Literature Review

This deliverable is the first part of the summative assessment and feedback from this submission will help you in the focus and direction of the main report and project implementation. The purpose of this submission is to demonstrate your understanding of the wider issues related to the project through an extensive literature review. The literature review should provide justification of your project and set the context by discussing and critically evaluating the past and current relevant literature sources. The review should conclude with a summary highlighting the main gaps and opportunities discovered and proposing the future direction of the research/ implementation.

The Literature Review will be graded based on the following aspects (the grading grid is available in Appendix C and on moodle.)

* Relevance and quality of sources
* Use of academic references
* Analysis of context and consideration of alternatives
* Evidence of systematic review of appropriate sources of information
* Evidence of critical appraisal of techniques and practices used in previous research or professional practice
* Evidence of organisation of an clear argument
* Summary of literature review and presentation of research question
* Overall presentation and structure

**Titles Sections**

Background

Flight Tracking Technology

ADS-B

MLAT

Comparison of ADS-B and MLAT

Flight Tracking Application Programming Interface

OpenSky Network

FlightAware

Augmented Reality

Metro AR google WebGL or WebJL globe

Chrome experiments

Amcharts

Usability Concepts

User Experience

Desirability

Comparison of Features and Design

This review aims to research into flight tracking technology, how augmented reality aids in user experience, the use of augmented reality in other fields of mobile applications, and techniques used to assist in usability of mobile applications. It also compares current flight tracking mobile applications and critically evaluates relevant features with the study of reviews.

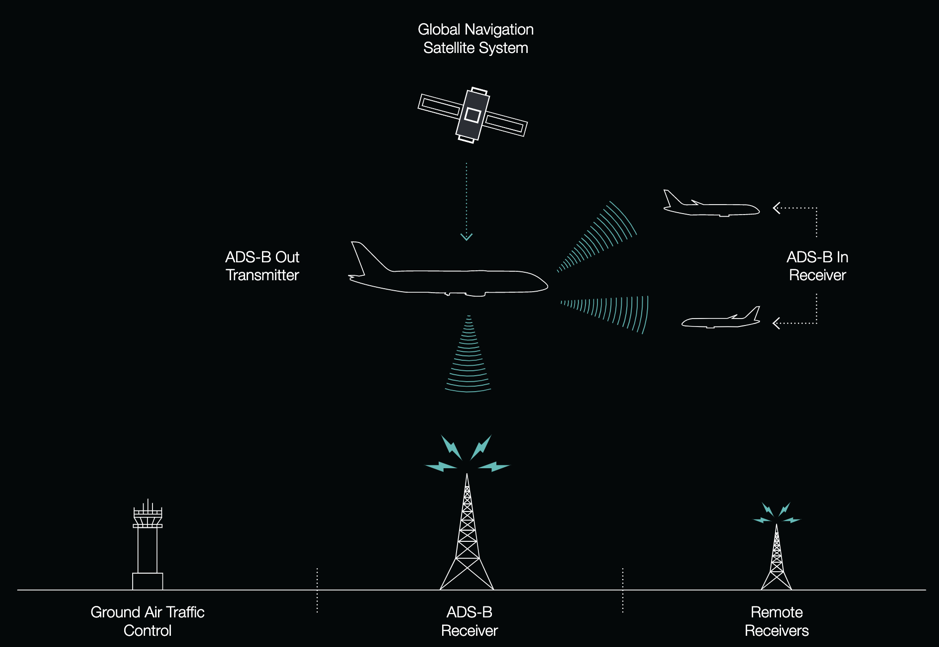
* 1. Flight Tracking Technology

The technology behind flight tracking comes from combining multiple data sources such as ADS-B and MLAT. This data is combined with aircraft schedules and statuses of flights which are acquired from airlines and airports. Newer aircraft such as all Airbus models, Boeing models between 737-787 are equipped with Automatic Dependent Surveillance-Broadcast (ADS-B) transceiver whereby it transmits signals containing data about the flight such as location, altitude etc. (“How flight tracking works - Learn how we track flights | Flightradar24,” n.d.) The data is transmitted at a frequency of 1090 MHz with a transmitting pulse length of 120 μ s allowing for data to be received by anyone/network with the appropriate ADS-B receivers. (Huang, Narayanan, & Feinberg, 2008) Older aircraft which are not equipped with the newer ADS-B transceivers can be located by calculating their position using Multilateration (MLAT). This uses a method called the Time Difference of Arrival which measures the time a signal is received from an aircraft using an older transponder, the ModeS, whereby the position can then be calculated. (“How flight tracking works - Learn how we track flights | Flightradar24,” n.d.) The literature will convey the benefits and disadvantages of the data receivers to convey which one is better suited to retrieve flight data or if a combination of the two is more beneficial.

1.1.1 Automatic Dependent Surveillance-Broadcast (ADS-B)

Air Traffic Management systems will face considerable challenges over the coming decades due to rapid growth in air traffic and demand. America alone expected in 2015 for air traffic to increase by 25-30% and in some cases exceed that prediction. (Huang et al., 2008) Modernisation of flight tracking has been gradual with places such as western China beginning to consider ADS-B tracking due to restrictions of terrain and meteorological conditions preventing construction of new radar stations. (Zhang, Liu, & Zhu, 2011) Developed countries/continents such as Europe, United States, Australia, Canada and others are beginning to enforce/drive ADS-B as a mandatory requirement on aircraft by 2020 (“How flight tracking works - Learn how we track flights | Flightradar24,” n.d.) within their respective airspace making ADS-B data sources favourited by tracking applications for future data retrieval due to the drive to expand the network world-wide. (“ADS-B: 2019 & Beyond,” n.d.) ADS-B is a composition of CNS/ATM (Communication, Navigation and Surveillance/Air Traffic Management) and the recommended surveillance method by the ICAO (International Civil Aviation Organisation) for the future generation of ATM.

With the use of ADS-B, air traffic control will change from a radar-based system into a satellite-derived location system. The change will increase safety as aircraft will no longer rely solely on ATC as aircraft will have surveillance of other aircraft. (Part III Department of Transportation Federal Aviation Administration 14 CFR Part 91 Automatic Dependent Surveillance-Broadcast (ADS-B) Out Performance Requirements To Support Air Traffic Control (ATC) Service; Final Rule mstockstill on DSKH9S0YB1PROD with RULES3, 2010) This surveillance will greatly improve a pilot’s situational awareness of the traffic environment due to data of location and bearings being transmitted by aircraft in close proximity. (Huang et al., 2008) Additionally from this change brings enhanced accuracy and speed of data beneficial for precise flight positioning for tracking applications. (Part III Department of Transportation Federal Aviation Administration 14 CFR Part 91 Automatic Dependent Surveillance-Broadcast (ADS-B) Out Performance Requirements To Support Air Traffic Control (ATC) Service; Final Rule mstockstill on DSKH9S0YB1PROD with RULES3, 2010)



*Figure 1: How ADS-B works* (Richards, O’Brien, & Miller, 2010)

Although many clear advantages of ADS-B for airlines related to safety and fuel efficiency, from more direct routings, (Richards et al., 2010) airlines such as JetBlue Airways are difficult to persuade due to historic tendencies to not invest in technologies unless a compelling safety and business case is given. (“Unlocking the Benefits of ADS-B In - Aviation Today,” n.d.) However, due to the lesser cost of older technologies and the reliability of current global infrastructure ADS-B in comparison lacks the overall worldwide coverage its counterparts have established. (Zhang, Liu, & Zhu, 2011) Hence airlines are discussing whether to outfit their aircraft with newer ADS-B transponders compared to the traditional Mode S transponder rendering some aircraft hidden to ADS-B tracking. Flight tracking applications require accurate data for users and with limitations of reduced aircraft activity shows an obstacle for app developers. The problem shows that the data source is crucial for the most accurate data.

1.1.2 Multilateration (MLAT)

The International Civil Aviation Organisation (ICAO) in the early 1990s approved the model of the Future Air Navigation System (FANS) to be based on satellite and data link technology, later this would be known as CNS/ATM. As traditional air traffic control surveillance had limitations that would have constrained future air traffic growth. The solution was to upgrade to newer technologies such as ADS-B, as already discussed, SSR and MLAT. (Xu, He, Tang, & Li, 2015)

Aircraft that do not broadcast their latitude and longitude through ADS-B transponders such as older Boeing models (737-200) Bombardier CRJ/Dash models, Embraer models, Fokker 50 and most helicopters and propeller aircraft (“How flight tracking works - Learn how we track flights | Flightradar24,” n.d.) use another tracking technology called Multilateration. This uses 1090 MHz signals broadcasted by a ModeS transponder to determine the aircraft’s location from locating the source of the transmission (Xu et al., 2015) using a method called the time difference of arrival (TDOA).

This method involves using four or more receivers/ground stations to detect aircraft by taking the time for a signal to be received by one receiver at a stationary point and the time taken for the signal to be received by at least 3 other different receivers. (“Multilateration (MLAT) - FlightAware,” n.d.) As the data is transmitted the position of the aircraft will be at different distances to each receiver, therefore, the data will be received at marginally different times. The different times at which the transmissions are received can be used to accurately determine the aircraft’s position. (Xu et al., 2015) The data is transmitted to a server to be combined to calculate the latitude and longitude as shown in Figure 2. The signals also broadcast the aircraft’s transponder identification and the altitude. Using a collaboration of the information, real-time flight tracking can be provided. However, aircraft must be within line-of-sight with the receivers for an accurate position to be determined. (“Multilateration (MLAT) - FlightAware,” n.d.) Although considered real-time, calculation delays and processing latency hinder true real-time flight activity with a 4-6 second delay. (“Multilateration (MLAT) - FlightAware,” n.d.) MLAT coverage is limited to areas with receivers/ground stations present and normally only achieved at altitudes between 3000-10000 feet. Due to this limitation general aircraft flying below the range may be hidden to MLAT surveillance. (“How flight tracking works - Learn how we track flights | Flightradar24,” n.d.)

A picture containing sky, green

Description automatically generated

*Figure 2: How MLAT works* (“Multilateration (MLAT) - FlightAware,” n.d.)

Another disadvantage to MLAT can be the positioning accuracy as it can be greatly affected by the factor of Geometric Dilution of Precision (GDOP). This can be due to a large surveillance area and positioning of fixed ground stations/receivers. As the distance increases from the aircraft to the polygon created by the multiple receivers the larger the GDOP and consequentially the less accurate the positioning of the aircraft. (Xu et al., 2015)

As current airspace contains a variety of old and new aircraft successful tracking applications must be open to multiple tracking technologies to give users the full airspace traffic. Users limited to one dimension of traffic would not be drawn to an application with reduced availability. The main audience of flight trackers being plane enthusiasts diverges into different categories of interest such as airplanes (single-engine/multi-engine), rotorcraft (helicopter/gyroplane) and gliders. These different audiences should be taken into account with the choice of the data source to maximise user interest in an application.

References

Figures

Figure 1: How ADS-B works (Richards et al., 2010)

Figure 2: How MLAT works (“Multilateration (MLAT) - FlightAware,” n.d.)