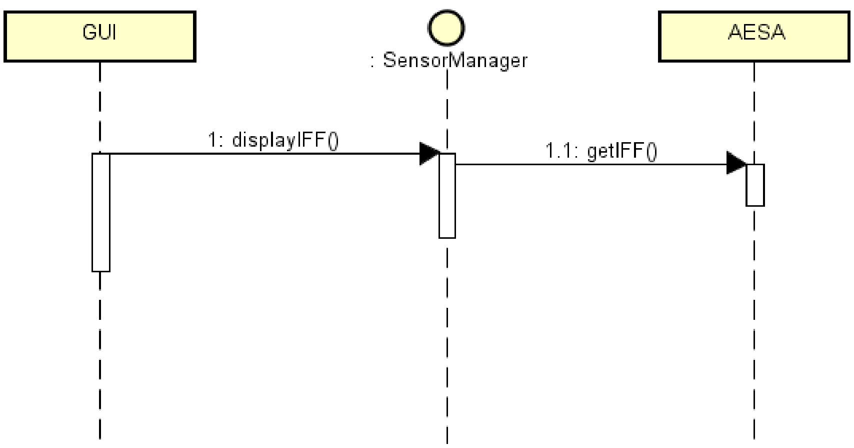
This sequence diagram describes the situational awareness functionality that relates to keeping track of the friendlies to the side of the F-35 in its 360° surroundings. The friendlies will appear on the dashboard and helmet GUI through the use of the SensorManager and CommsManager interfaces. Keeping track of the friendlies needs the use of the DAS and the comms supported by the CNI component. The seamless transition of the outside surroundings and tactical data to the GUI display greatly improves the pilots advantage going into their mission.

11. Ground Pinpoint Sequence Diagram



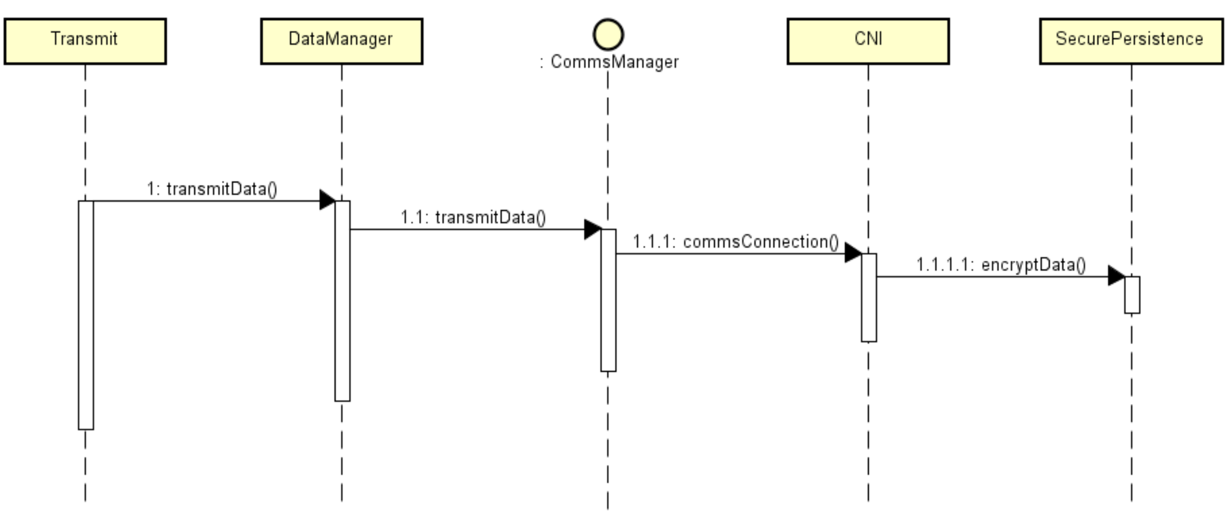
This sequence diagram describes the actions taken in response to a sudden ground SAM (Surface-to-Air Missile). As soon as the SAM is detected by the EOTS, the F-35's DAS can also simultaneously pinpoint where the SAM came from. The pinpointed target as well as the missile heading for the jet (or other friendlies) is sent back through the SensorManager interface and displayed to the GUI.

12. Long Range Tracking



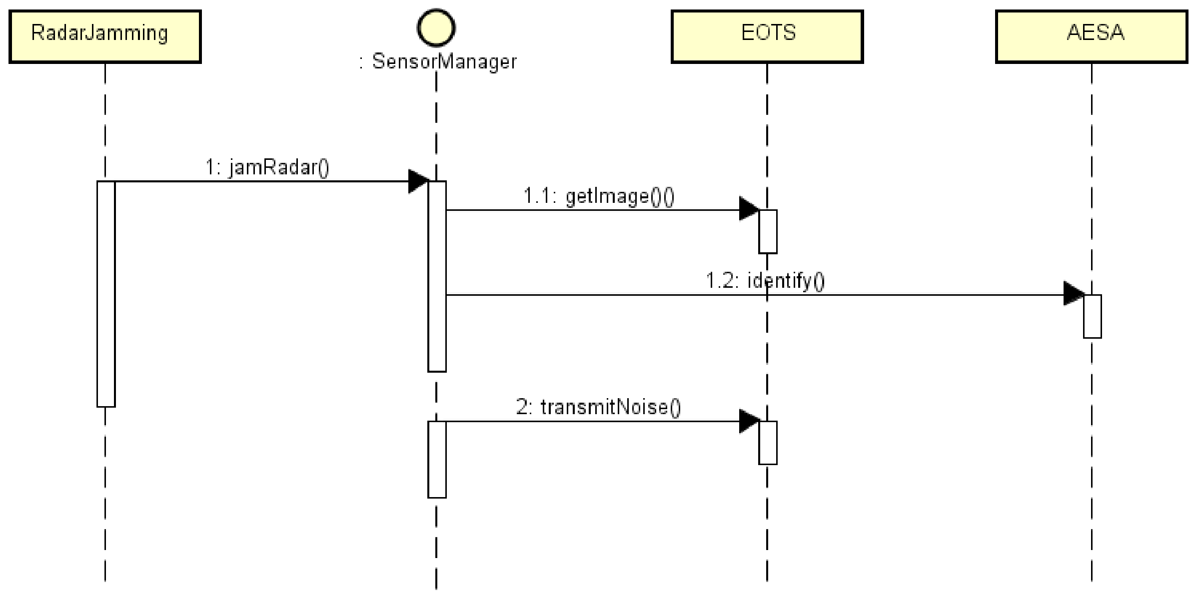
This sequence diagram describes the seemingly simple long range tracking of any airborne objects in the range of the F-35. The automatic display of either friendlies or foes will be handled by the SensorManager controller retrieving the active AESA radar, that sends out beams of signals in various instantaneous directions, and when locates the new acquired unidentified object, can also as well identify. This information is then sent back quickly, and seamlessly to the GUI dashboard.

13. Transmit Data HQ



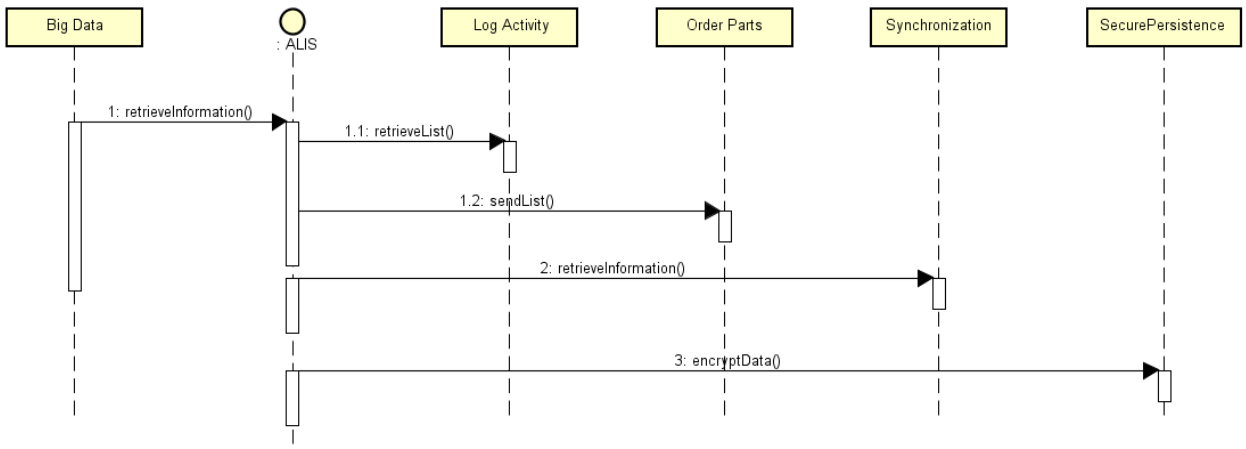
This sequence diagram describes the highly-sensitive transmission of data to HQ (headquarters) from the F-35. First, the transmitData function is passed to the DataManager, to retrieve the appropriate internal data, and as well transmit it. The data that will be sent needs to be over a connection, and in extension, needs to be secure. Thus, the CommsManager will establish a link through the CNI, and will be encrypted with the SecurePersistence class. The transmission can be done either by the pilot or appropriate personnel or authorizations such as HQ, or a mobile command center (e.g., Aircraft Carrier)

14. Counter Jamming Sequence Diagram



This sequence diagram describes the steps in countering radar jamming. The activities pertaining to radar jamming is almost entirely on the sensors on board the F-35. To explain how radar jamming works, a radio frequency signal is emitted to overpower or mess with the enemy radar. Radar jamming isn't solely just suppressing the enemy radar, it can as well be making false targets, or network attacks that is handled by the EOTS. As mentioned, the F-35 can emit a superior overpowering signal to disrupt enemy radars, this is what is known as "noise" and can be carried out by the Electro-Optical Targeting System.

15. Big Data Sequence Diagram

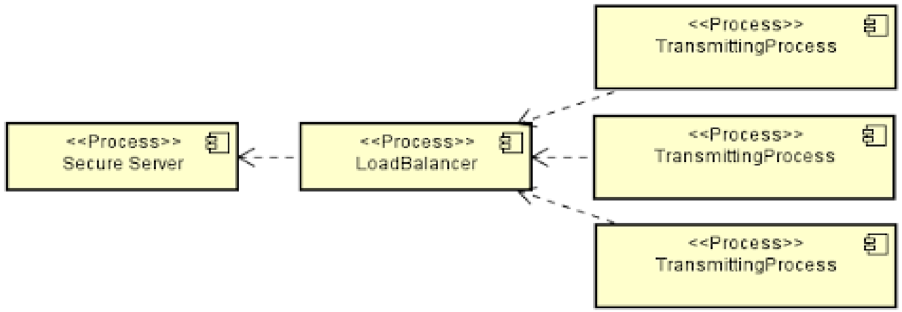


This sequence diagram describes Big Data that is important in keeping the fleet-wide F-35s operational and ready. The ALIS (Autonomic Logistics Information System) is a critical service for keeping track and even maintaining the large number of F35s. As the F35s are a decades-long rollout for not only the US, but to 11 other countries, the information needed to keep track of each single of the jets will be critical to any countries' military, most importantly for the largest customer that is the U.S that is projected to have over 2,300 F35s at the end of the contract. ALIS will retrieve all the information from each F35 about their parts, on how far into their life-expectancy the parts are in, and if recommended, will order the parts. Not only can it keep track of the maintenance for the jets, but it also has the capability for operations. Of course, the up-to-date sensitive information on each aircraft will be encrypted with the SecurePersistence class.

6. Process View

Proc01 Back-End Processes

This diagram presents the GUI interfaces and how a load balancer works to increase performance scaling and availability. This is important in our system since, for example, all the data that goes in in the pilot is recorded and transmitted into the HQ's database for viewing, even what the pilot is seeing through his/her helmet. Due to this large amount of data being transmitted, and the unpredictable amount of F-35s in flight, scalability is an issue which can be provided with a load balancer. This load balancer will work with the databases and HQ's applications to not overwork them with the amount of information that is being sent.



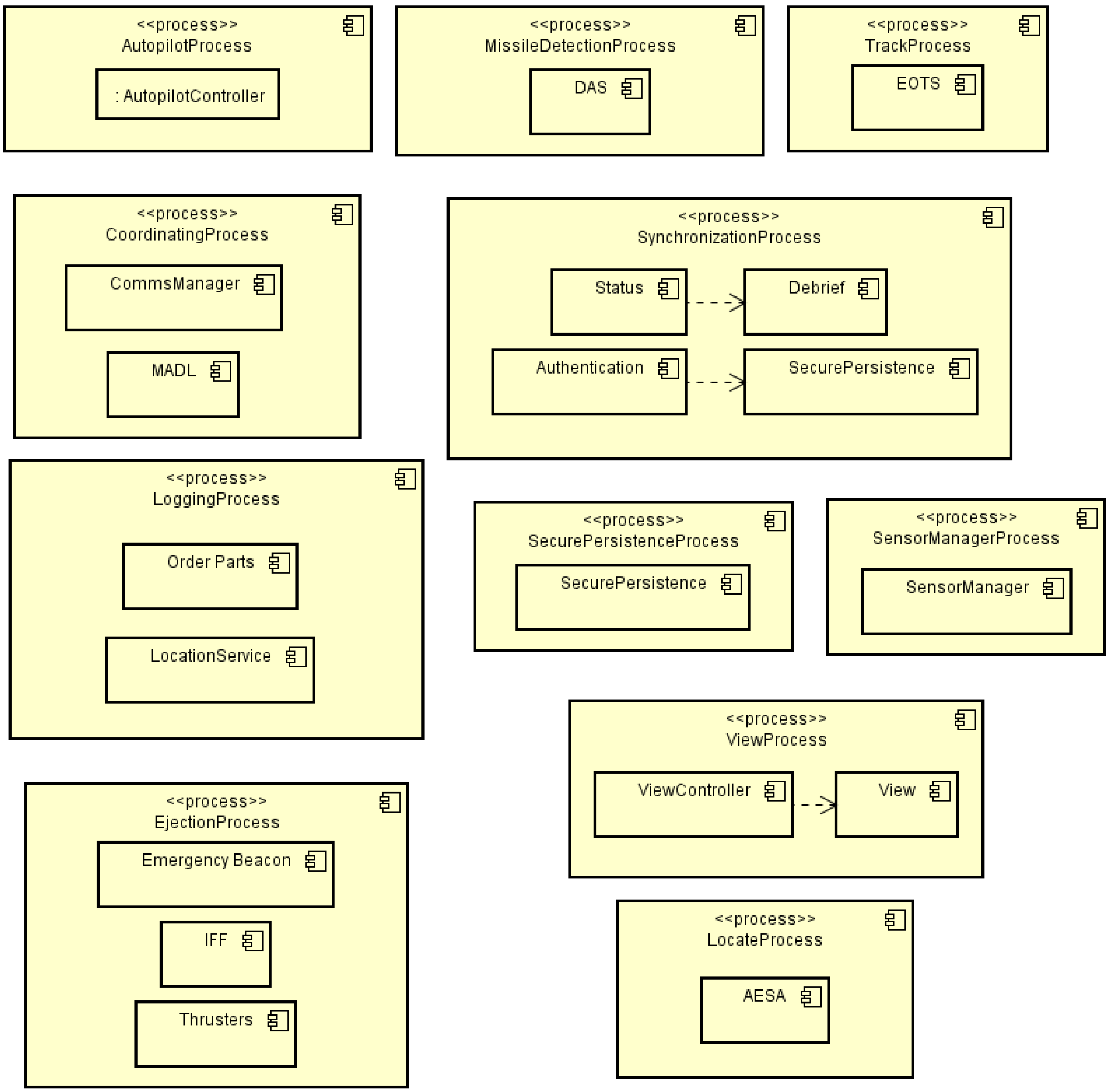
Secure Server: This is the database in HQ where data is being sent from the pilot, and all the data must be stored securely.
LoadBalancer: This technique helps provide performance scaling and availability, and acts as a front-end to all client transmissions.
PresentationProcess: These represent the different processes of the aircraft that have the information that will be sent to the secure server.

2. Proc02 Application Processes

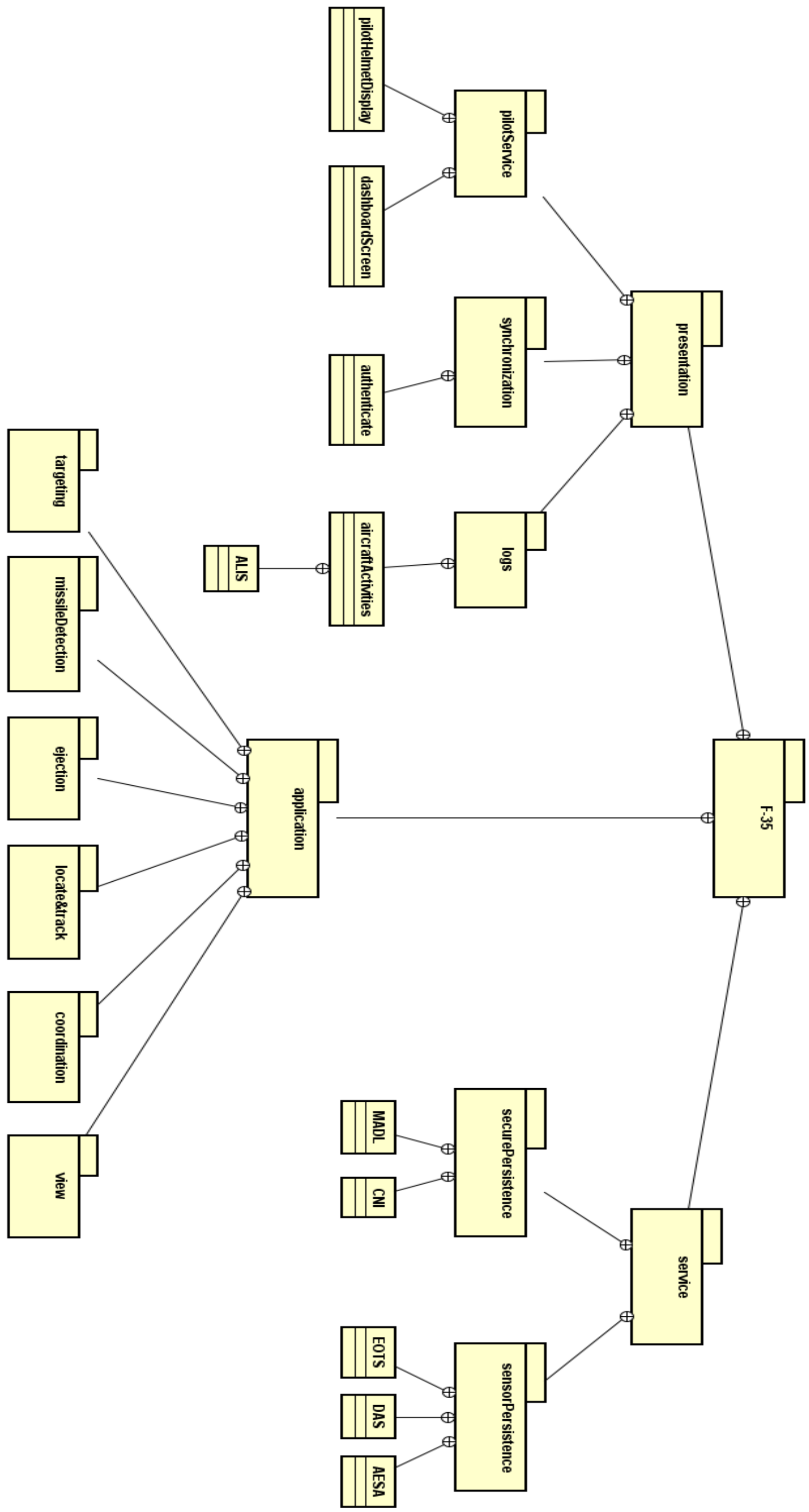
This diagram represents the view of the system and maps the logical view into the process view. It describes the system's decomposition into executing tasks and processes by grouping the processes into elements with high cohesion, and this process view of the system is mapping the logical view into threads of control.

AutopilotProcess: This task contains the controller which triggers the different elements needed when the pilot decides to put the aircraft on autopilot.
MissileDetectionProcess: This task contains contains the process that is primarily used for missile detection awareness.
TrackProcess: This task contains the process that is primarily used to identify areas of interast.
CoordinatingProcess: This task contains the processes needed to establish a connection with other entities to be able to communicate with them through voice or data.
SecurePersistenceProcess: This task contains the process required to persist data securely which can be important when gathering the mission debriefing.
SensorManagerProcess: This task contains the process that can gather information from the sensors, both to provide
SynchroniztionProcess: This task contains the processes that are needed to have up-to-date information that is secure.
LocateProcess: This task contains the process that is primarily used for long-range situational awareness.
LoggingProcess: This task contains the processes that are needed to log aircraft status information and then order parts per what may be needed from the log.

EjectionProcess: This task contains the processes that are needed to provide major support throughout the pilot ejection process.
ViewProcess: This task contains the processes that are primarily responsible for providing the interfaces that the pilot interacts with.



7. Development View

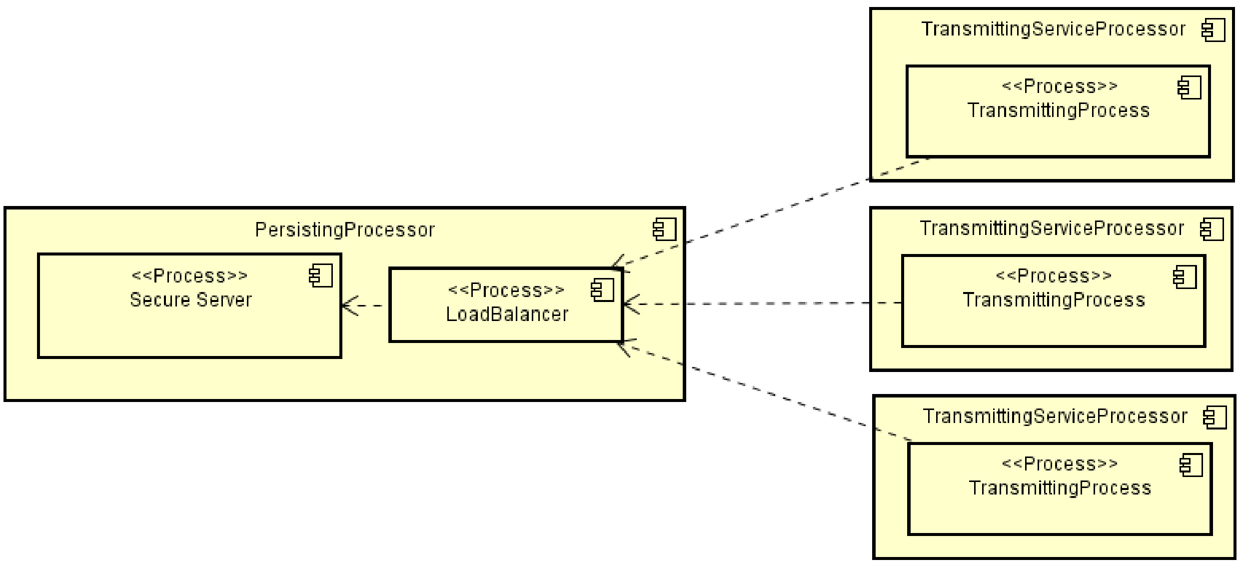


8. Physical View

Architecture diagrams of the hardware infrastructure showing the mapping of components, processes and code files to hardware nodes.

Phy01 Load-Balanced Transmitting Deployment

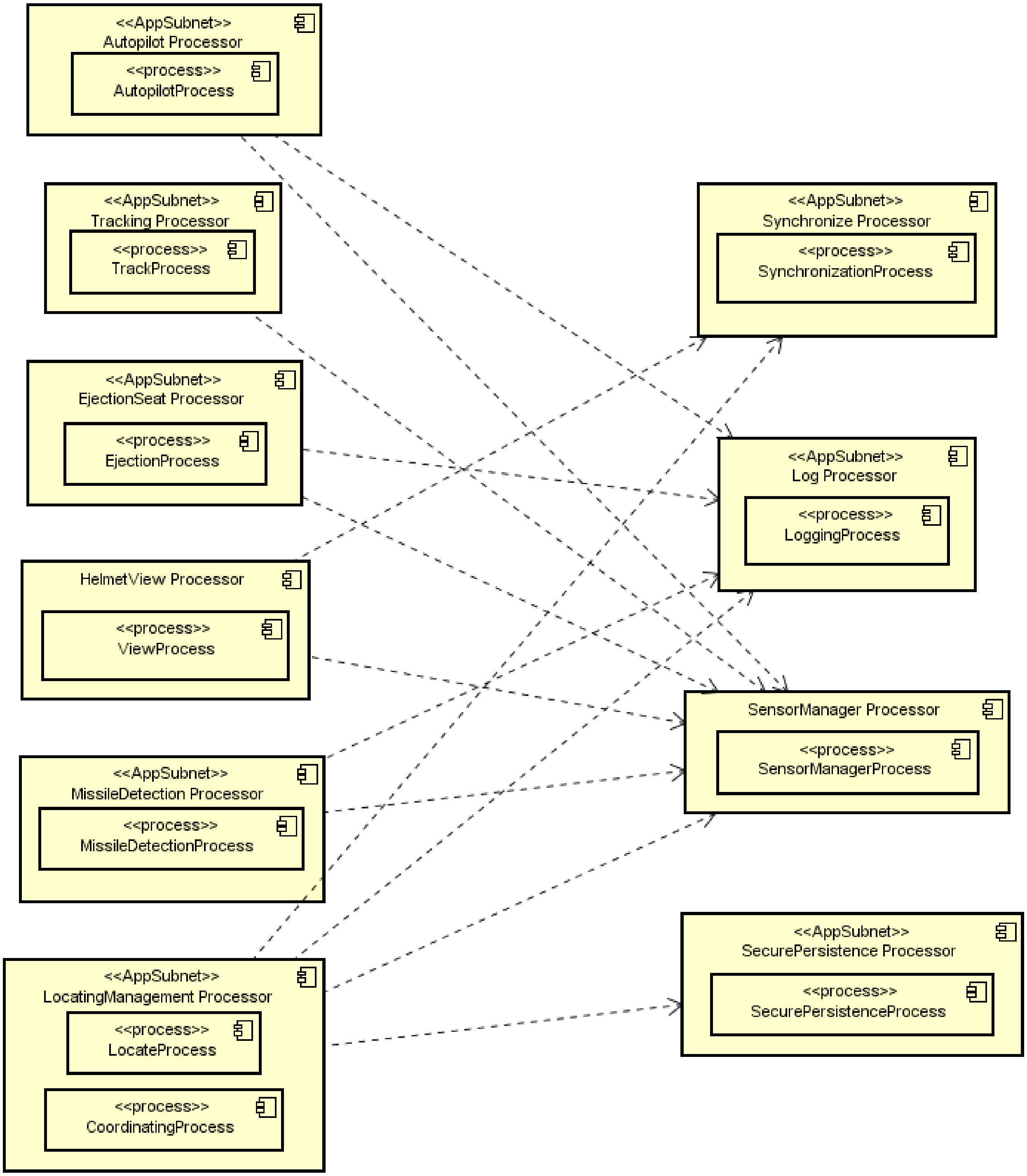
This diagram presents the mapping of processes to hardware nodes. As you can see, the load balancer is on the same node as the server, this is so that the load balancer can receive all requests (data) from the different aircraft's processes to be able to direct that data to the different servers to not overwork them. This will then allow servers to run at max performance and efficiency.



Phy02 Application Deployment

This diagram presents the mapping of the different processes in an aircraft to the different hardware nodes to show how the software is deployed onto the hardware infrastructure. It also shows the associations between nodes, which can be seen through the dotted lines signifying the interactions.

SE 4352 Design Project



9. Conceptual Framework (Glossary)

Stakeholders: People eager to see a successful completion of the technology

Event-Driven Architecture: Software Architecture pattern promotes production, detection, consumption of, and reaction to events

Logical View: view of the static structure of the architecture in terms of its components, their interconnections, and the interfaces and operations offered by the components.

Sensor Fusion: enables pilots to draw information from all of their on-board sensors to create a single integrated picture of the battlefield

AESA Active Electronically Scanned Array

ALIS Autonomic Logistics Information System

CNI Communications, Navigation, Identification

DAS Distributed Aperture Systems

EOTS Electro-Optical Targeting System

HQ Headquarters

MADL Multifunction Advanced Data Link

10. Conclusion

Although the recommended approach is to have a low-coupling software architecture, this system has elements where components are dependent on each other, sometimes resulting in high-coupling. However, this is one of the aims of the system's main goals, Sensor Fusion. This is the seamless integrated picture of what is transpiring around the pilot, that behind the screen, are many sensors working together supported by the F-35s Integrated Core Processor. This sophisticated advantage derived from the non-functional requirements is one of many reasons why the F-35 is hailed as the next generation fighter jet.

There are many more non-functional requirements that must be met, such as the response time and documentation of data. One of the F-35's function is to perform reconnaissance, that is record, log, and send the data back to the appropriate command centers, such as the airbase, aircraft carrier's command center, or to Air Force One. The security and accessibility NFR is then the next requirements that needs to be met to deliver this one function of reconnaissance.

The biggest nonfunctional requirement in my opinion, is the security NFR. The system shall be as close to 100% secured because the software, sensors, hardware, etc. of the F-35, are what gives the utmost advantage to the US and the other 11 countries against their foes. In 2011, the US RQ-170 drone (UAV) was hacked by the Iranian cyberwarfare unit, that Iran has since claimed to have extracted the data and reverse-engineered the drone. The ever-increasing cyberwarfare capabilities then and now are what places limits to the aircraft and to the security NFR. Yet, this too has made the security NFR to be that much more important. The security NFR absolutely must be satisfied, to prevent the aircraft and its systems from being hacked into, to as well delete its data in the potential events of being recovered by an unauthorized user (e.g., Iran, Russia, etc.).

A risk is not only within a design, but also from the outside world. There are many risks involved in today's world, as mentioned already, cyberwarfare. Other risks are the hotspots such as in Syria and Afghanistan, where there are operations happening currently. In Syria, there are multiple countries operating over a single zone walking on a fine line as to not provoke the other. This is where communications have been established to not accidently conflict with one another. However, if for various reasons, communications are down or silent, the AESA radar will give the F-35s a heads up about other jets in their range. Here, the F-35s non-functional requirements of Reliability and Response Time are met and exceeded as the F-35s have a stronger, wider range of locating other jets first than other legacy aircrafts.

This high-tech sophisticated aircraft is not without argument however. There are issues pertaining to its well-agreeable exuberant costs for the F-35s, each one about 100 million USD, costs varying between the different three F-35 models. The criticism from the public to even within the government has led to decreased costs for the F35 program, where it is certain the future F-35s will be affected and limited in its capabilities to stay within budget.

In conclusion, in taking in account the nonfunctional requirements, limitations, advantages, risks and issues: The F-35 is by far this is the most advantageous fighter jet and system in the world.