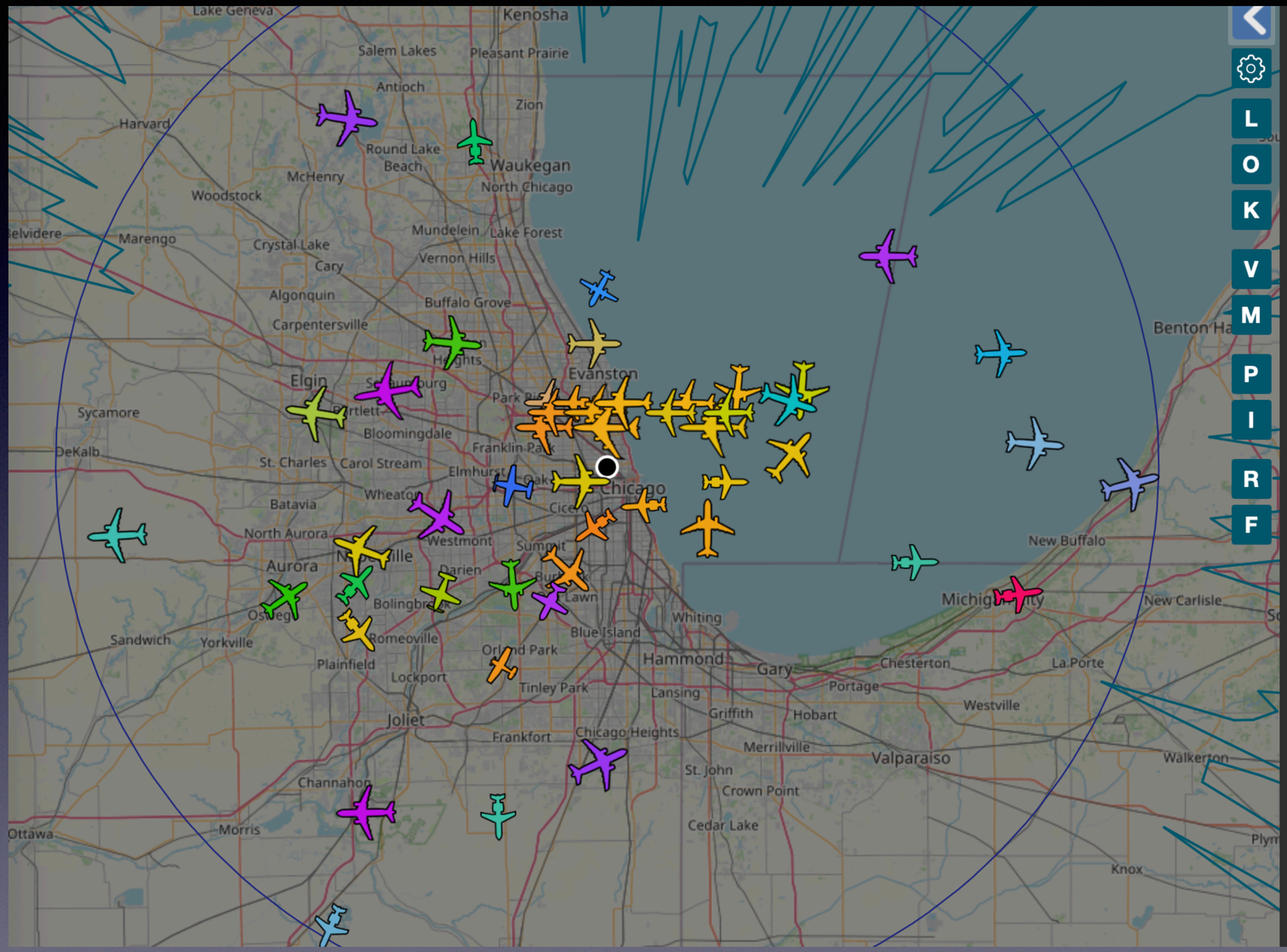
ADS-B Flight Tracking

Seth Heckard, AD9GZ
Chicago FM Club



Total Aircraft: 61
With Position: 55
Stats available here

Messages: 373.1/sec
History: 5030 positions

Search | Filters | Columns

Search:

Search | Clear Search

Jump to Airport or Latitude, Longitude:

Jump | Clear

	Callsign	Route	Type	Squawk	Alt. (ft)	Spd. (kt)	Dist. (nmi)	RSSI
	LRC630	SJO-GUA-ORD	A20N	1727	▼ 6275	307	2.6	-8.0
	GTI8245	?? EHU-ANC	B748	7210	▼ 3650	171	3.6	-16.1
	N46VE		CL30	3725	3000	162	4.8	-8.4
	UAL959	LHR-ORD	B763	2574	▼ 3400	175	5.1	-16.9
	EJA965		C68A	3606	▼ 1425	100	5.6	-24.1
	AAL2644	LGA-ORD	B738	3351	3975	165	5.9	-23.7
	SKW5912	LNK-ORD	CRJ2	3656	▼ 2925	165	6.5	-11.8
	AAL2590	SNA-ORD	B38M	2053	▼ 1850	143	6.8	-21.6
	ENY3902	ORD-SYR-ORD	E75L	1442	▼ 2125	160	7.0	-23.5
	RPA3619	GSP-ORD	E75L	5776	▼ 5500	198	7.5	-26.5
	ENY4174	SGF-ORD	E170		▼ 1900	146	7.9	-28.6
	N900CY		TBM9	4115	26000	287	8.7	-14.7
	RPA3485	CVG-ORD	E75L	6727	4000	206	9.3	-24.7
	ANA8402	NRT-ORD	B77L	0576	5000	196	10.1	-20.8
	SWA4745	MDW-PVD	B737	3256	▲ 2300	238	10.1	-26.3
	SWA653	DAL-MDW	B738		3000	194	10.6	-25.1
	VTE3548	TBN-ORD	CRJ2	2121	5000	257	10.8	-24.1
	DAL1544	MSP-ORD	BCS1	3071	▼ 5050	307	11.2	-25.9
	ENY3600	ORD-YUL-ORD	E75L		7000	256	11.9	-20.2
	N109TD		C56X	2461	36000	404	13.4	-23.5

Contents

- What can I see?
- Why should I do this?
- How does it work?
- What do I need?
- How to install?
- What can I do next?

What can I see?

- Callsign / operator / aircraft registration
  - Airline ICAO code then flight number (usually)
  - Charter flights not predictable
  - General aviation uses “tail” (registration) number
- Airplane type
  - B38M = Boeing 737-8 MAX
  - Unfamiliar? Search here
- Route (maybe)
- Altitude / speed / heading
- Distance from you
- ADS-B hex identifier / “squawk” code
  - Hex identifier doesn’t change, can view airplane history
  - Squawk code changes every flight

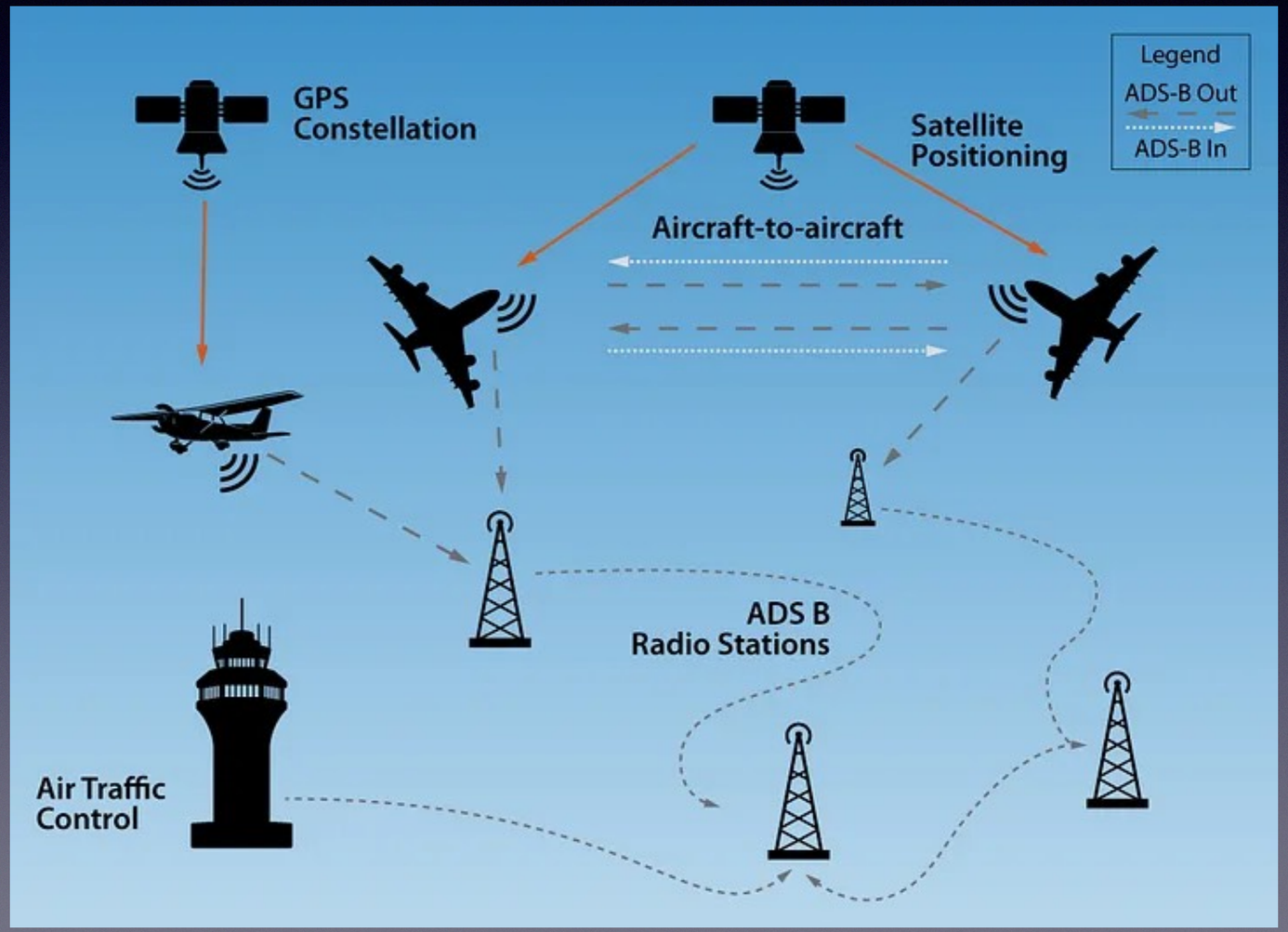
Why would I do this?

- Aviation enthusiast
  - See “hidden” planes
- Curious about what is flying over your house
  - Free subscription to sites/apps (FlightRadar24, Flightaware, etc.) that you feed with your data
- Fun radio project
  - UHF line-of-sight propagation principles
  - Think of it as another digital mode that you can decode
- Have most of the parts sitting around already (Pi, SDR)
  - It’s a great way to put that gear to another use

ADS-B: Automatic Dependent Surveillance - Broadcast

Mandatory in the US since 2020

with a few exceptions

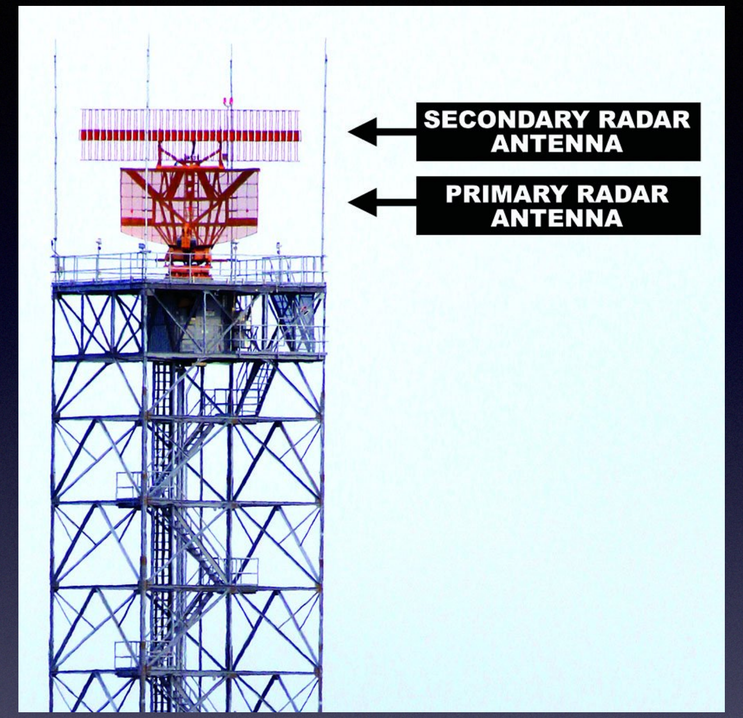


1090 MHz (large airplanes)

978 MHz (small/general aviation)

History Lesson

- How did planes report their position prior to ADS-B?
  - They didn't — they were interrogated by ATC by a process called *secondary surveillance radar* (SSR)
  - Ground radar sends *(primary & secondary)* →
    Aircraft transponder receives *(Mode S or Mode C, 1030 MHz)* →
    Aircraft replies with transponder code & altitude *(1090 MHz)* →
    Collated by radar system and displayed to controller
  - This is kept around as a backup to ADS-B
    - We can still receive these signals from Mode S transponders, and using ***multilateration*** (MLAT), identify their location using other participating receivers nearby



1090 vs 978

- What's the difference?
  - Aircraft transponders replied on **1090 MHz** prior to ADS-B, so the FAA reused the existing frequency
    - This is sometimes called **1090ES**
    - **Focus your efforts here,** it will be way more interesting than 978
  - Concerns about frequency congestion drove the need for **978 MHz** (also called **978 UAT**) for smaller/general aviation aircraft
    - Aircraft with 978 are not allowed outside of the US, or above 18,000 ft.
    - If you live near a small airport, consider running both 1090 & 978

What do I need?

- **Raspberry Pi** (or Orange Pi, or similar) ~$50-75
  - Best price/value points to Pi 4 at this point
    - 1 or 2 GB of ram is fine, any more is overkill
    - 512 MB is possible but with limits in number of sites to feed
- **Power supply** (get the branded one)
- **microSD card**
    - Buy a name-brand **endurance** model
    - Storage needs are low (32-64 GB is plenty)
- **A case**, or 3D print one in PETG!
- *Maybe:* **Wifi power plug**, if it's in a remote location

What do I need?

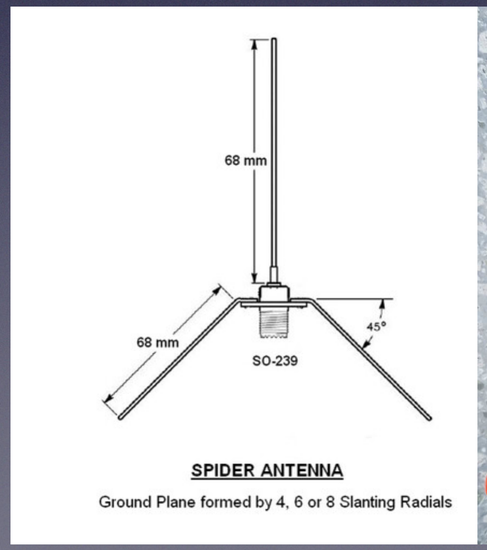
- **USB SDR adapter** ~$40
  - Some come with filter/LNA, some do not
  - If you want to run both 1090 & 978, you will need one SDR for each band

Supported Software Defined Radios (SDRs)

- Airspy Mini (expensive, but by far the best supported SDR for ADS-B/1090MHz)
- NoName Chinese 1090MHz SDR (directly from AliExpress, also comes in various branded versions like airplanes.live, airframes.io, ADSBexchange) -- this is a fairly good RTL SDR with 1090MHz filter and a low noise amplifier - and it's in a blue metal housing which really helps with heat dissipation and longevity
- Rtl-Sdr.com v3 and v4 dongle (it appears that the v3 is slightly better for ADS-B use cases)
- FlightAware pro stick (includes 1090MHz filter and a low noise amplifier - because of the plastic housing I prefer the one above)
- RadarBox green stick (includes 1090MHz filter and a low noise amplifier - this appears to be slightly lower quality than the ones above)
- RadarBox red stick (includes 978MHz filter and a low noise amplifier -- for UAT978)
- Nooelec NESDR SMArt and SMArTee
- Most other RTL2838 based USB sticks should work
- SDRplay RSP1a and RSP1b - other models might work as well

What do I need?

- **Antenna** – outdoors, if possible, mounted as high as you can ~$50
  - Consider obstacles: even a small increase in height can dramatically increase range
    - Check with heywhatsthat.com, but doesn't know about buildings
  - Type-N connector *(antenna)* → SMA *(USB SDR)*
- Common antennas for ADS-B:
  - Quarter-wave ground plane (spider)
  - Colinear antenna

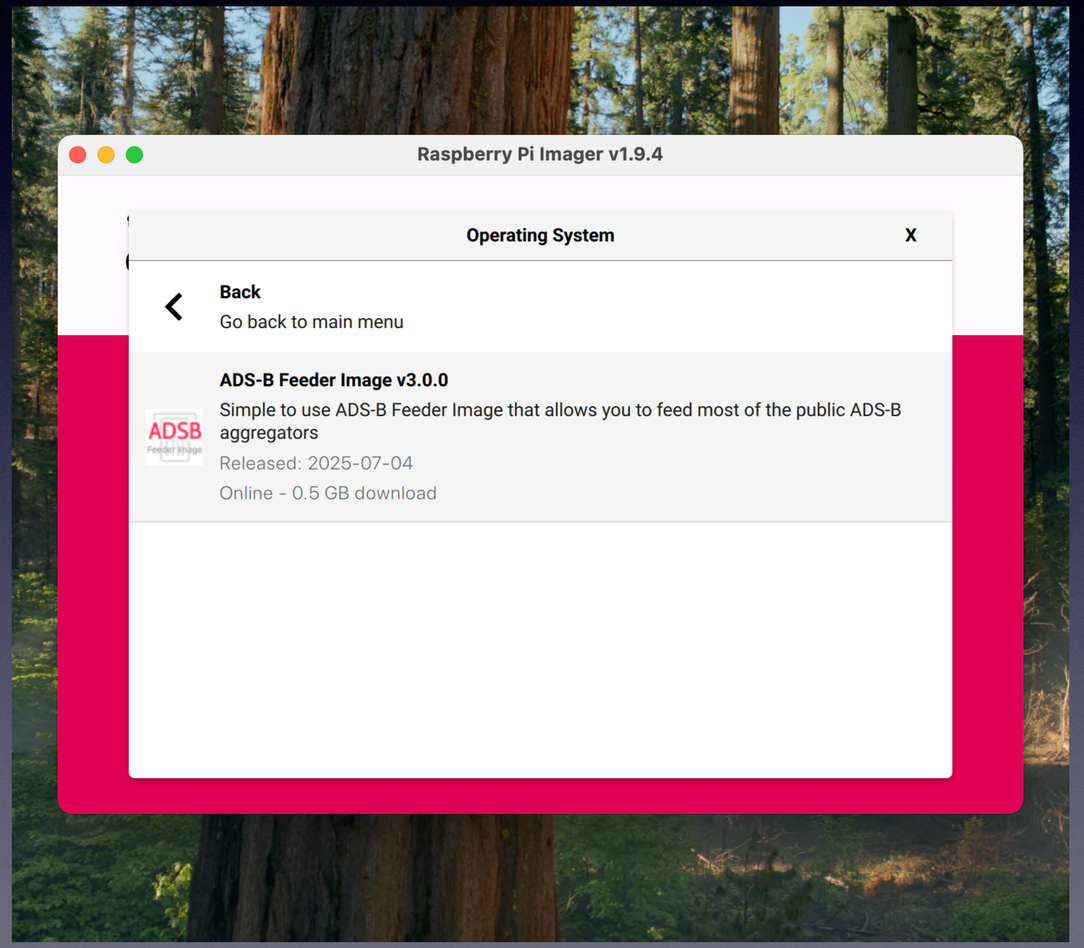


How to install

- Pick your feeder image
  - **PiAware**
    - *Easy, but only because of limited configuration*
      - Directly supports FlightAware, but can support anything with more work & terminal access
    - Even if you don't use the PiAware image, their forums are great
  - **ADSB.im**
    - *My recommendation*
    - Allows you to feed numerous sites at once, easy install, has a web-based interface, no terminal/ssh needed (unless you like that sort of thing…)

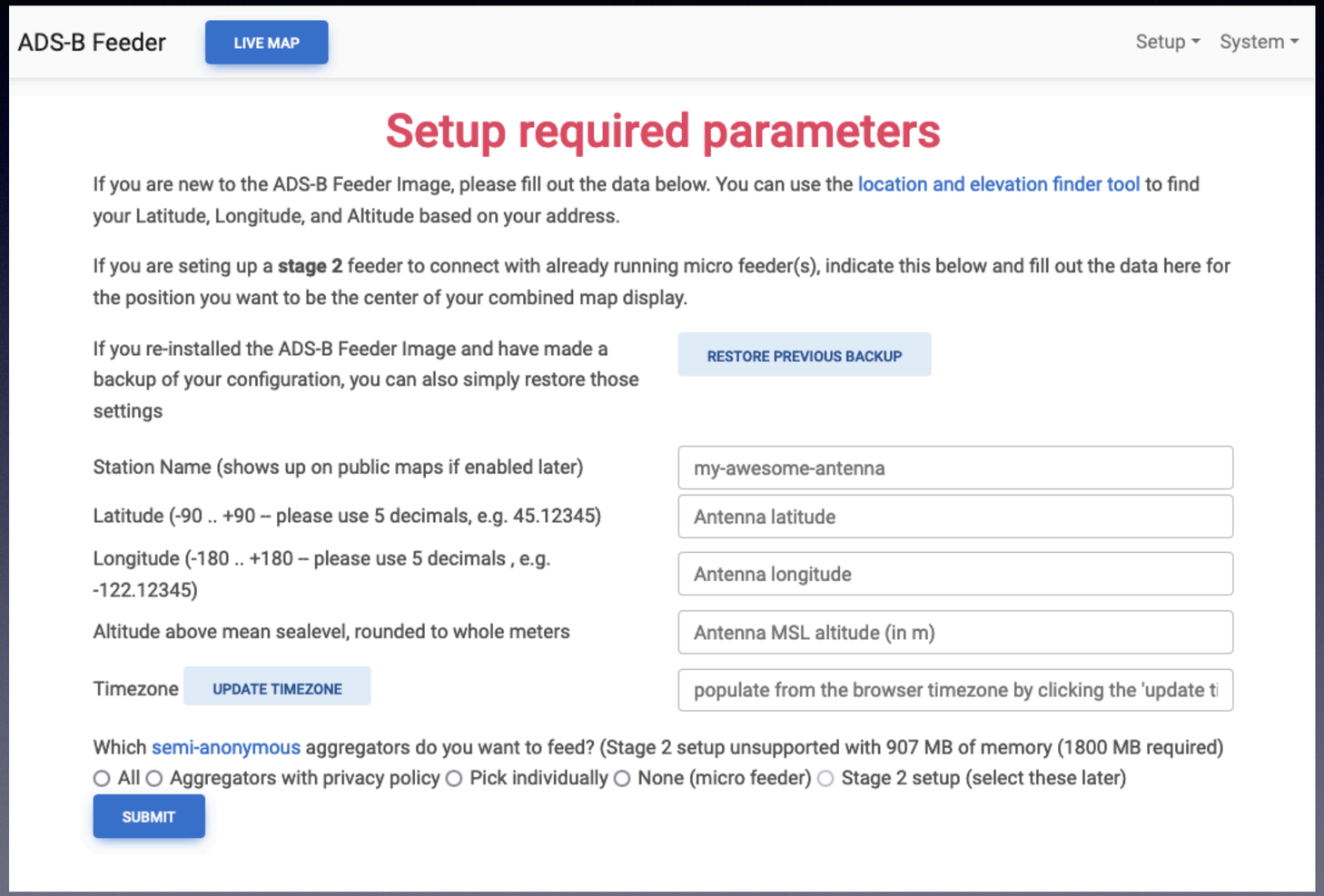
How to install

- Use the Raspberry Pi Imager to copy the image to your micro SD card
  - ADSB.im is built into the Pi imager
    - “Other specific-purpose OS” → “ADS-B Feeder Image”
    - You can either set up wifi in the imager, or if you don’t, it will create a hotspot that you can connect to & share wifi credentials
      - SSID: *adsb-im.feeder*
    - https://adsb.im/howto



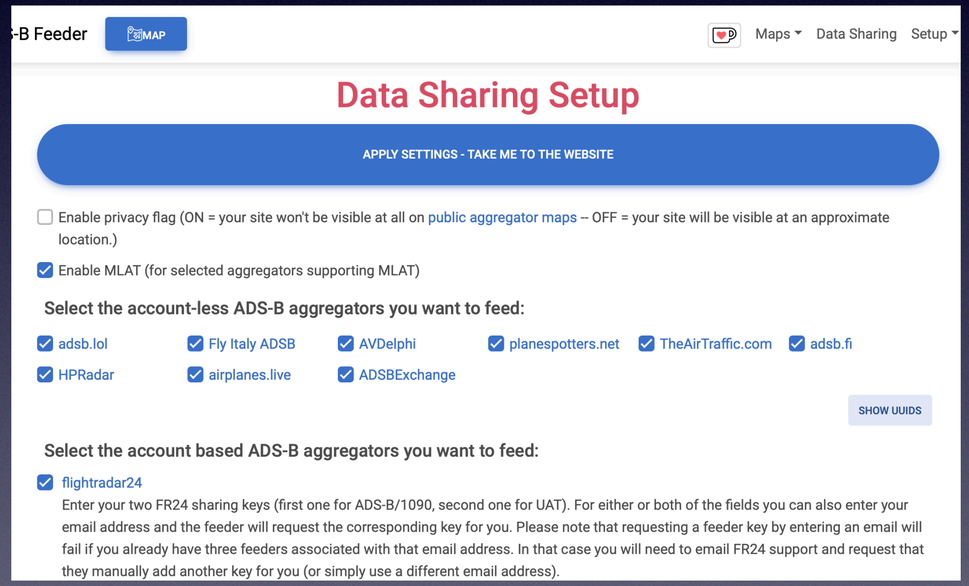
How to install

- For ADSB.im:
  - Try **http://adsb-feeder.local/**
  - Connect to its hotspot if you didn't configure wifi
- Once you connect to the website, you will need:
  - Latitude
  - Longitude
  - Altitude of antenna
  - https://www.mapcoordinates.net



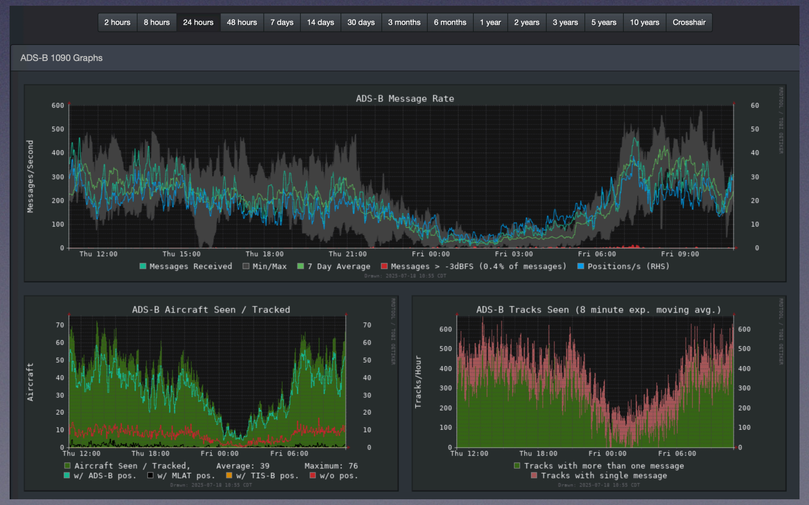
How to install

- Feeders upload your data to commercial/enthusiast flight tracking sites, which combine your data with all participating users
  - *Commercial:* FlightRadar24, FlightAware, AirNav Radar, etc.
    - **These sites will give you the highest-tier membership** in exchange for feeding your data.
    - **An account is required** so they can update your profile, or associate it with a sharing key that you load into your feeder
  - *Enthusiast:* ADSBExchange, ADSB.fi, OpenSky Network, etc.
    - **Typically, no account is required**, although some do require one
    - Some sites have geographic restrictions



What’s next?

- Optimize!
  - Reconsider antenna placement?
  - Consider a filter or LNA? - Shopping list
- Add 978 UAT tracking?
  - Will need another SDR, maybe another antenna
- Add other stations and combine them?
  - ADSB.im “stage 2” setup
- Other aviation related things that are not flight tracking?
  - ACARS decoding?
  - VHF Data Link (VDL2)/HF data link decoding?
- AIS tracking (marine/ships)?
- External access with Zerotier



Questions?