



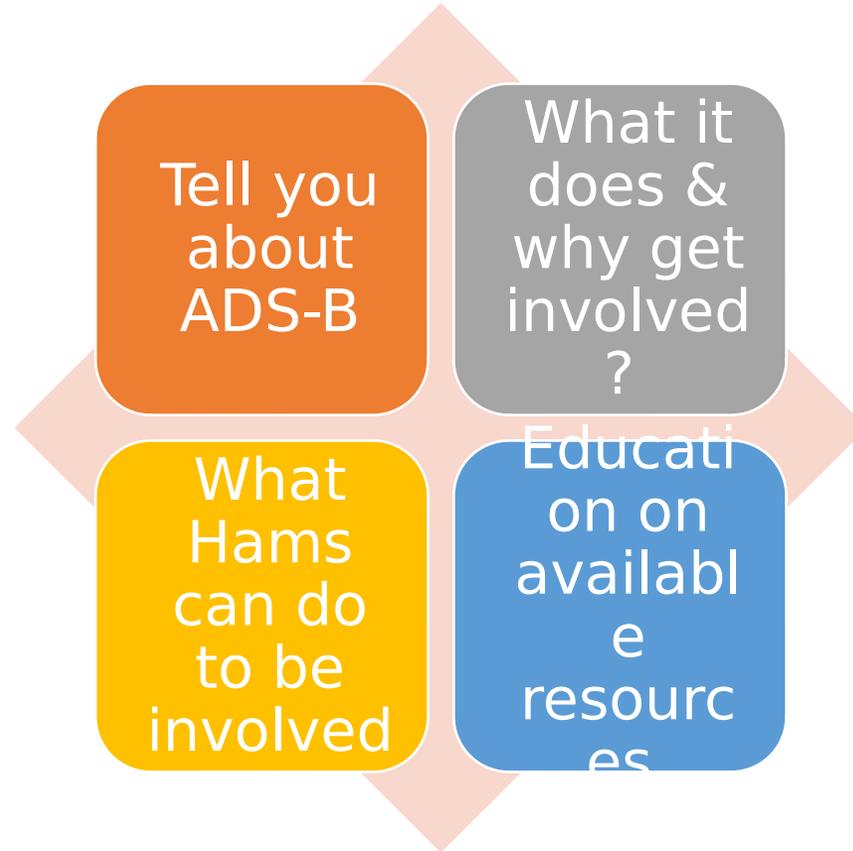
# ADS-B flight Monitoring Flightaware and other services

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Purpose of the presentation  
and lets have some fun!



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Disclaimer – I have no affiliation with any organizations I will be discussing

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**ARRL**  
The national association for  
**AMATEUR RADIO®**



# I wrote an article on it for QST

Copies of article available on request

## What it does?

- Enable real-time data acquisition from Aircraft in using ADS-B data
- 1090 MHz and 978 MHz also in USA
- Transmitted from Aircraft continuously

## What does flightaware do?

- Design, build and ship FlightFeeders
- Design and build software (PiAware)
- Design, manufacture and sell specialized parts
- Aggregate data

## For whom ?

- FlightFeeders where we need coverage
- Software for everyone
- Parts for everyone

## What value are we bringing?

- Enabling free flight tracking at [flightaware.com](http://flightaware.com)
- Global flight coverage data sent and stored

# What does it accomplish?



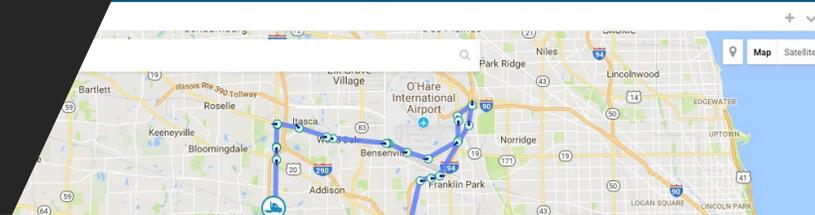
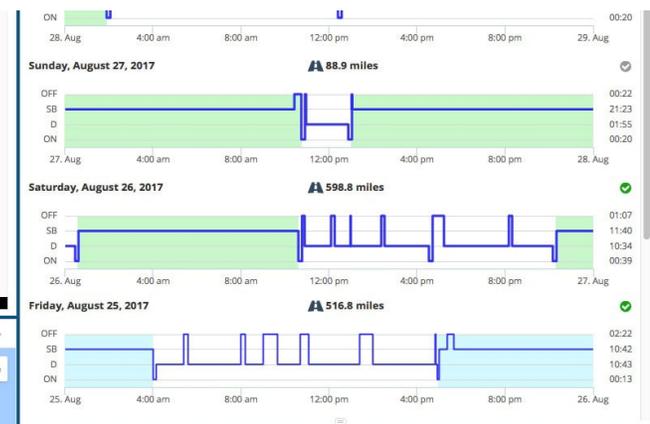
What does it accomplish? Prevents another MH370 mystery & provide real time tracking info

# Monitoring planes as part of the IoT & Big Data

- UPS and FedEx drivers tracked
- Truck drivers tracked
- Delivery vehicles tracked
- Sales people tracked (electronics distributor)
- Area manager for a muffler shop chain tracked
- Cruse ships tracked
- Insurance companies want to track you for a discount
- Why not aircraft globally?



Time	Location	Time	Location	Time	Location	
11:20 PM	DUMAS, IA	07:36	US			
4:31 AM	BLACKWELL, OK	05:34	05:26	US		
10:34 PM	WOOD RIVER, NE	00:00	10:57	US		
Mon 3:27 PM	BRYAN, TX	00:00	19:14	US		
Sun 6:46 PM	WOOD RIVER, NE	11:00	00:00	US		
OFF	6:16 AM	00:15	SAN ANTONIO, TX	05:35	05:25	US
SB	10:50 PM	07:41	LUBBOCK, TX	00:00	05:58	US
OFF	5:53 AM	00:38	BRYAN, TX	10:45	00:15	US
OFF	8/18/17 1:10 PM	257:21	WOOD RIVER, NE	11:00	00:00	US
SB	1:31 AM	05:00	LEBANON, MO	00:00	09:44	US
SB	9:48 PM	08:43	AMARILLO, TX	04:00	07:00	US
SB	Mon 5:08 PM	13:23	BRYAN, TX	11:00	00:00	US
OFF	8:45 PM	09:46	BEVIER, MO	00:00	04:49	US
OFF	Mon 3:19 PM	15:12	EL PASO, TX	11:00	00:00	US



Duty Started	Duty State	Duty Duration	Location
Mon 12:34 PM	SB	17:57	ADDISON, IL
Mon 12:24 PM	POST	00:10	ADDISON, IL
Mon 12:24 PM	SB	00:00	ADDISON, IL

Mode S and ADS-B signals are transmitted continuously by aircraft

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graph TD; A[Mode S and ADS-B signals are transmitted continuously by aircraft] --> B[Receiver sites listen for signals and decode them]; B --> C[Receiver sites send data over the Internet to FlightAware]; C --> D[MLAT results are sent back to receiver sites (when available)]; D --> E[Data is integrated with other flight tracking data such as that from FAA and then shown on the web site and aggregated];
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Receiver sites listen for signals and decode them

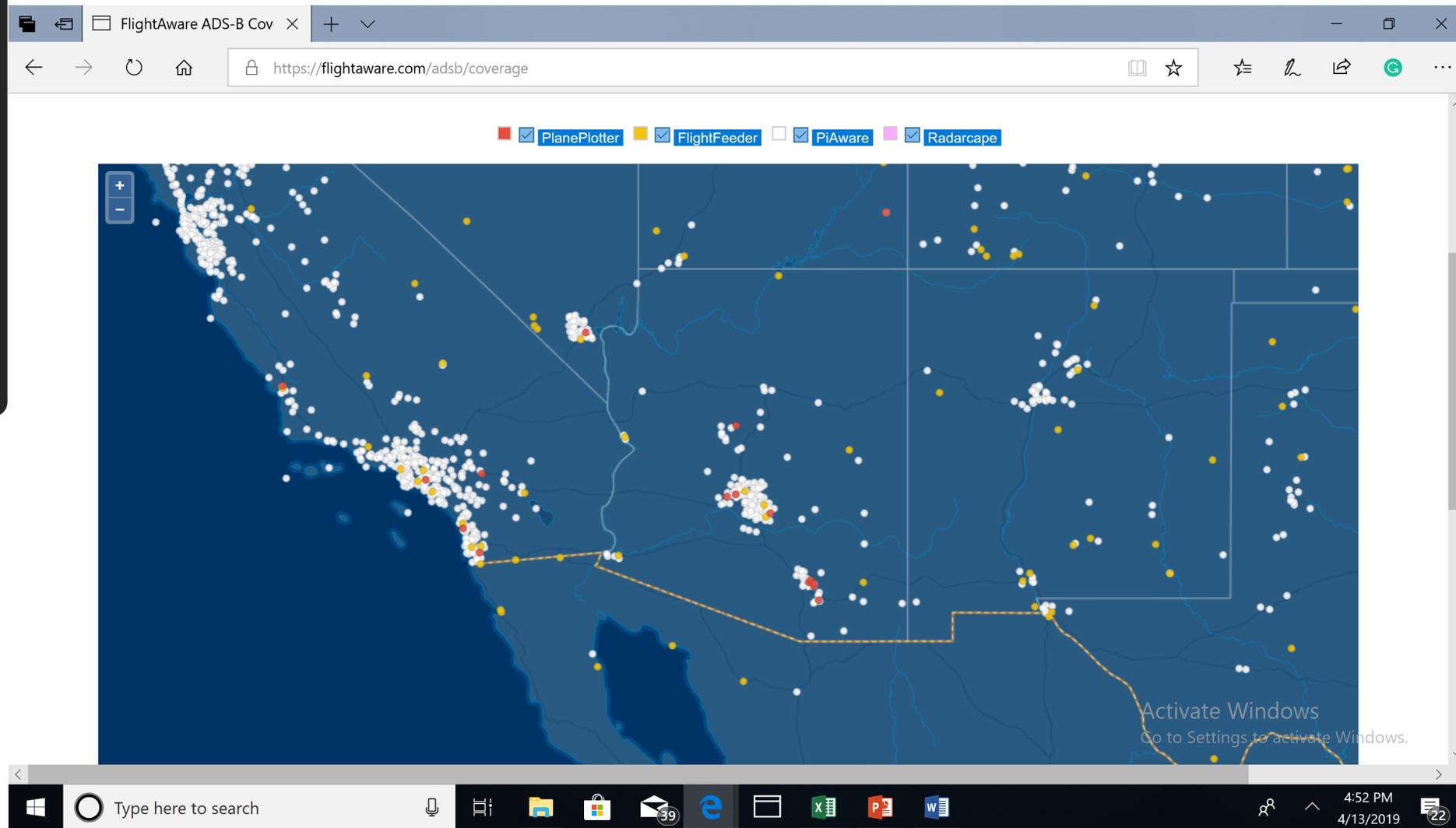
Receiver sites send data over the Internet to FlightAware

MLAT results are sent back to receiver sites (when available)

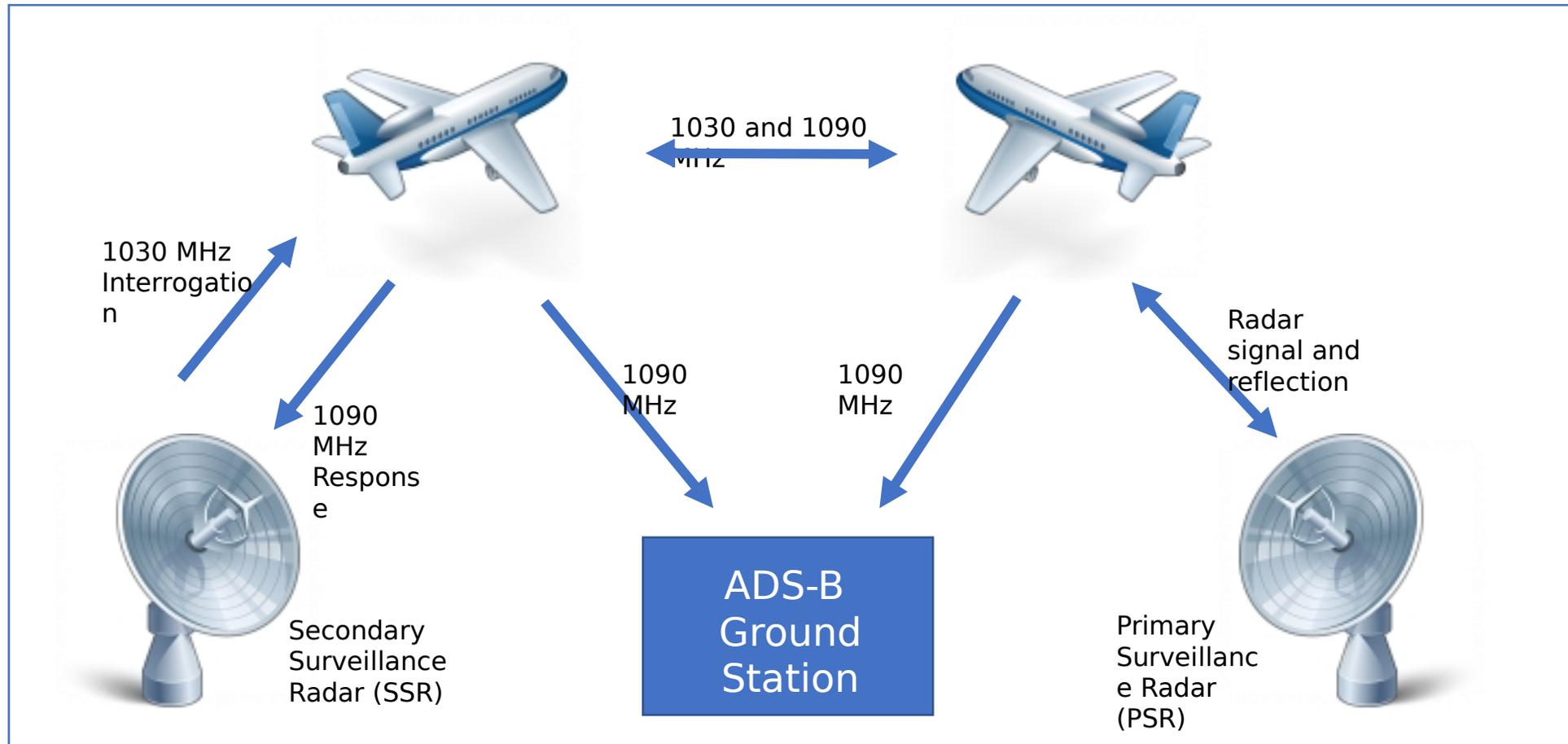
Data is integrated with other flight tracking data such as that from FAA and then shown on the web site and aggregated

# How does it work?

# Coverage in the Southwest



# How does the RF part work?



# Why is the FAA transitioning away from radar to ADS-B technology?

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ADS-B is an environmentally friendly technology that enhances safety and efficiency, and directly benefits pilots, controllers, airports, airlines, and the public. It forms the foundation for NextGen by moving from ground radar and navigational aids to precise tracking using satellite signals.

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With ADS-B, pilots for the first time see what controllers see: displays showing other aircraft in the sky. Cockpit displays also pinpoint hazardous weather and terrain, and give pilots important flight information, such as temporary flight restrictions.

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ADS-B reduces the risk of runway incursions with cockpit and controller displays that show the location of aircraft and equipped ground vehicles on airport surfaces – even at night or during heavy rainfall. ADS-B applications being developed now will give pilots indications or alerts of potential collisions.

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<https://www.faa.gov/nextgen/programs/adsb/faq/#g1>

# What data do we get?

## Mode S

- ICAO24 “hex code”
- Ident
- Squawk
- Altitude
- TCAS RAs

## Mode S Extended Squitter (“ADS-B”)

- All Mode S plus...
- Position (lat/long)
- Heading
- Speed
- Vertical Rate
- **And more... I will get to that in a moment.**

## MLAT

- All Mode S plus...
- Mathematically derived position (lat/long)

## TIS-B

- ADS-B-like data from ATC

ADS-B	UAT	ADS-A/ADS-C	ADS-R	TIS-B	FIS-B
<ul style="list-style-type: none"> <li>• Automatic Dependent Surveillance-Broadcast</li> <li>• <b>“Out” (from aircraft)</b></li> </ul>	<ul style="list-style-type: none"> <li>• Universal Access Transceiver</li> <li>• 978 MHz</li> <li>• USA-only (so far)</li> </ul>	<ul style="list-style-type: none"> <li>• Automatic Dependent Surveillance-Addressed</li> <li>• Automatic Dependent Surveillance-Contract</li> </ul>	<ul style="list-style-type: none"> <li>• Automatic Dependent Surveillance-Rebroadcast</li> <li>• Bridges ADS-B and UAT</li> <li>• Part of “ADS-B In”</li> </ul>	<ul style="list-style-type: none"> <li>• Traffic Information Service-Broadcast</li> <li>• Visibility of Mode C aircraft</li> <li>• Part of “ADS-B In”</li> </ul>	<ul style="list-style-type: none"> <li>• Flight Information System-Broadcast</li> <li>• Weather, NOTAMs, etc.</li> <li>• Via UAT</li> <li>• Part of “ADS-B In”</li> </ul>

Do you like abbreviations?

# What is multilateration (MLAT)?

Mathematically  
derived aircraft  
position

Based on “time  
difference of  
arrival” (not  
“triangulation”)

Requires 4\* or  
more sites to  
receive the  
same message  
from an aircraft

ICAO24 “hex  
code” in Mode S  
makes this work

Needs timing  
synchronization  
between  
receivers

\* *FlightAware requires 4 or more to improve accuracy.*

# What's new?

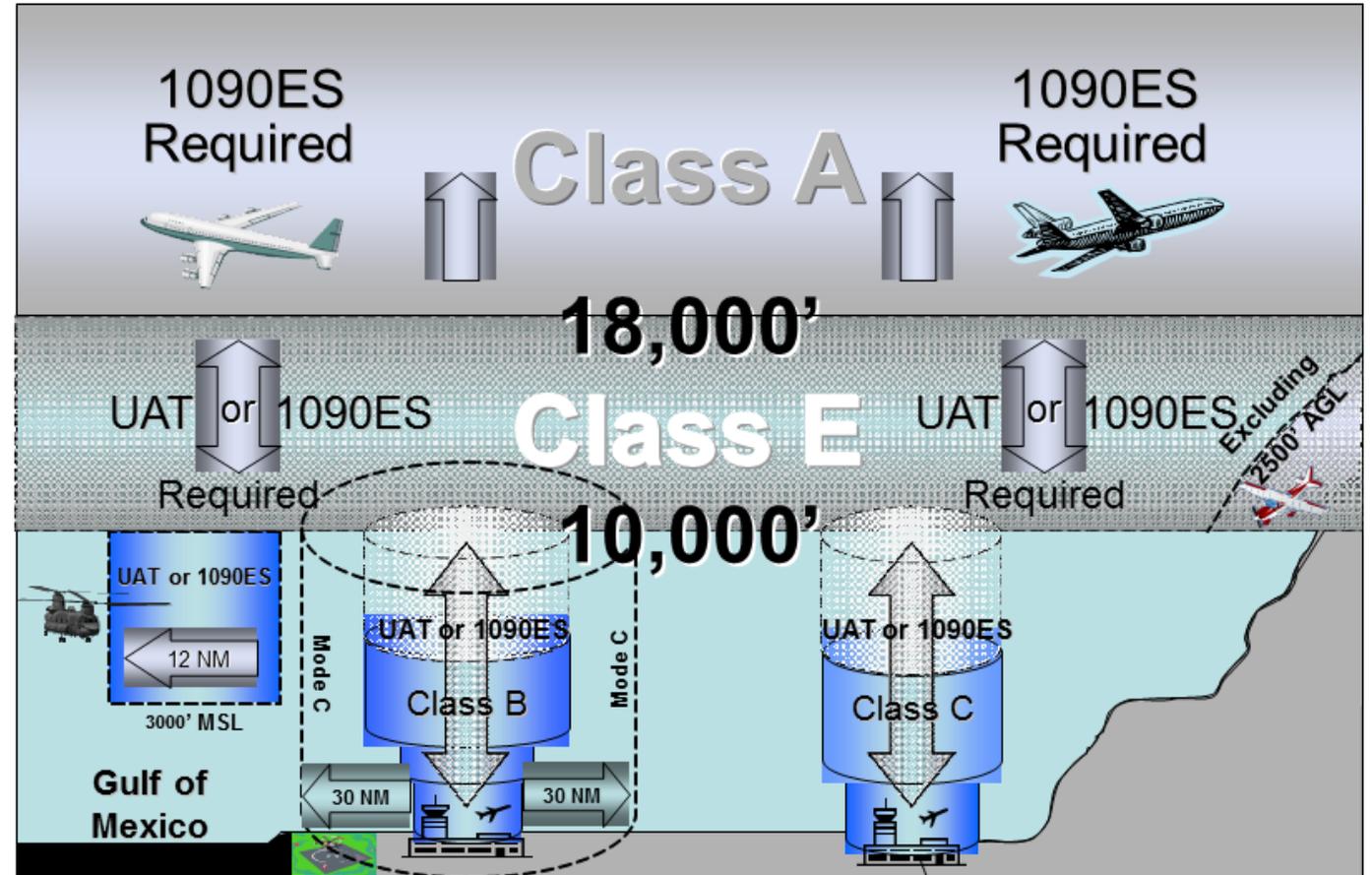
- **What's new?**

The following data is now available: airspeeds (indicated/true), Mach number, headings (magnetic/true), roll angle, auto pilot settings (selected altitude and heading), ADS-B version, aircraft category (aircraft type), and data accuracy metrics.

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# What is the USA (FAA) ADS-B mandate?

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# More on FAA mandate from the federal register:

- <https://www.govinfo.gov/content/pkg/FR-2019-04-01/pdf/2019-06184.pdf>
- “After January 1, 2020.1 ADS-B Out equipment is an advanced surveillance technology that combines an aircraft’s positioning source, aircraft avionics, and a ground infrastructure to create an accurate surveillance interface between aircraft and air traffic control (ATC). Use of ADS-B Out will move ATC from a radar-based system to an aircraft location system based on satellite-derived position and velocity”
- **Intention is to make non-use so onerous that it will be next to impossible in NA airspace.**



# Why do we need hams?



We usually have towers and antennas



Technical expertise



Internet connections and IT –backup redundancy expertise



Makers- know how to build and troubleshoot things



Power electronics – backup power systems



Repeater sites have great view of the sky



Get things done attitude

SITE 33298  
-- KSOW at  
KG5Q my  
location



- <https://flightaware.com/adsb/stats/user/kg5q>
- Part of an ecosystem
- Overall globally:
- Live FlightAware ADS-B Sites -22,108
- 18,001 participants
- 193 countries represented
- 147,583,100 positions/hour
- 254 sites added last 7 days

# Uptime is key – I live in the Forrest

- UPS with battery backup:
  - surge and transient protection
  - 8 hour battery backup time for flight feeder
- Cradlepoint Modem:
  - Frontier DSL service – it works most of the time but unremarkable
  - When DSL drops Cradlepoint model automatically backs up to 4G Verizon service



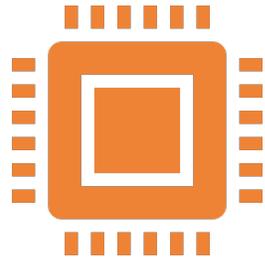
Sent to volunteers in areas where coverage is needed

Provide a complete kit of needed parts

User installs and connects to power and Internet

FlightFeeders from FlightAware

# Other ways to feed data to FlightAware



## PiAware

Runs on a Raspberry Pi computer  
User builds his/her own hardware from parts (ours or others)  
Free software from FlightAware  
Feeds us data and sends back MLAT results to the user

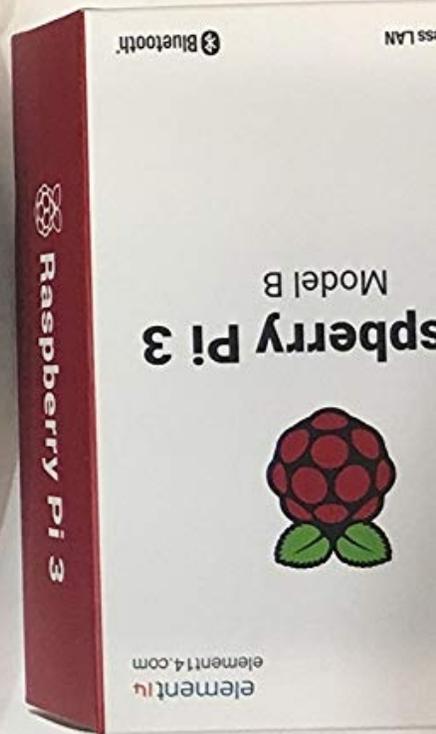


## Radarcape

Latest version runs PiAware to feed data

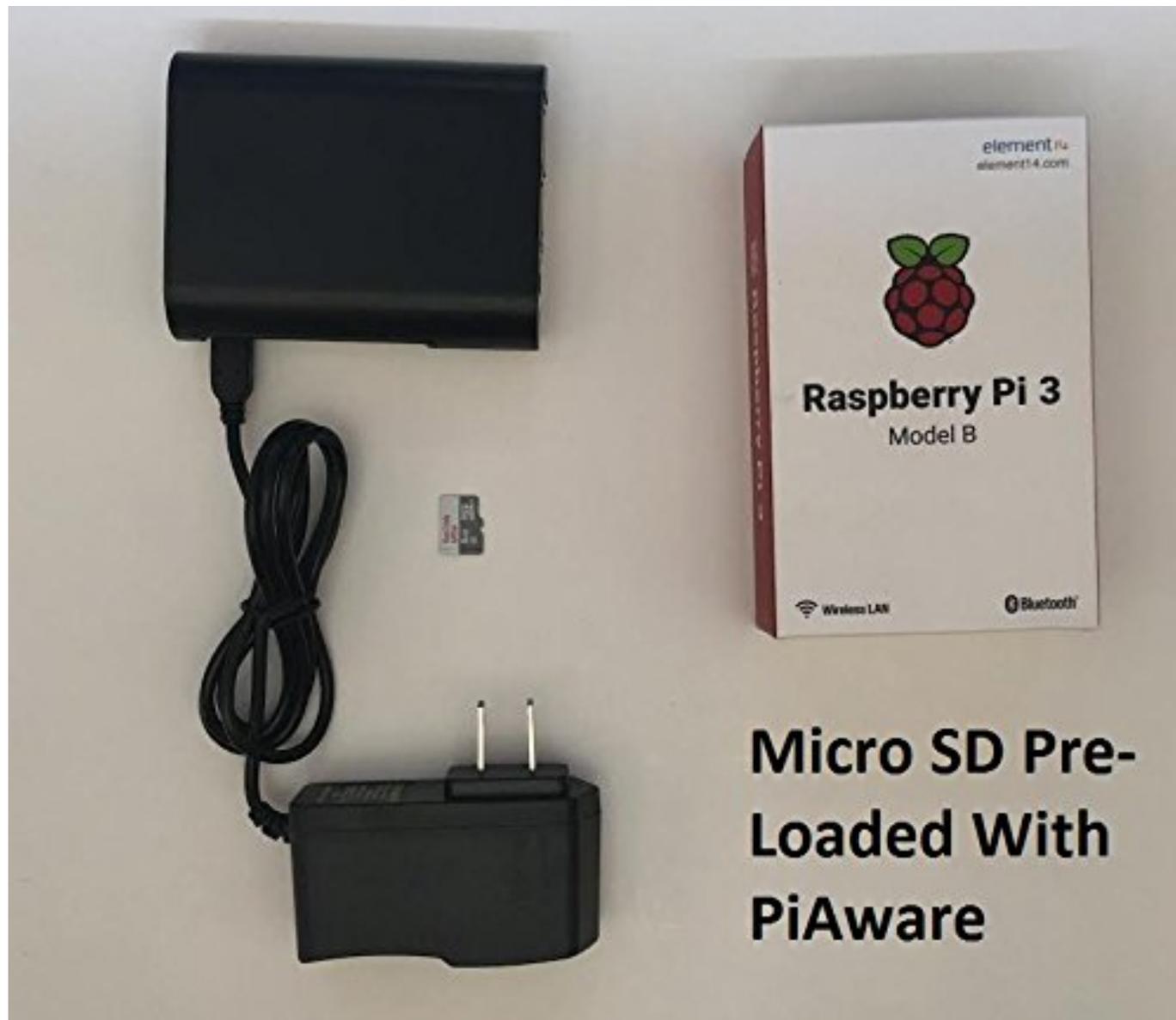
# Call To Action

- FlightAware ADS-B ULTIMATE System - Pro Stick Plus + Raspberry + 1090MHz Antenna + 25 foot cable



FlightAware  
ADS-B  
Raspberry Pi  
and Micro SD  
Pre-Loaded  
PiAware

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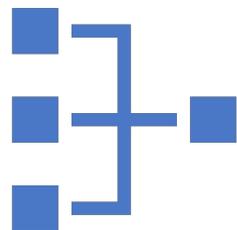


**Micro SD Pre-Loaded With PiAware**

Pro Stick	Built-in amp
Pro Stick Plus	Built-in amp and filter
1090 MHz antenna	Tuned specifically to the desired frequency
1090 MHz bandpass filter	Filters out noise Useful in urban areas

# Hardware parts

# Free ADS-B Software



## **PiAware/ FlightFeeder**

“Skyview” map of data received by the device

Sends data to FlightAware

Receives MLAT results



## **Public web site**

“My ADS-B” statistics

Global statistics

FlightAware.c  
om

- Discussion forum
- Web site content

Social media

- Facebook
- Twitter
- YouTube

E-mail

- Monthly newsletter
- <https://us14.campaign-archive.com/home/?u=7bd8986a8ad54991c01e23939&id=a7b1182a9d>

Staying in touch

from FlightAware

join our mailing list

03/28/2019 - Coming Soon: 978 MHz UAT capable PiAware!

03/19/2019 - PlanePlotter Support And FlightAware

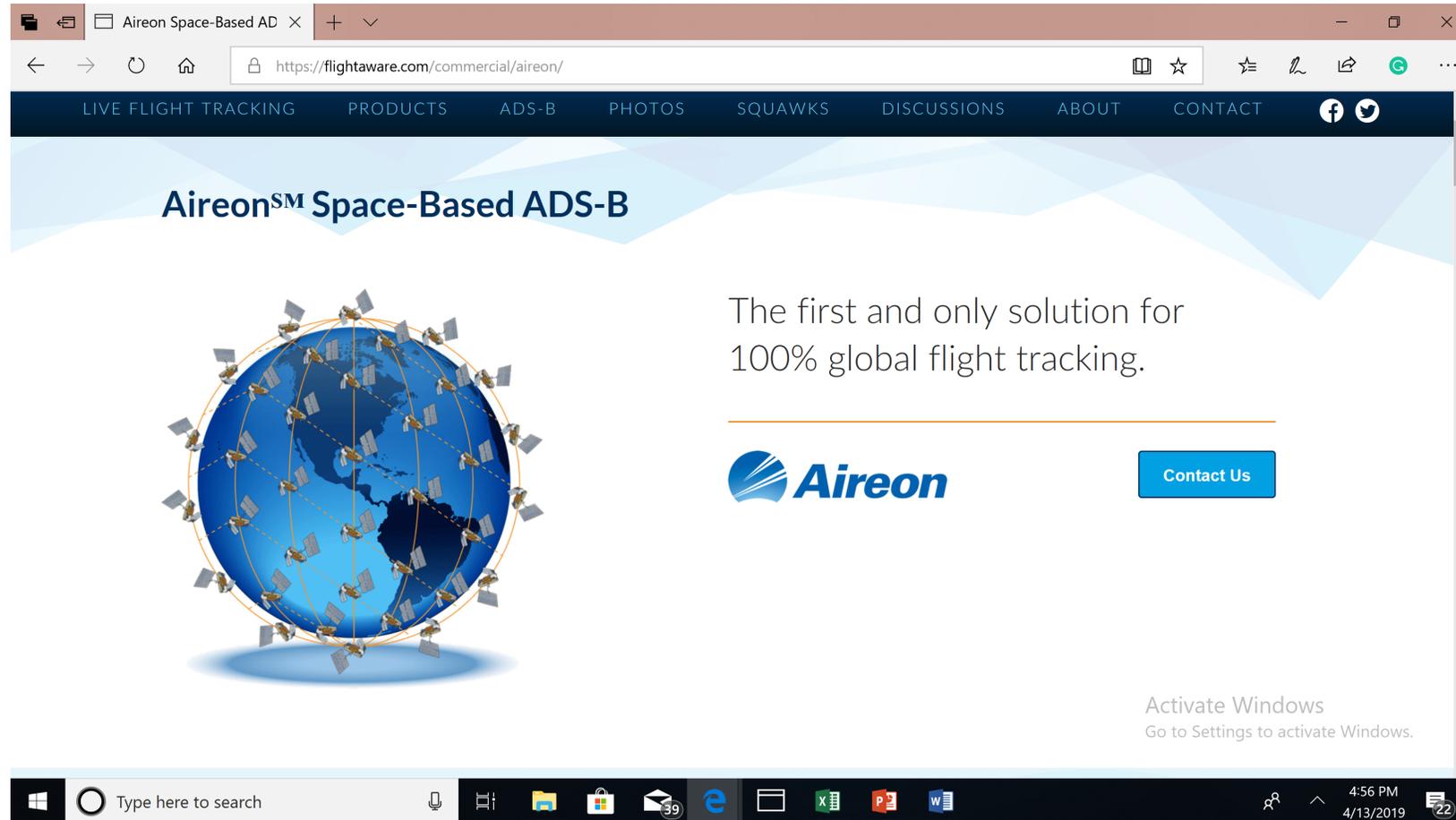
02/26/2019 - 978 MHz UAT transponders and how GSM can interfere with ADS-B

01/30/2019 - PlanePlotter Support And FlightAware

01/23/2019 - FlightAware ADS-B network now has over 20,000 sites

Sample of newsletter info

# Aireon space-based ADS-B



The screenshot displays a web browser window with the URL <https://flightaware.com/commercial/aireon/>. The browser's address bar and navigation icons are visible at the top. The website's navigation menu includes links for LIVE FLIGHT TRACKING, PRODUCTS, ADS-B, PHOTOS, SQUAWKS, DISCUSSIONS, ABOUT, and CONTACT, along with social media icons for Facebook and Twitter.

## Aireon<sup>SM</sup> Space-Based ADS-B

The first and only solution for 100% global flight tracking.



**Aireon** [Contact Us](#)

Activate Windows  
Go to Settings to activate Windows.

The Windows taskbar at the bottom shows the search bar with the text "Type here to search", several application icons (including File Explorer, Mail, Edge, and Office apps), and the system tray with the time 4:56 PM and date 4/13/2019.

# Build a PiAware

- Everything you need to know for hardware and software:  
<https://flightaware.com/adsb/piaware/build>

# Getting Started

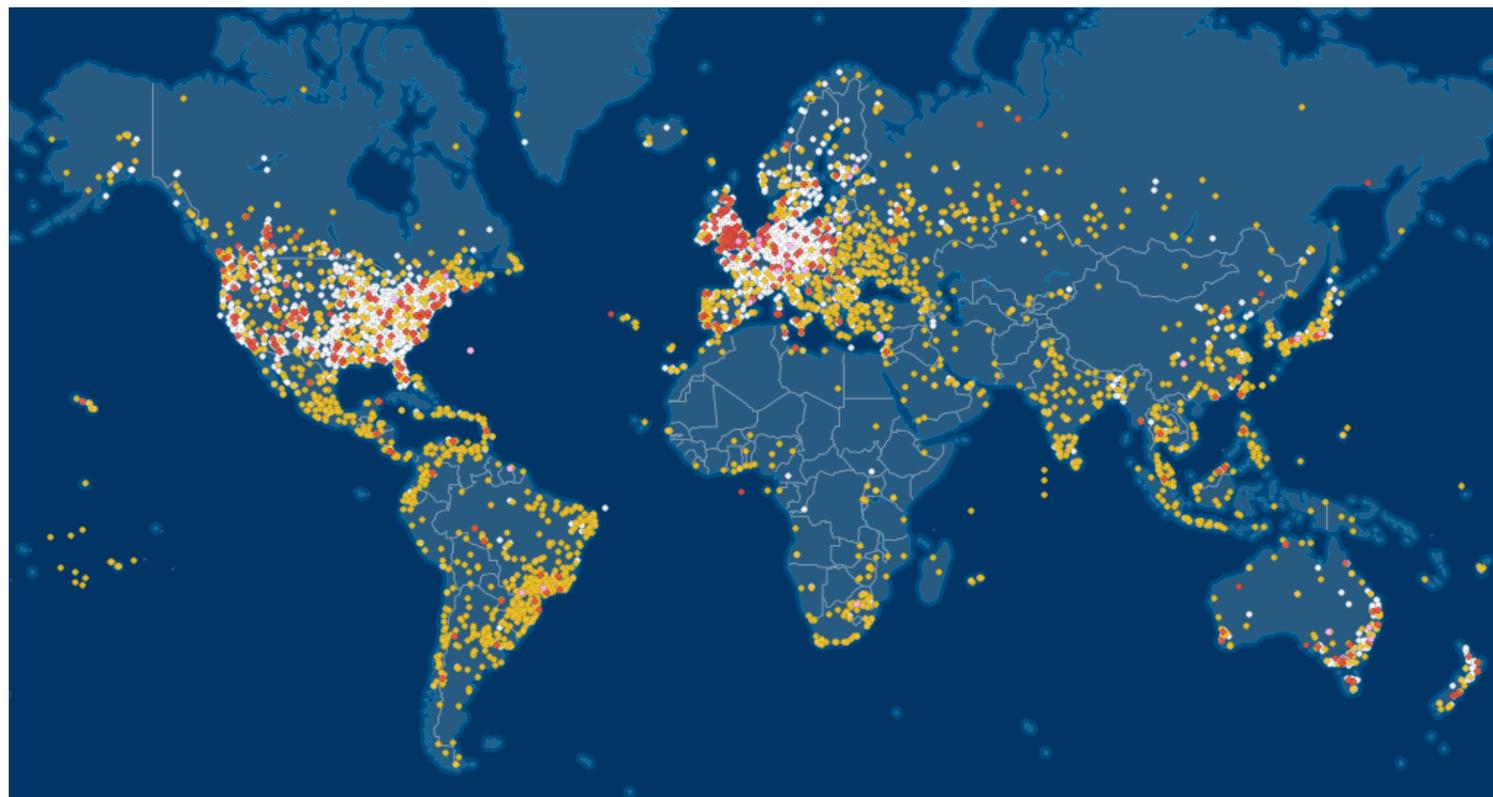
## •Required –must have

- FlightAware Pro Stick USB ADS-B Receiver (Amazon) \$19.00
- Indoor Antenna MCX plug with a SMA adapter (eBay) \$5.00
- Raspberry Pi Starter kit (Amazon) \$80.00

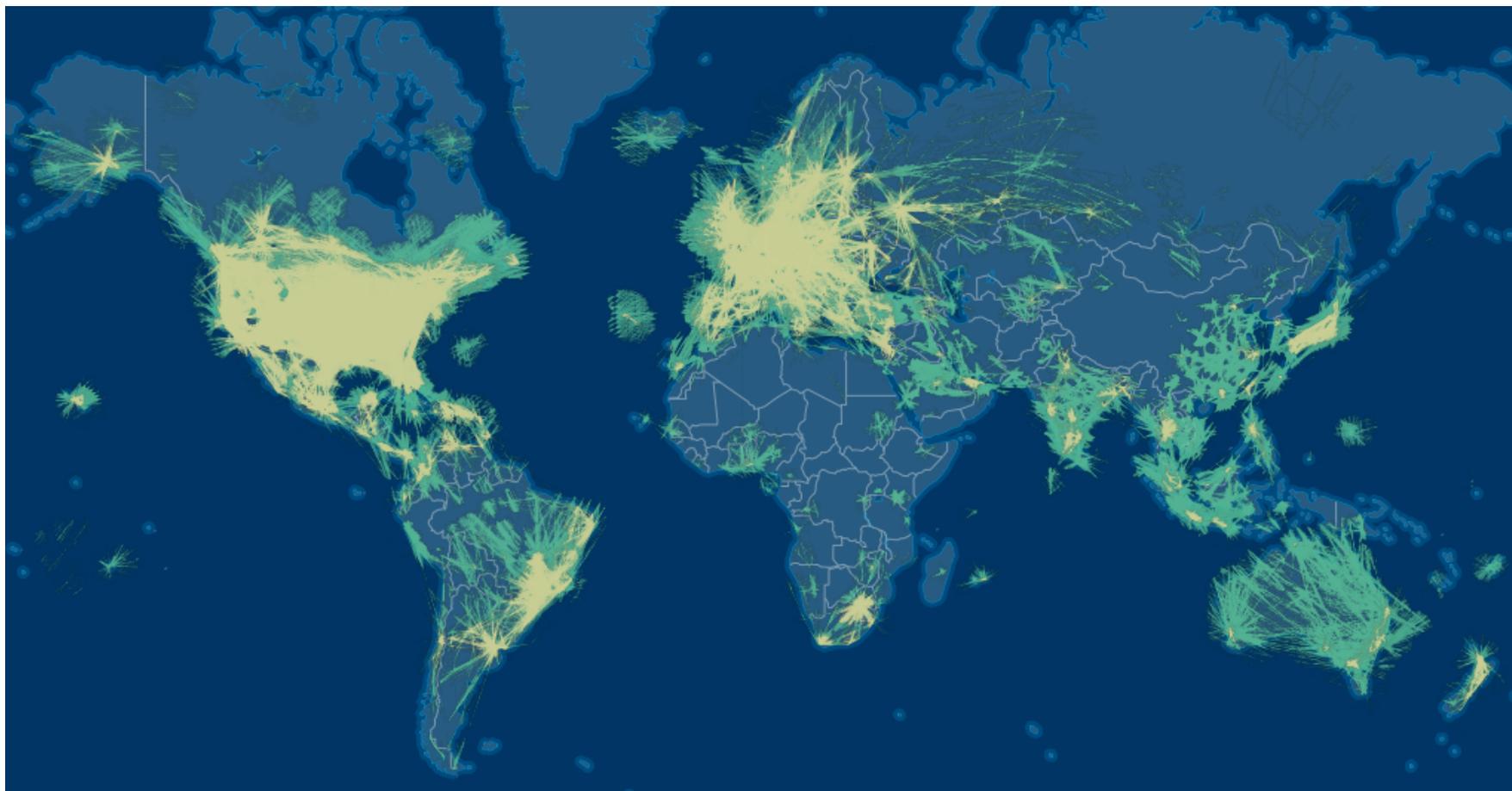
## •Optional –nice to have

- Raspberry Pi Model 3 Computer (Amazon) \$36.00
- FlightAware Pro Stick Plus USB ADS-B Receiver (Amazon) \$20.00
- CanaKit Power Supply (Amazon) \$10.00
- SD Card (Amazon) \$10.00
- Raspberry Pi 2 Case Raspberry Pi B+ Case (Amazon) \$6.00
- Indoor/Outdoor 1090MHz ADS-B Antenna with mounting bracket (Amazon) \$40.00
- ADS-B 1090MHz Band-pass SMA Filter (Amazon) \$15.00
- USB 3.0 SD Card Reader (Amazon) \$7.00
- Standard USB Keyboard (Amazon) \$14.00
- 3ft Ethernet Cable (Amazon) \$5.00
- 1090MHz filter + preamp (Nevis Computers) £40.00
- Adapter for Outdoor Cable to Dongle (MCX Right Angle Male to N Female Straight) (eBay) \$7.00
- LMR240 Outdoor Cable: Connector A: N Plug/Male - Straight to Connector B: N Plug/Male - Straight (AIR802)  
\$21.00
- FlightAware Pro Stick USB ADS-B Receiver + Cable + Filter + Antenna (eBay) \$120.00
- 8GB PiAware pre-loaded MicroSD Card (eBay) \$16.00
- Pre-built complete PiAware kit (pre-loaded Pi, Pro Stick, filter, and power/cables) with indoor antenna (Amazon)  
\$150.00
- Pre-built complete PiAware kit (pre-loaded Pi, Pro Stick, filter, and power/cables) with outdoor antenna (Amazon)  
\$200.00
- 200 joules Surge Protector (Amazon) \$9.00

# Current Sites



# Current Ground Coverage



# Other Resources

- <https://www.adsbexchange.com/>
- <https://www.flightradar24.com/how-it-works>
- <https://planefinder.net/about/how-it-works>
- <https://opensky-network.org/>
- <https://flightaware.com/>
- <https://www.radarbox24.com/>
- <https://www.aopa.org/news-and-media/all-news/2017/october/10/flightaware>
- <https://cradlepoint.com/>
- <https://www.ecnmag.com/news/2017/0>

# Q&A?

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Questions?

