END SEMESTER PRESENTATION

November 2018

ADS-B AIR TRAFFIC MONITORING AND COLLISION AVOIDANCE RECEIVER USING RTL SDR

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THE OBJECTIVE

To implement air traffic monitoring for airplanes and assist them in avoiding collisions using the ADS-B receiver and an RTL SDR.

MOTIVATION

Since the inception of the Aviation industry, aircraft surveillance and safety has been a major concern to everybody. Over the years there have been serious accidents and threat to airplanes and the passengers; due to inefficient surveillance and safety measures. Study says that about 1/5th of the accidents taking place on air are due to technical errors. Link

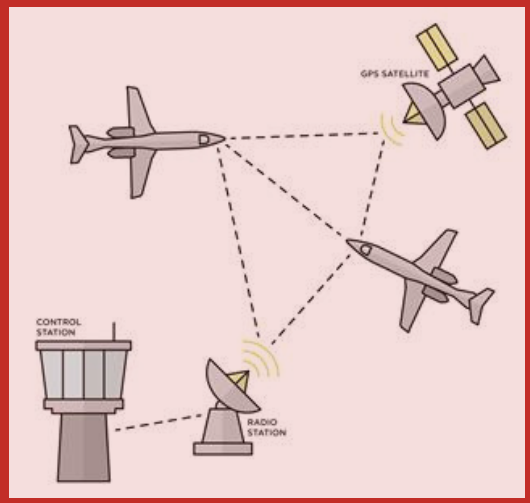
- Need to improve the safety of the airplanes in non-radar environments.
- Need to enhance situational awareness of the pilot.
- Need to improve the ability to perform search and rescue when accidents occur.

PROBLEM STATEMENT

With the world making tremendous progress in technology the number of airplanes that humans are using is increasing at a rapid rate.
Airplanes are the fastest way to travel around the world. There have been accidents and threats that are caused by the human errors and lack of reliable and secure communication between the airplanes. These collisions can prove to be deadly as the debris have devastating impact on the land. The existing radar systems are outdated and are not effective. ADS-B provides a cost effective and reliable way to detect the threat well in advance and provides foolproof solution to prevent mid air collisions(MAC).

INTRODUCTION

ADS-B is a surveillance technology in which an aircraft determines its position via satellite navigation and periodically broadcasts it, enabling it to be tracked. The proposed system periodically checks the parameter values with reference to the pre-set thresholds.When the value exceeds the threshold, a warning is given to both the aircrafts and necessary protocols are initiated to prevent collision.



LITERATURE SURVEY

PAPER 1:

"CAN SOFTWARE DEFINED RADIO BE USED TO COMPROMISE ADS-B AIRCRAFT TRANSPONDER SIGNALS?" [REF: SLIDE NO.16]

AUTHORS:

REVELS M.A, CIAMPA M.

Summary:

Air traffic control is moving from independent primary surveillance radar to the automatic dependent surveillance-broadcast (ADS-B) system. This holds the potential of reducing the total cost of deployment and improving the detection accuracy of aircraft. However, as currently being deployed these systems lack strong security mechanisms and are susceptible to a variety of radio frequency attacks. In this paper, a basic $200 software defined radio (SDR) transceiver was used to simulate an ADS-B replay attack to determine if a ground-based user could interfere with an aircraft in flight. It was demonstrated that using a low cost SDR transceiver, such an attack could not occur. The ability to record-and-replay ADS-B signals such that they would interfere with navigational systems is limited by two factors: low output power and poor transmitted signal quality. Despite the fact that attacks on aircraft have frequently been proffered by attackers at hacker conventions and by academic researchers, the research shows that these are only theoretical in nature and have not demonstrated a firm proof of concept.

Ideas Obtained:

The overview of ADS-B along with its current implementation, advantages and vulnerabilities were discussed along with the implementation of its methodology.

LITERATURE SURVEY

PAPER 2:
"KEY DISTRIBUTION SYSTEM FOR AIRCRAFT EQUIPPED WITH SECURE ADSB-IN " [REF: SLIDE NO.16]

AUTHORS:
THABET KACEM AND DUMINDA WIJESEKERA

Summary:

Lists about Primary Surveillance Radar (PSR) and Secondary Surveillance Radar (SSR) and drawbacks of these old technologies. The paper suggests a cost effective and accurate way to determine GPS coordinates of the airplanes at all times. ADSB will soon replace the traditional radar methods. ADSB has a large field and has various parameters like coordinates altitude, velocity ,bearing etc due to the size of its packets.

Ideas Obtained:

The protection and security of the data is highly essential in an ADS-B and can be done by two one-way hash chains of keys.

LITERATURE SURVEY

PAPER 3:

"DESIGN APPROACH FOR WIDEBAND FM RECEIVER USING RTL-SDR AND RASPBERRY PI" [REF: SLIDE NO.16]

AUTHORS:

SATYA NARAYANA P, SYAM KUMAR M.N.V.S, KEERTHI KISHAN A, SURAJ, K.V.R.K.

Summary:

Software defined radio replaced majority of hardware modules like mixers, filters, modulators and demodulators etc., with Software blocks in the field of radio electronics and communication. Various SDR transceiver modules can be interfaced with digital computer and aided with firmware like GNU radio, SDR shark, etc., allowing us to construct blocks with the help of built in components that decode and process the received data and produce required output. The main purpose of the software defined radio is to act as very cheap, multi operating system compatible RF front end for the wide range of the signals frequencies. In this paper, the implementation of an FM receiver along with a brief look of SDR based communication system with the help of RTL-SDR as an RF front end and implementation of some modulation schemes in GNU-RADIO with Raspberry pi as a computational device is done.

Ideas Obtained:

The theoretical analysis of Software Defined Radio, RTL-SDR, Raspberry PI and GNU Radio is performed along with the experimental setup of the WBFM receiver implemented practically using RTL-SDR.

LITERATURE SURVEY

PAPER 4:
"AIRCRAFT MONITORING BY THE FUSION OF SATELLITE AND GROUND ADS-B DATA" [REF: SLIDE NO.17]

AUTHORS:
XUAN ZHANG , JINGJING ZHANG , SHUFAN WUA, QIAN CHENG , RUI ZHU

Summary:
This paper first introduces the CubeSat mission, then discusses the integrated application of ADS-B data received from ground stations and from satellites, analyze their characteristics with statistical results of comparison, and explore the technologies to fuse these two different data resources for an integrated application. The ADS-B data received from two different resources will complement each other, such as to increase the coverage of space for air traffic and to monitor the whole space in a better way.

Ideas Obtained:
The usage of satellites for ADS-B to increase it's coverage area, which in-turn causes better efficiency of the system and making it more cost effective.

LITERATURE SURVEY

PAPER 5:
"SOFTWARE DEFINED RADIO BASED RECEIVERS USING RTL - SDR: A REVIEW" [REF: SLIDE NO.17]

AUTHORS:
MISHRA M, POTNIS A, DWIVEDY P, MEENA S.K

Summary:
Software Defined Radio is one of the most important and latest technique for modern wireless communication. SDR is a radio which can be tuned to any frequency band which the hardware supports, implement different modulation and demodulation schemes and different signal types and standard(s) in the same device by using reconfigurable hard-ware and using powerful SDR systems. The main types of devices that can be implemented using SDR are only Radio Receiver, only Radio Transmitter and a Transceiver which provides function for both transmitter and receiver. The availability of low cost SDR hardware with good functional capability has reduced the overall cost of SDR system. This paper also provides a comparison between different types of radio systems developed using SDR and their performance analysis.

Ideas Obtained:
The importance of SDR along with its working, its radio configurations, benefits and challenges have been obtained. Along with this, the working of the RTL-SDR Dongle and the interfacing of Computer and SDR is mentioned.

LITERATURE SURVEY

PAPER 6:
"SPECTRUM ALERTING SYSTEM BASED ON SOFTWARE DEFINED RADIO AND RASPBERRY PI " [REF: SLIDE NO.17]

AUTHORS:
DAVID BALL,NITIN NAIK AND PAUL JENKINS

Summary:
Inexpensive and generic Spectrum Alerting System (SAS), based on software defined radio by employing an RTL-SDR USB device, Raspberry Pi and Python. The SAS device is fully automated and the frequency of the sweep can be configured according to the sensitivity and type of operation taking place. When the results are compared with the baseline and if a difference is detected, according to pre-set thresholds, an alert is generated and sent.

Ideas Obtained:
Using the sweeps to keep track of the parameters, alerts will be sent to avoid collision if any of the thresholds are crossed.

LITERATURE SURVEY

PAPER 7:

"HOW TO PROTECT ADSB-: CONFIDENTIALITY FRAMEWORK FOR FUTURE AIR TRAFFIC COMMUNICATION" [REF: SLIDE NO.18]

AUTHORS:

EMAN HABLEEL,JOONSANG BACK, YOUNG JI BYON AND DUNCAN S WONG

Summary:

ADS-B needs less infrastructure as they use the Global Positioning System (GPS) satellites which allows the airborne objects to be monitored with fewer ground stations, and any entity that owns transmission receivers can capture and receive ADS-B signals. ADS-B applications can be installed on any smart devices to allow users to monitor the movement of aircraft. for displaying up-to-date live monitoring of flights, airlines. Security flaws persist in this type of system and it is vulnerable to security attacks.

Ideas Obtained:

Real time monitoring and parameters can be displayed on a mobile app, to protect the ADS-B system.

LITERATURE SURVEY

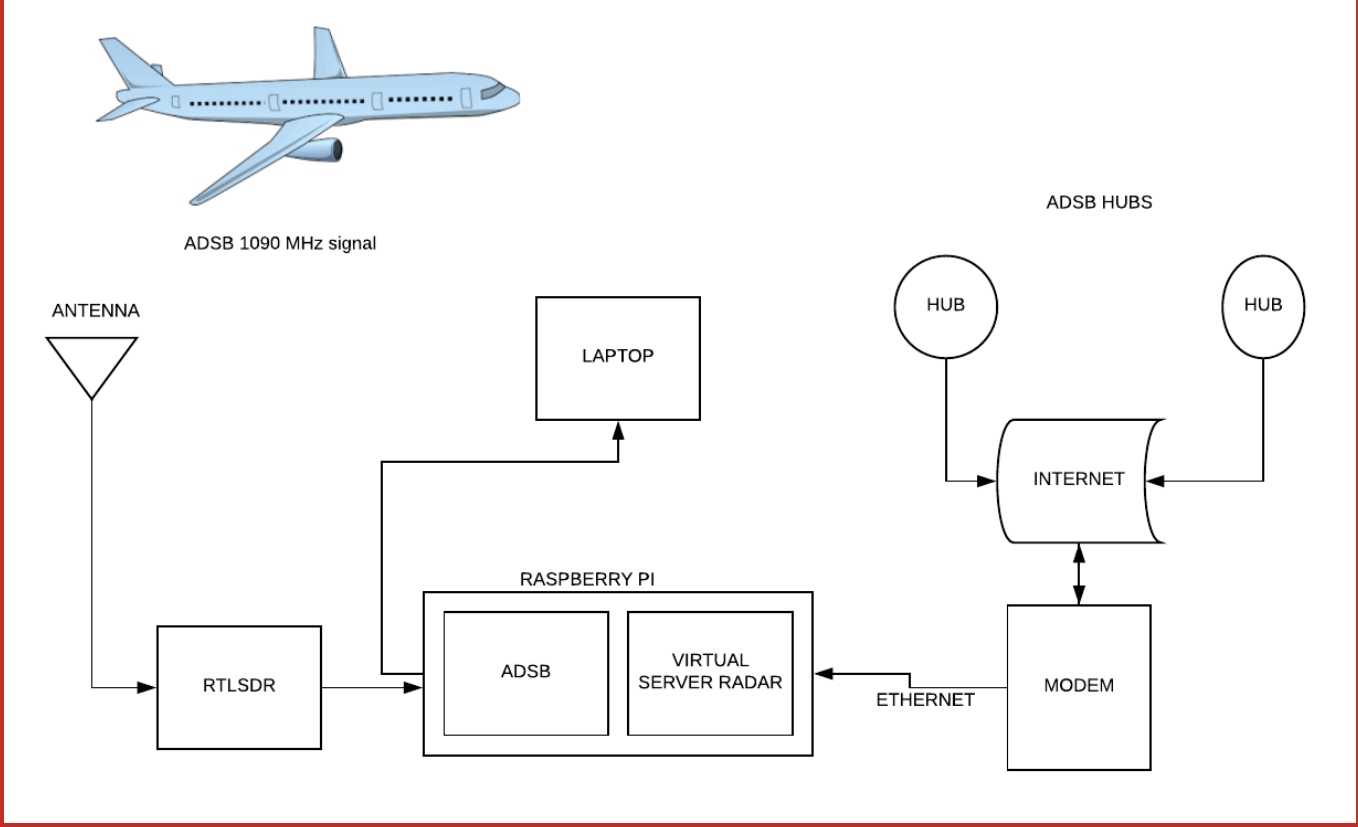
PAPER 8:
"ADS-B SIGNALS RECEPTION: A SOFTWARE DEFINED RADIO APPROACH" [REF: SLIDE NO.18]

AUTHORS:
EMILIO G. PIRACCI, GASPARE GALATI, MARCO PAGNINI

Summary:
ADS-B systems are characterized by an easy implementation and a lower cost as compared to surveillance radars however, they are affected by problems related to security, system integrity, and system performance in high traffic density areas.
The open mode S protocol does not guarantee security: actually low cost devices are available to receive the ADS-B signals and then to track the pertaining flights. It is also possible to generate false traffic (spoofing).
A 1090 MHz multi-channel receiver was implemented. Transponder Data Recorder(TDR) is designed to receive and record live signals from an array antenna, useful for channel characteristics estimation, as well as to collect signals for trials and tests. It also helps to increase surveillance capacity and detect a jammer.

Ideas Obtained:
Using this, data can be secured and ensure that no jamming or spoofing occurs thus improving the reliability of the system.

PROPOSED BLOCK DIAGRAM



BASIC ADS-B BLOCK DIAGRAM

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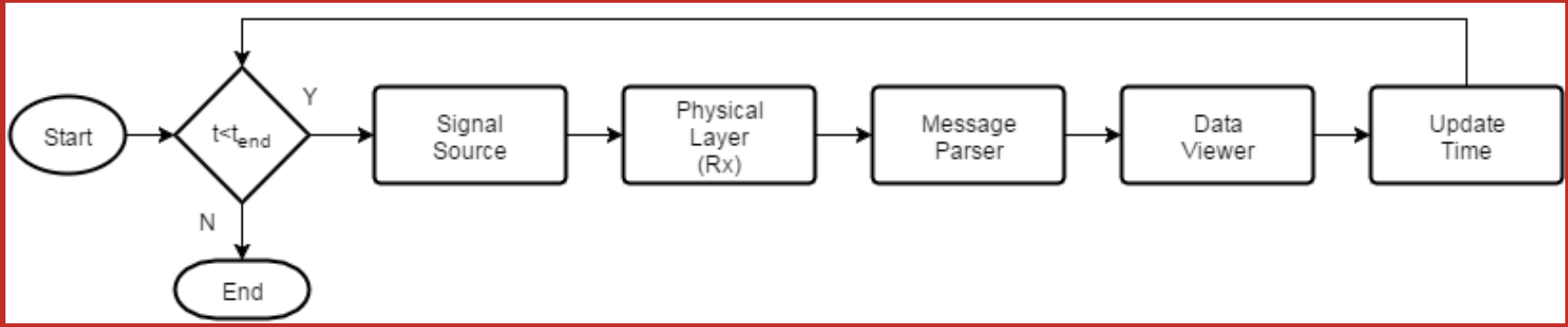
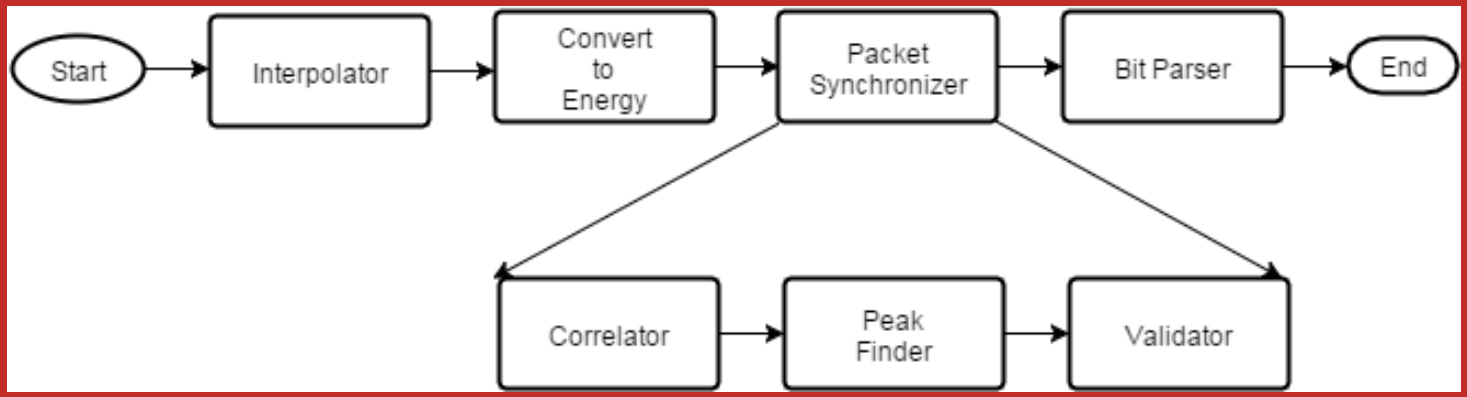
PROPOSED BLOCK DIAGRAM



ADS-B FLOW DIAGRAM

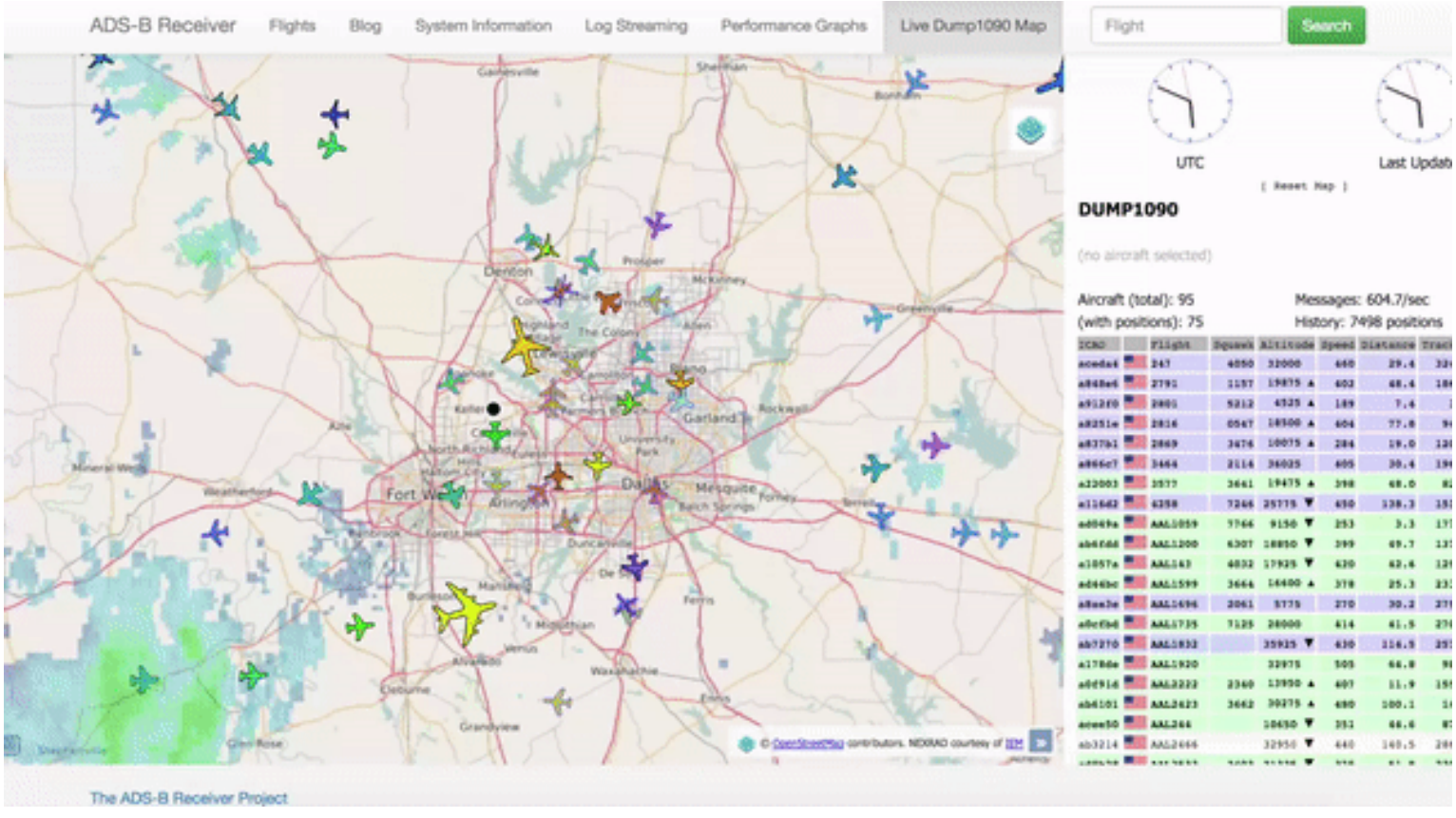


ADS-B PHYSICAL LAYER

HARDWARE SPECIFICATION

- Raspberry pi 3B with adsb-receiver_2.6.3_dump1090-mutability_raspbian-stretch-lite OS
- NooElec NESDR Mini SDR & DVB-T USB Stick (RTL2832 + R820T)
- Antenna with MCX connector

DESIRED OUTPUT



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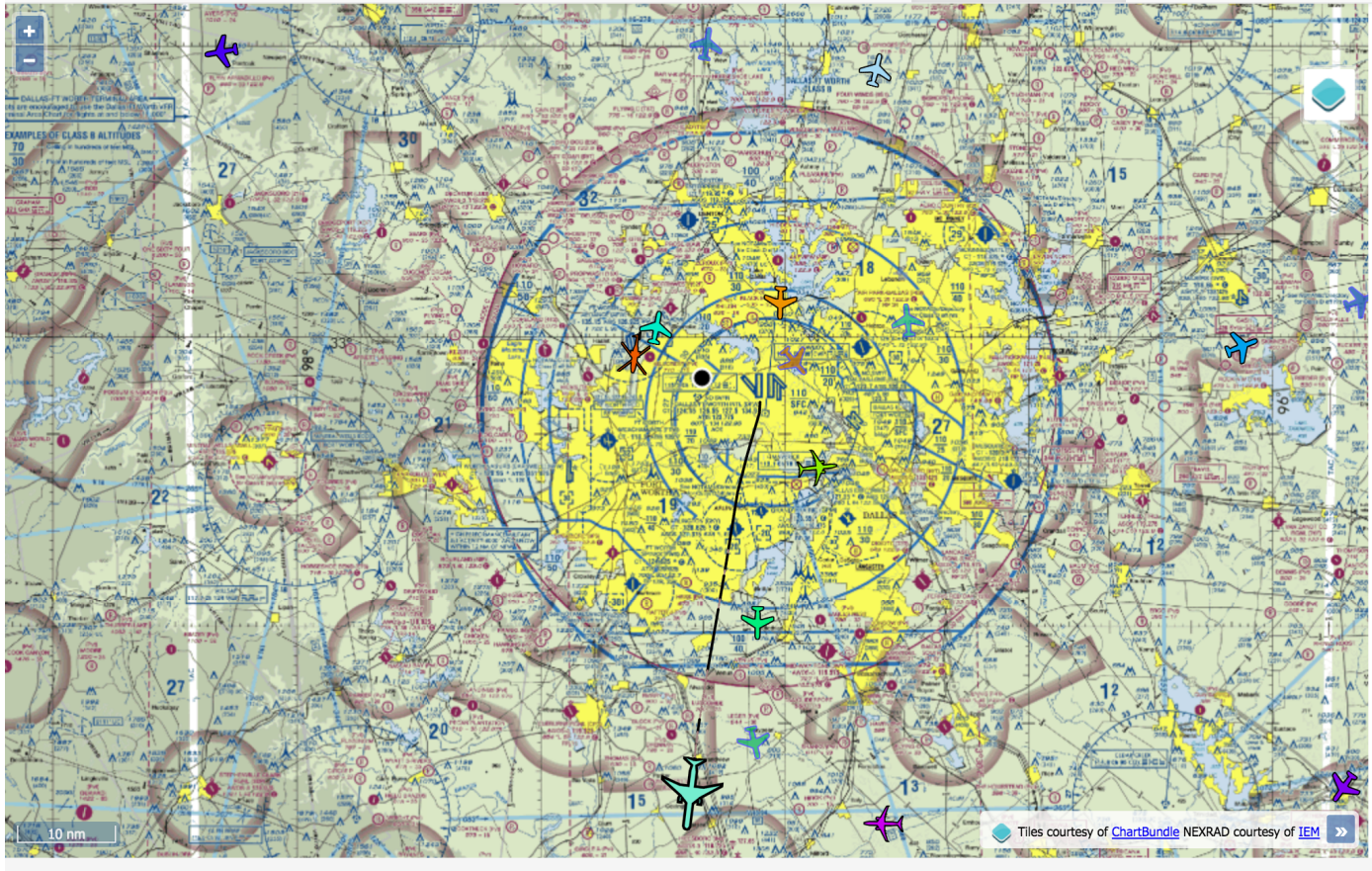
DESIRED OUTPUT

ADS-B Receiver | Flights | System Information | Performance Graphs | Live Dump1090 Map | Flight | Search



UTC | Last Update

[Reset Map]

AAL997 ⇒ AAC337 N793AN B772 [FlightAware] [FR24] [FlightStats] [PlaneFinder]

Country of registration: United States

Altitude: ▲ 14300 ft | 4356 m — Squawk: 0551

Speed: 382 kt | 707 km/h — RSSI: -28.0 dBFS

Track: 187° (South) — Last seen: 6.4s

Position: 32.211°, -97.193° (8.9s)

Distance from Site: 43.3 NM | 80.1 km

ICAO		Flight	Squawk	Altitude	Speed	Distance	Track	Msgs	Age
addf01		AAL1408	5203	15175 ▲	392	7.0	11	5158	0
a5ad73		N465P	1200	1500	109	7.4	188	233	4
a5fd2d			1412	2700	216	9.7	139	2740	0
a0541b		AAL2505	2675	2950 ▼	171	11.3	182	8494	0
acb59c		AAL2267	2356	6225 ▲	282	15.1	84	2814	0
ace19a			0534	15225 ▲	392	22.1	354	1773	0
adc8e7		AAL1268	2320	11925 ▲	350	26.1	181	4123	0
acf946			1732	21525 ▲	416	34.5	10	6263	0
acfd2c		AAL1010	2263	21050 ▲	420	36.5	14	7349	43
a8d717			2314	11975 ▲	259	38.3	167	416	4
aac337		AAL997	0551	14300 ▲	382	43.3	187	3638	6
a83e86		JBU7	3676	33975	465	45.0	286	7132	39
ac76b6		ENY3701	0527	19250 ▲	398	46.7	33	4522	3
a45091		DAL1061	3223	37975	471	50.0	271	4457	0
ad6884		AAL2501	0542	21350 ▲	445	55.9	69	5915	0
a722b1		AAL1862	2676	32000	481	59.9	260	2710	1
a02443		AAL1743	2223	23975 ▲	413	68.5	69	6625	2
a8e32b		2767	2220	23200 ▲	398	76.5	20	3353	8

The ADS-B Receiver Project

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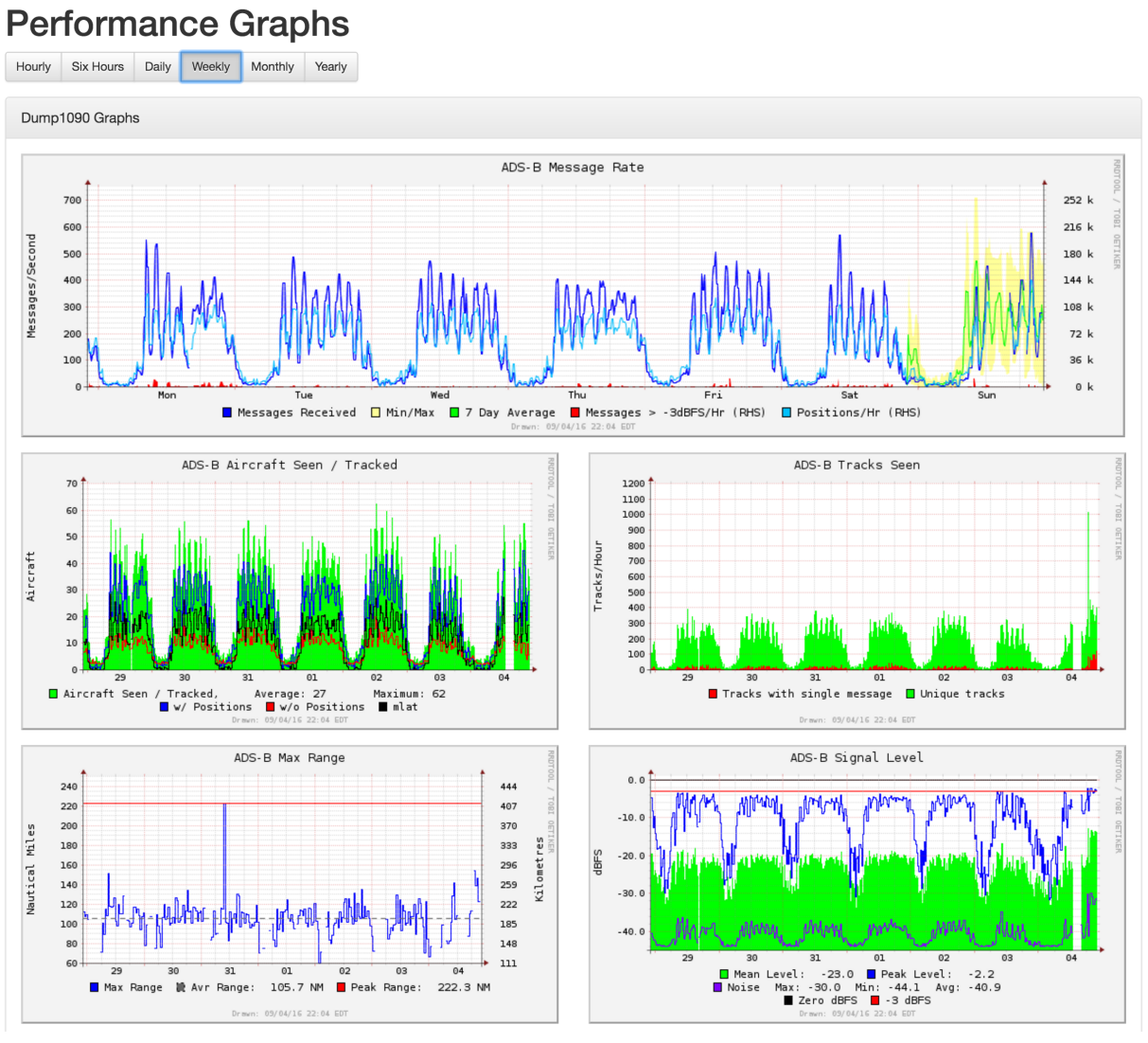
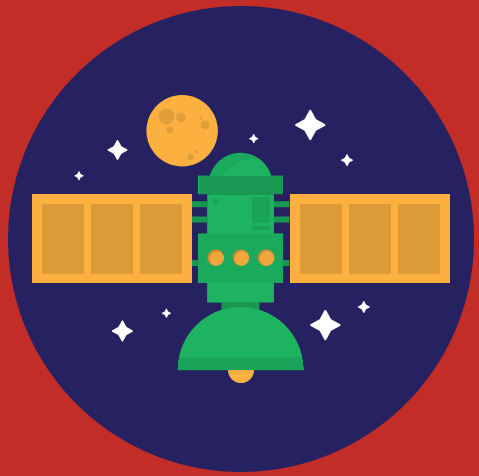
DESIRED OUTPUT



APPLICATIONS

- Used for commercial airplanes.
- Useful in high volume traffic areas, and poor weather conditions.
- Useful in places where ground stations are not available.
- Can be linked through any smart device and is accessible through mobile apps.

PLAN OF WORK



Timeline	Module of Work to be Completed
September 2018	Literature survey
October 2018	Literature survey and partial implementation
Nov 2018	Presentation

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THANK YOU!