



# ADS-B For Everyone

A Pilot's Guide To NextGen



# About: Steve Sokol

- + Private Pilot
- + Founder, Open Flight Solutions
- + Member of Stratux community
- + 20+ Years in Telecommunications
- + 14 Years in Open Source Software
- + Owner of N74662 – Grumman Tiger
- + Serving on several Part 23 ASTM committees





# About: Open Flight Solutions



- + Founded in January, 2016
- + Focused on reducing costs in aviation
- + Launched with a Kickstarter campaign
- + Initial product is FlightBox ADS-B
- + Hope to launch a revolution in “kit” avionics



# Agenda



- + ADS-B 101
- + ADS-B Options
- + Stratux Open Source ADS-B
- + FlightBox ADS-B
- + Live Demo

# ADS-B 101



ADS-B Is:



- + Part of FAA's NextGen ATC program.
- + The key to tighter separation and thus higher throughput at major airports.
- + Similar in concept to Mode C / Mode S transponder but with much more data.
- + Required by January 1, 2020 for access to Class A, B, and C airspace and the Mode C veil around some Class B airports

# ADS-B 101



ADS-B Defined

**A**utomatic – occurs automatically, no interrogation required

**D**ependent

**S**urveillance

**B**roadcast

# ADS-B 101



ADS-B Defined

**A**utomatic

**D**ependent – depends on the aircraft to provide the data

**S**urveillance

**B**roadcast



# ADS-B 101



ADS-B Defined

**A**utomatic

**D**ependent

**S**urveillance – allows ATC to monitor your activity

**B**roadcast

# ADS-B 101



ADS-B Defined

**A**utomatic

**D**ependent

**S**urveillance

**B**roadcast – sent in the clear for anyone to pick up

# ADS-B 101



## Two Systems

- + UAT
- + 1090-ES

## Two Functions

- + ADS-B Out
- + ADS-B In



# ADS-B 101 – Two Systems

## UAT System

- + US Only
- + Not for use in flight at or above 18,000'
- + Intended for light aircraft
- + Uses 978 MHz frequency (unused DME channel)
- + Lots of bandwidth (> 1 mbps)
- + Includes more data



# ADS-B 101 – Two Systems

## 1090-ES System

- + International Standard
- + Required for flight at  $> 18,000'$
- + Intended for heavy iron, international travellers
- + Uses the same 1090 MHz band as transponders
- + Potentially just a software update for S-Mode transponders
- + Limited bandwidth in crowded spectrum





# ADS-B 101 – Two Systems

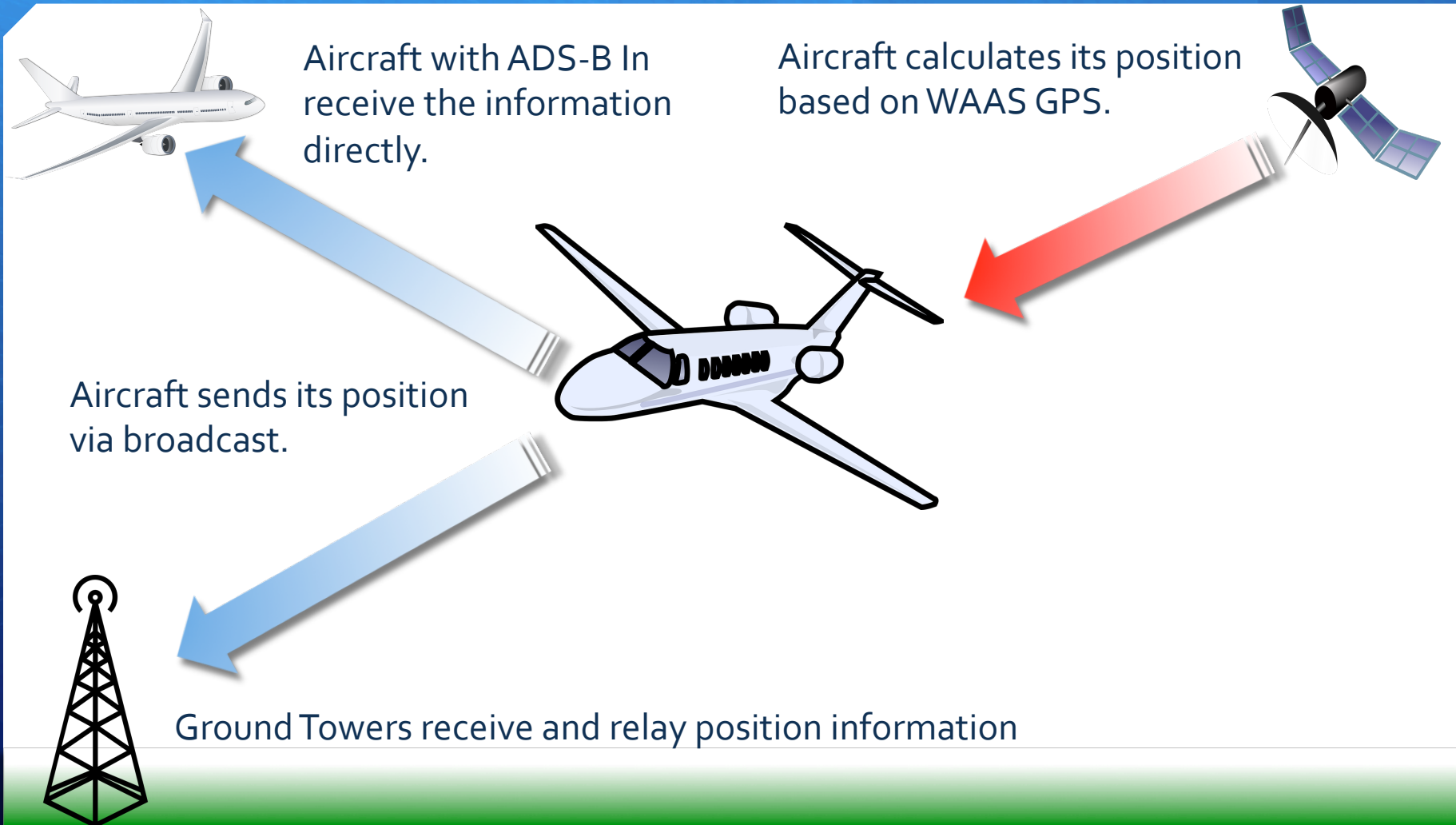
- + You can outfit with either system – the rules do not mandate one or the other.
- + Which system you pick for ADS-B Out depends on mission and current equipment.
- + For ADS-B In, you will frequently want to have support for both systems.



# ADS-B 101 – ADS-B Out

- + Sends latitude, longitude, GPS altitude, pressure altitude, ground track, ground speed, ICAO identifier, N-number, ADS-B In status, and other data once per second.
- + Requires a very accurate position source. Currently WAAS GPS is the only approved position source.
- + Data is received by FAA ground towers which forward it to ATC and re-broadcast it to aircraft in the area (more on this in a bit).
- + Data is received by other aircraft equipped with ADS-B In.

# ADS-B 101 – ADS-B Out





## ADS-B 101 – ADS-B Out

- + Position source must meet very stringent performance and error detection requirements outlined in a TSO.
- + Even experimental aircraft must meet the performance requirements, though they can use non-TSO hardware.
- + Must be installed. Portable devices are not currently allowed.
- + This is the part of ADS-B that is required under the 2020 Mandate.



# ADS-B 101 – ADS-B Out

## Which System?

- + If you fly internationally or in Class A airspace, you don't have a choice: you must use 1090-ES.
- + If you already have an approved WAAS position source, it may be cheaper to go with 1090-ES.
- + If you already have a Mode S transponder, it may be cheaper to go with 1090-ES.
- + If you don't fly internationally or in Class A, and you don't already have a WAAS position source, UAT is a less expensive option.





# ADS-B 101 – ADS-B In

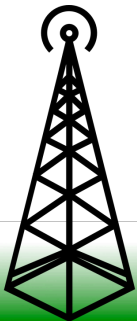
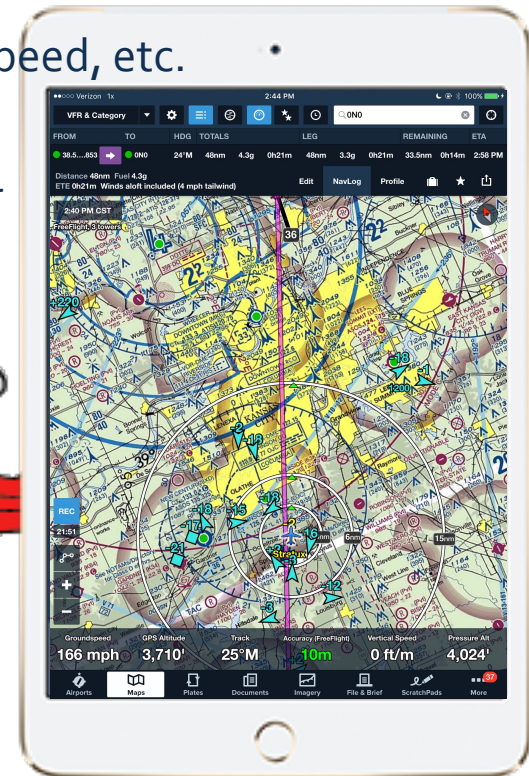
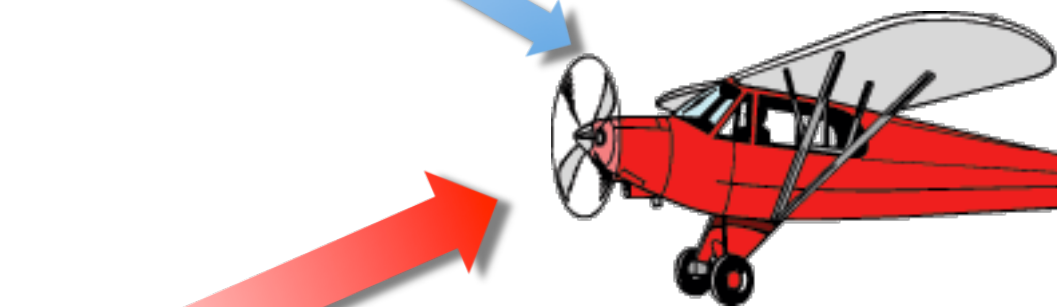
- + Receives data from FAA ground towers.
- + Receives data from aircraft equipped with ADS-B Out.
- + May be certified + installed system or portable.
- + Data is displayed on:
  - + PFD / MFD
  - + EFIS
  - + Tablet App

# ADS-B 101 – ADS-B In



Nearby aircraft send their location, track, speed, etc.

Weather and Traffic data are displayed on a tablet, EFIS or MFD.



Ground Towers send FIS-B, TIS-B and ADS-R Traffic



# ADS-B 101 – ADS-B In

## ADS-B In over UAT (978 MHz)

- + Includes FIS-B
  - + Weather
  - + TFRs, NOTAMs, SUAs
- + Includes TIS-B
  - + Direct ship-to-ship traffic sent on UAT frequency
  - + TIS-B traffic
  - + ADS-R traffic



# ADS-B 101 – ADS-B In

## ADS-B In over 1090-ES

- + Includes Traffic
  - + Direct ship-to-ship traffic sent on UAT frequency
  - + TIS-B traffic
  - + ADS-R traffic
- + Does *NOT* include FIS-B services
  - + Not enough bandwidth available
  - + Most are flying IFR
  - + Many have XM services

# ADS-B 101 – ADS-B In



## FIS-B Weather Products

- + Regional and CONUS NEXRAD Radar
- + METARs
- + TAFs
- + AIRMETs / SIGMETs
- + Winds / Temps Aloft
- + PIREPs





# ADS-B 101 – ADS-B In

## ADS-B Traffic

- + Direct Traffic – your ADS-B receiver picks up a broadcast from a nearby aircraft.
  - + Not all that common today as only 10% of aircraft are equipped
  - + Will be much more common by 2020
- + TIS-B Traffic
  - + Copy of all Mode A / Mode C traffic visible to ATC
- + ADS-R Traffic – “Rebroadcast”
  - + Traffic from “the other system”
  - + UAT → 1090-ES
  - + 1090-ES → UAT



# ADS-B 101 – ADS-B In

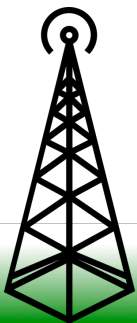
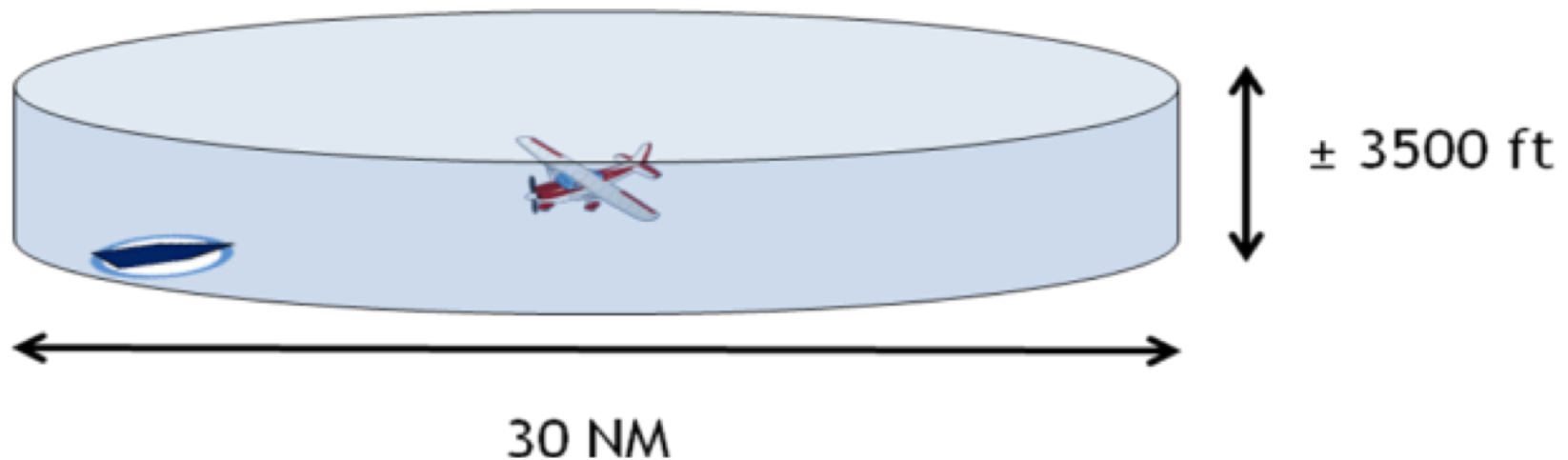
## ADS-B Traffic

- + Advisory ONLY
- + Does not display traffic not visible to ATC radar
  - + Below the radar horizon
  - + Not equipped with Mode C
- + TIS-B and ADS-R (tower services) are **NOT** broadcast unless triggered by an aircraft with ADS-B Out
  - + Broadcast is customized for “client” aircraft
  - + Broadcast only includes targets in a small “puck”
  - + May change in the near future

# ADS-B 101 – ADS-B In



## The ADS-B Traffic Puck



# ADS-B 101 - Coverage

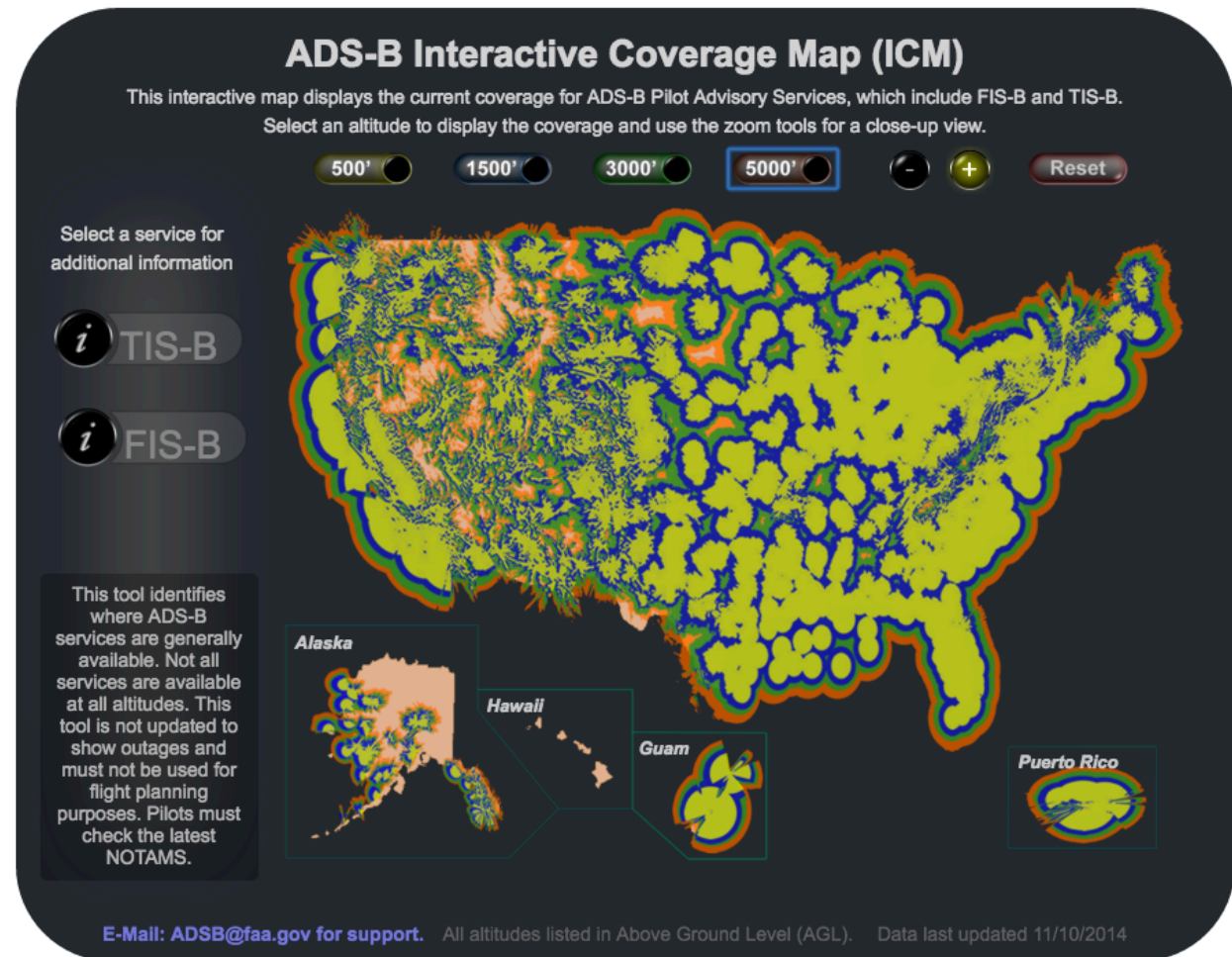


5000

3000

1500

500





# ADS-B Options

## Option 1: Avoid ADS-B

- + Locate your aircraft outside of airspace where ADS-B is required.
- + Do not fly to / through any ADS-B airspace except with prior permission of the controlling authority.
- + You can still fly both VFR and IFR if you stay outside of airspace requiring ADS-B.
- + Expect a lower resale value.



# ADS-B Options

## Option 2: Equip With UAT

- + Typically less expensive than 1090-ES
- + Several “all-in-one” systems that include a position source
- + Transmitter (“Out” only) and Transceiver (“Out” + “In”) options available.
  - + FreeFlight RANGR, RANGR Lite - \$2000+
  - + NavWorks ADS600 - \$2000+ cert. / \$1200 E-AB + LSA
  - + Garmin GDL-88 - \$4000



# ADS-B Options

## Option 3: Equip With 1090-ES

- + Cheapest option if you already have WAAS position source and / or a Mode S transponder.
- + Several “all-in-one” systems that include a position source
- + Transmitter (“Out” only) and Transceiver (“Out” + “In”) options available.
  - + Garmin GTX335 - \$3000 (\$3700 w/ WAAS GPS)
  - + Garmin GTX330 w/ ES - \$4000 (requires separate position source)
  - + Garmin GTX345 - \$5k (\$5800 w/ WAAS GPS)
  - + Appareo Stratus ESG - \$3k - \$3500
  - + Trig TT 21/22/31 - \$2000 + (requires separate position source)

# ADS-B Options



## Option 4: Integrated Flight Deck (G1000, Perspective, etc.)

- + Generally must be blessed by your vendor
- + Garmin and Avidyne both offer solutions
- + Both of them tend to be pricy since they can be



# ADS-B Options



## Option 5: Experimental / LSA

- + Low cost solutions available from E-AB / LSA vendors
- + Dynon has a 2020 compliant position source for \$500
- + More options likely between now and 2020



# ADS-B Timeline

- + You must be equipped by January 1, 2020 to fly in ADS-B airspace.
  - + This could change, but don't hold your breath. The FAA is under a lot of pressure to make NextGen a reality
- + You probably want to equip sooner rather than later as there are only so many avionics shops that can do the work.
- + Plan on \$1k+ for installation, depending on complexity
- + Plan on 1 – 2 weeks of down-time
- + Your A&P can do the installation but probably not the certification / paperwork. That requires specialized equipment / skills.



# Stratux – Open Source ADS-B

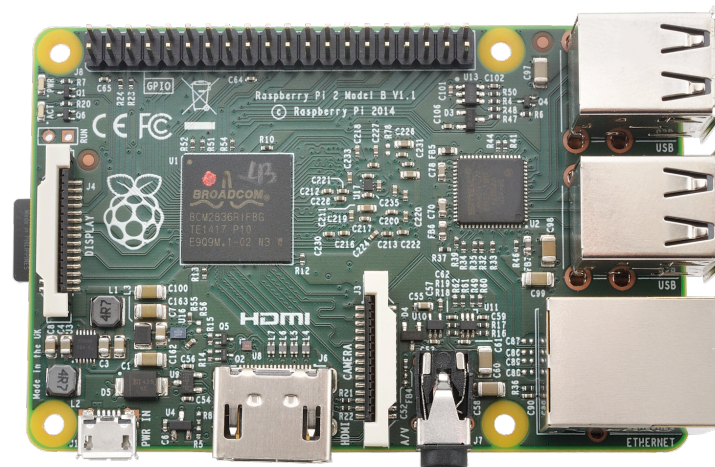
- + Open source project to create an ADS-B In system
- + Project started and managed by Christopher Young
- + Free software built by a community of developer / pilots
- + Constantly being updated to enhance capabilities and add new features
- + Can be built for as little as \$100 using COTS parts
- + Does In only, not Out – too many regulatory hurdles

# Stratux – Open Source ADS-B



## Hardware

- + Raspberry Pi
- + RTL-SDR Radios
- + Wifi Module
- + GPS (optional)
- + Antenna(s)
- + Power supply / battery





# Stratux – Open Source ADS-B

## Software Features

- + Single or Dual Band ADS-B In
- + GPS
- + AHRS (work in progress)
- + Compatible with most popular EFB applications
- + Comparable to current portable systems from Sporty's, Dual, iLevil, etc.
- + Free

# Stratux – Open Source ADS-B



## Learn More

- + <http://stratux.me> - Main website
- + <https://www.reddit.com/r/stratux> - Community forum
- + <https://github.com/cyoung/stratux> - Software dev site
- + <http://www.thingiverse.com/search/page:1?q=Stratux>
  - + 3D Printable Cases

# FlightBox ADS-B



A Quick Build Kit For Stratux

- + From Open Flight Solutions
- + Software is pre-loaded on the data card
- + Pre-configured radio modules
- + All required parts in one kit
- + Professionally manufactured case with cooling
- + Launched on Kickstarter - \$77,369 / 344 Backers In 30 Days





# FlightBox ADS-B

- + Single Band System: \$200 (UAT Only)
- + Dual Band System: \$250 (UAT + 1090-ES)
- + Case Only: \$40 / Fan: \$6
- + Future Upgrades
  - + AHRS (Attitude Sensor)
  - + ADC (Air Data Computer – Experimental Only)
  - + Carbon Monoxide Sensor
  - + Cabin Altitude Sensor



# FlightBox ADS-B



Learn More or Order At:

<https://www.openflightsolutions.com>

# Live Demo: Assembling A FlightBox



Questions?



Open Flight Solutions  
<https://www.openflightsolutions.com>