

# Digital Plane Spotting: High-Flying Applications for Cloud-Based Data

James McLane

NCTCOG Regional GIS Meeting

December 10, 2019

# Introduction

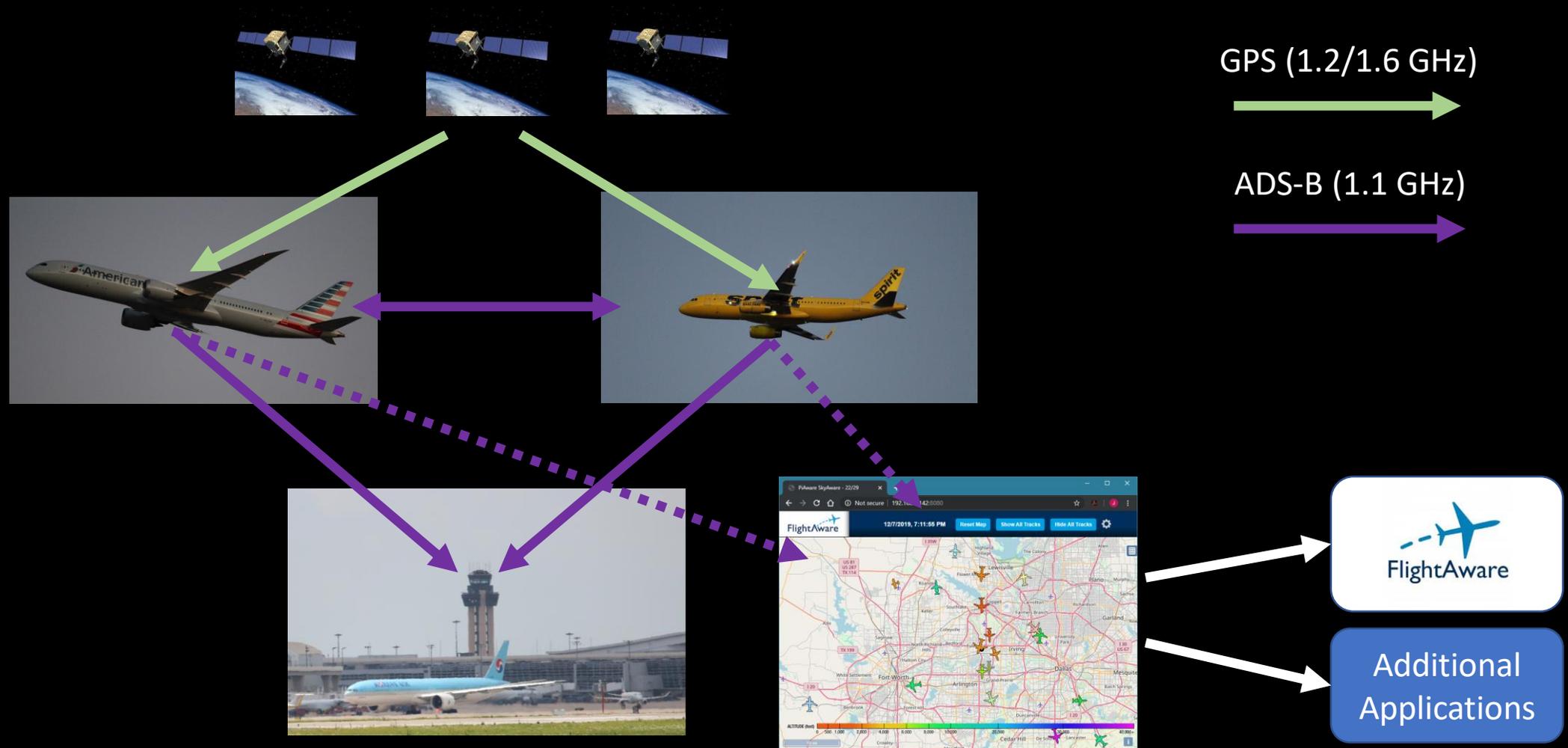
- Armchair interest (obsession?) in civil aviation
- Wanted more information about planes flying over my apartment near DFW Airport
- Using FlightAware's PiAware software package, Python, MySQL, and ArcGIS (Personal Use license) to log and analyze unencrypted flight data from aircraft



# What is ADS-B/Mode S?

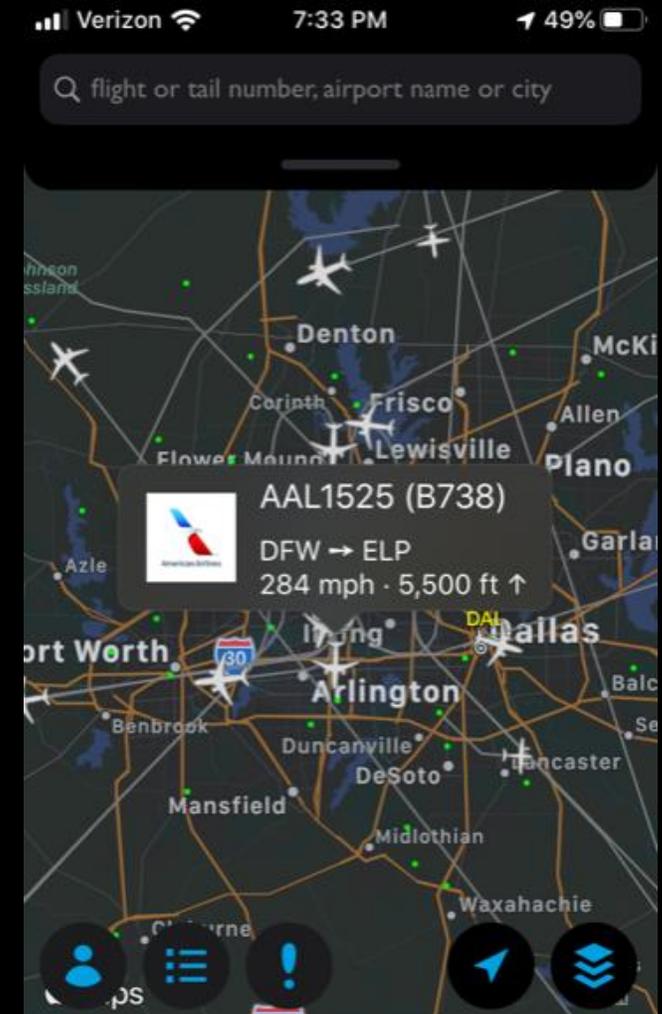
- 1090 MHz digital radio transmission from aircraft that can contain:
  - Identifying information (Callsign/Hex, flight number)
  - XYZ Location (Latitude, Longitude, Altitude)
  - Flight information (air speed, vertical speed, heading, etc.)
- Intended for use by secondary radar systems used by air traffic control
- Mode S (older) transmits in response to interrogation from ground stations and data stream contains less information
- ADS-B (newer) is transmitted constantly and provides a richer data stream
- Transmissions are unencrypted and can be received by third parties on the ground

# What is ADS-B/Mode S?



# What is FlightAware/PiAware?

- FlightAware is one of a handful flight data aggregators that uses ADS-B and other data streams to assemble a live picture of the world's commercial and civil aviation
- ADS-B data is usually collected by a volunteer network of privately-owned receivers
- FlightAware provides PiAware software and sells receiving equipment to volunteers to increase their ADS-B coverage



# What is FlightAware/PiAware?

Receivers consist of:

- An antenna optimized to receive 1090 MHz transmissions
- A software-defined radio dongle
- A Raspberry Pi or other lightweight computer running FlightAware's PiAware software



# PiAware - SkyAware

The screenshot displays the PiAware SkyAware web interface. The browser address bar shows the URL `192.168.1.142/dump1090-fa/`. The interface includes a map of the Dallas-Fort Worth metropolitan area with various aircraft icons and tracks. A data table on the right provides details for 15 aircraft, including their ICAO codes, identifiers, squawks, altitudes, speeds, distances, headings, message counts, and ages. The table also includes a legend for ADS-B, MLAT, Other, and TIS-B data sources.

FlightAware PiAware SkyAware 12/7/2019, 7:31:09 PM Reset Map Show All Tracks Hide All Tracks

Total Aircraft: 15 Messages: 75.7/sec  
With Positions: 12 History: 1005 positions

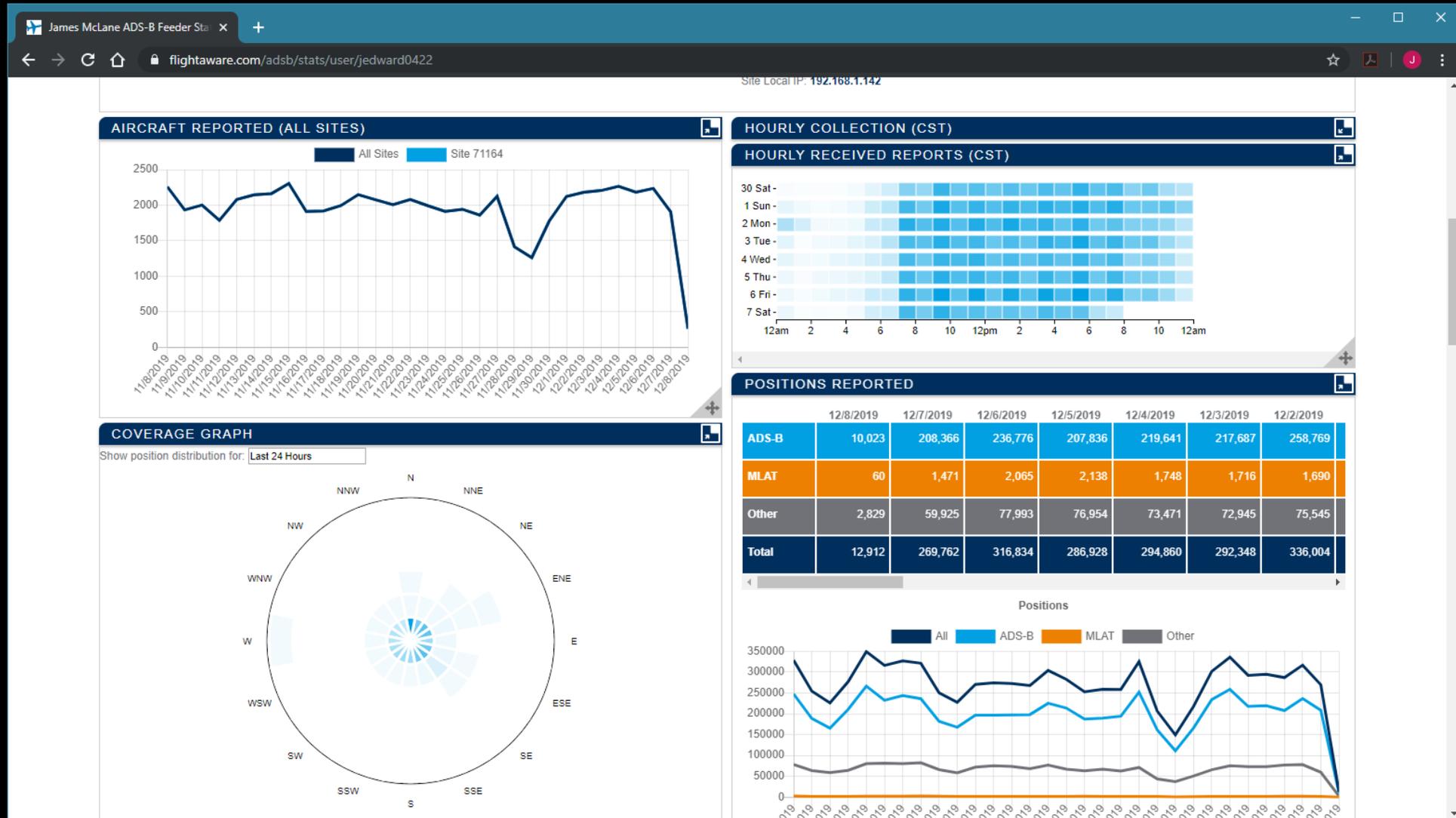
Filter by Altitude:  ft to  ft Filter Reset

ICAO	Ident	Squawk	Altitude (ft)	Speed (kt)	Distance (NM)	Heading	Msgs	Age
AB79CA	<a href="#">AAL2453</a>	2330	2,925 ▲	230	0.5	181°	1325	0
ACE0D2	<a href="#">AAL1191</a>	2507	8,875 ▼	261	8.1	1°	4787	0
A1AA24	<a href="#">AAL1966</a>	2270	9,750	328	9.6	260°	2910	0
A27FEA	<a href="#">N260KM</a>	2307	2,625 ▲	120	10.4	190°	321	0
A18239	<a href="#">AAL2469</a>	1337	10,775	242	10.9	316°	3715	0
A620B7	<a href="#">UAL217</a>	7333	32,000	404	11.8	322°	2268	0
A2B691	<a href="#">ENY3451</a>	1120	7,725 ▼	283	13.8	1°	1967	3
4D010C	<a href="#">CLX6616</a>	2654	10,800	332	15.1	44°	751	0
AC8577			3,100 ▼	158	17.0	205°	68	1
AA11DC	<a href="#">SKW3216</a>	2256	14,100 ▲	330	21.0	261°	5424	30
A33D97	<a href="#">FFT2300</a>		18,225 ▲	353	29.0	73°	4466	0
AB812D	<a href="#">SWA865</a>	1067	37,000	526	57.4	113°	2214	0
A752A2			2,000 ▼	163		180°	21	2
ABC40D			9,100 ▼	275		236°	36	1
ABD57E		1007	36,000				5	57

Legend: ADS-B MLAT Other TIS-B

ALTITUDE (feet) 0 500 1,000 2,000 4,000 6,000 8,000 10,000 20,000 30,000 40,000+

# FlightAware ADS-B Stats Page



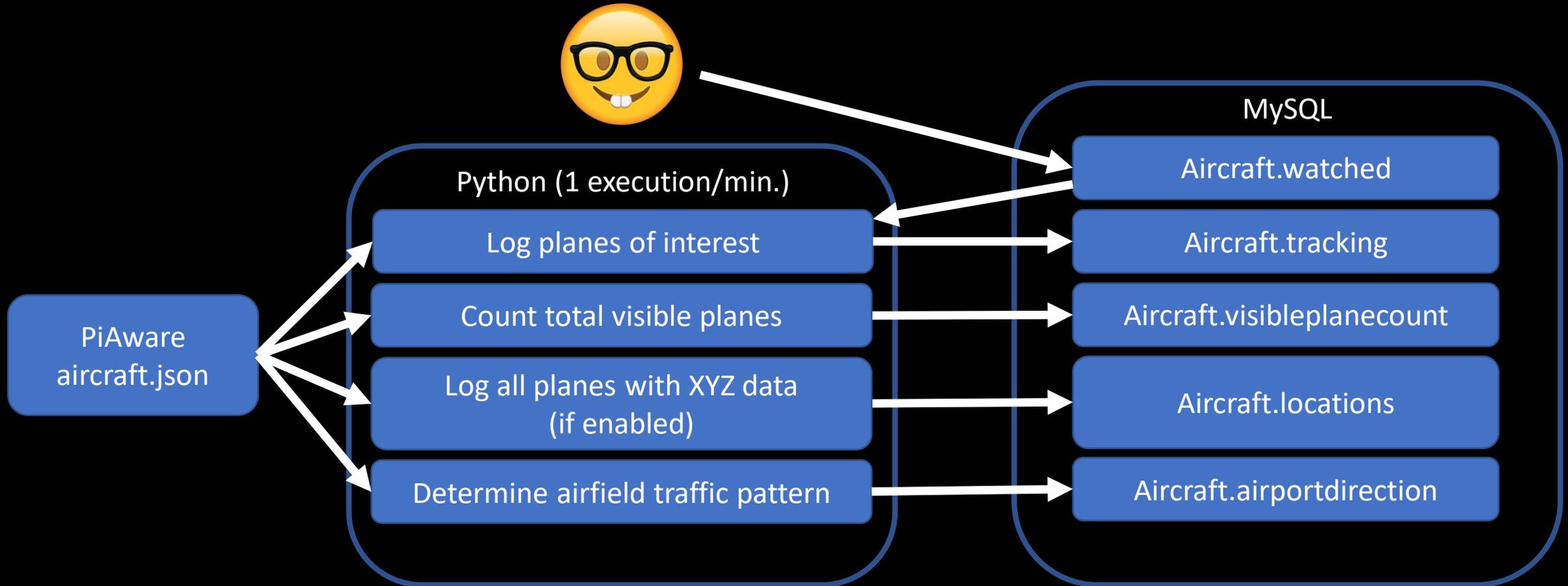
# Extensibility of PiAware Framework

- Stock information output is useful, but there's much more potential
- PiAware software continuously outputs information to a JSON file to provide the information seen on the Skyview page
- Stock PiAware distribution runs on Raspbian, a lightweight Linux distribution based on Debian
  - Allows for installation of additional useful components (Python, SSH, Samba, MySQL)

```
3:
  hex: "a17527"
  flight: "AAL855 "
  alt_baro: 7000
  alt_geom: 7150
  gs: 295.4
  track: 86.9
  baro_rate: 3008
  squawk: "2336"
  emergency: "none"
  category: "A3"
  nav_qnh: 1020.8
  nav_altitude_mcp: 16992
  nav_heading: 154.7
  lat: 32.743401
  lon: -96.974917
  nic: 8
  rc: 186
  seen_pos: 0.4
  version: 2
  nic_baro: 1
  nac_p: 9
  nac_v: 1
  sil: 3
  sil_type: "perhour"
  gva: 2
  sda: 2
  mlat: []
  tisb: []
  messages: 2181
  seen: 0.1
  rssi: -12.1
```

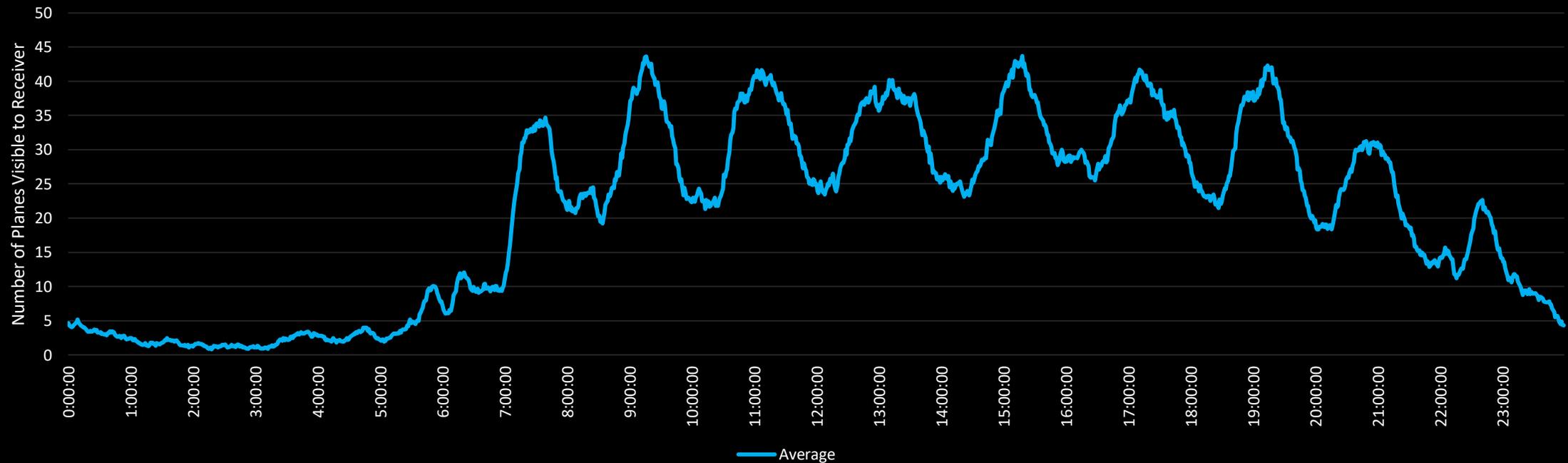
# Logging Process

- Series of Python scripts read Skyview JSON once per minute (cron) and insert relevant data into MySQL database



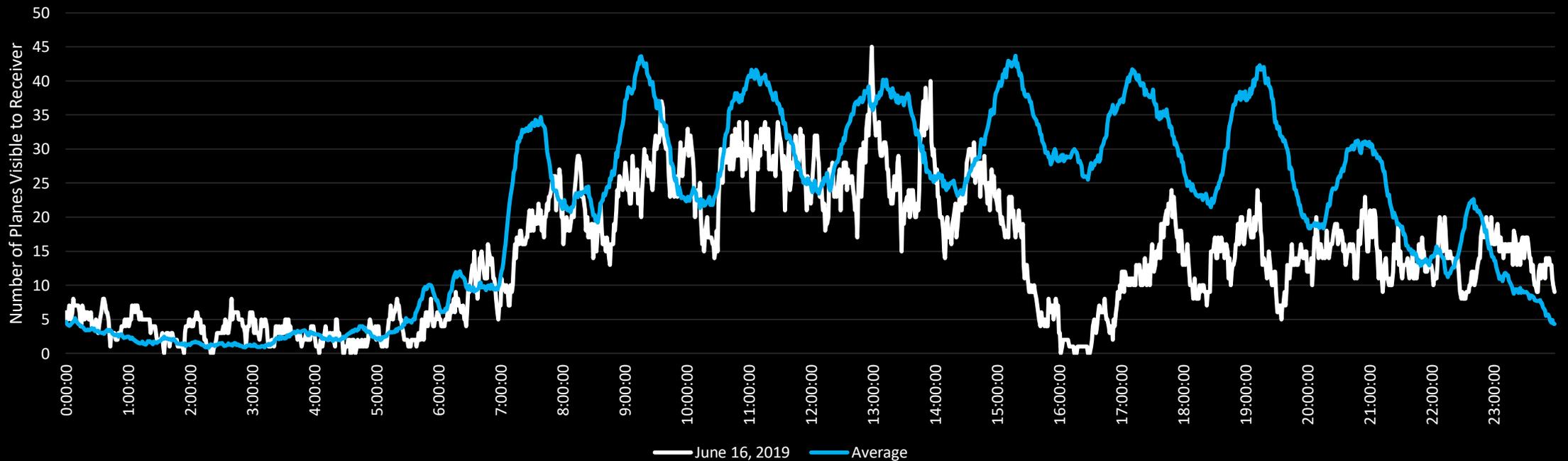
# Applications – Overall Airport Activity

- Clear banking pattern evident



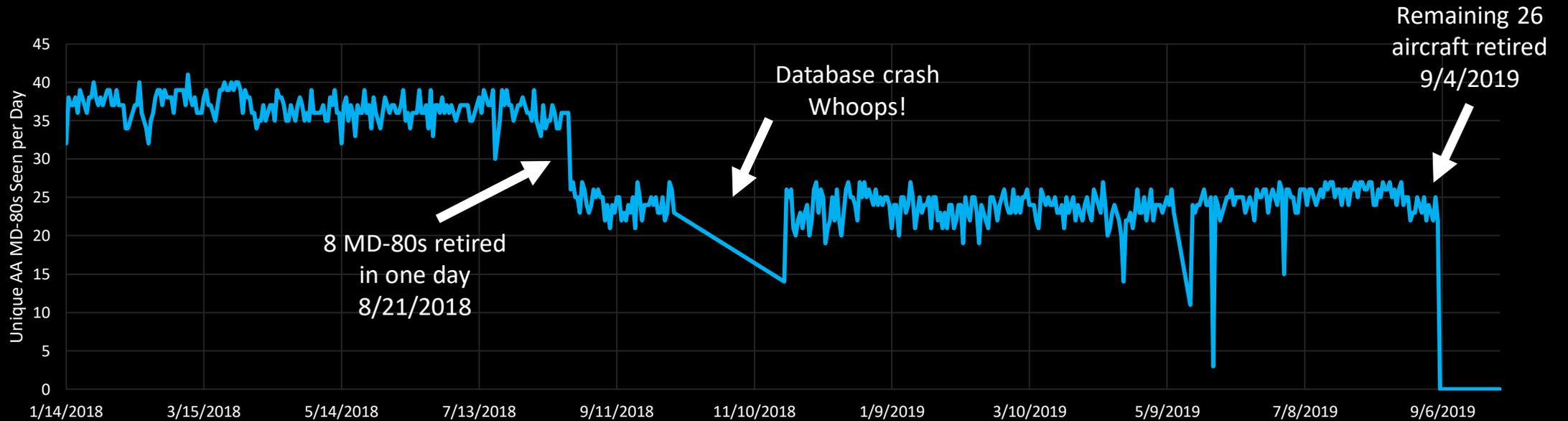
# Applications – Overall Airport Activity

- Clear banking pattern evident
- 6/16/2019 – 2.42 inches of rain recorded at DFW Airport

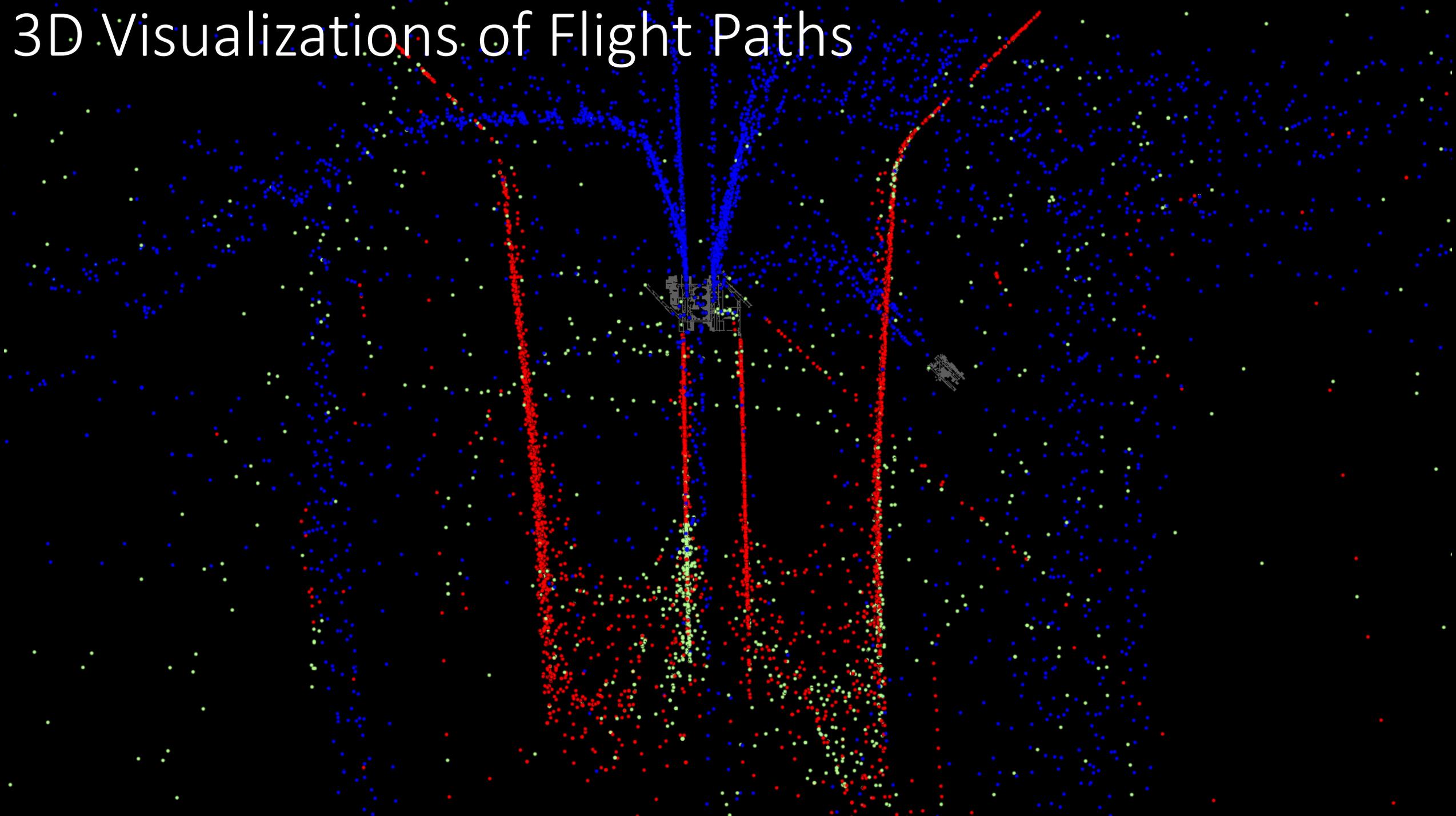


# Applications – Tracking Interesting Planes

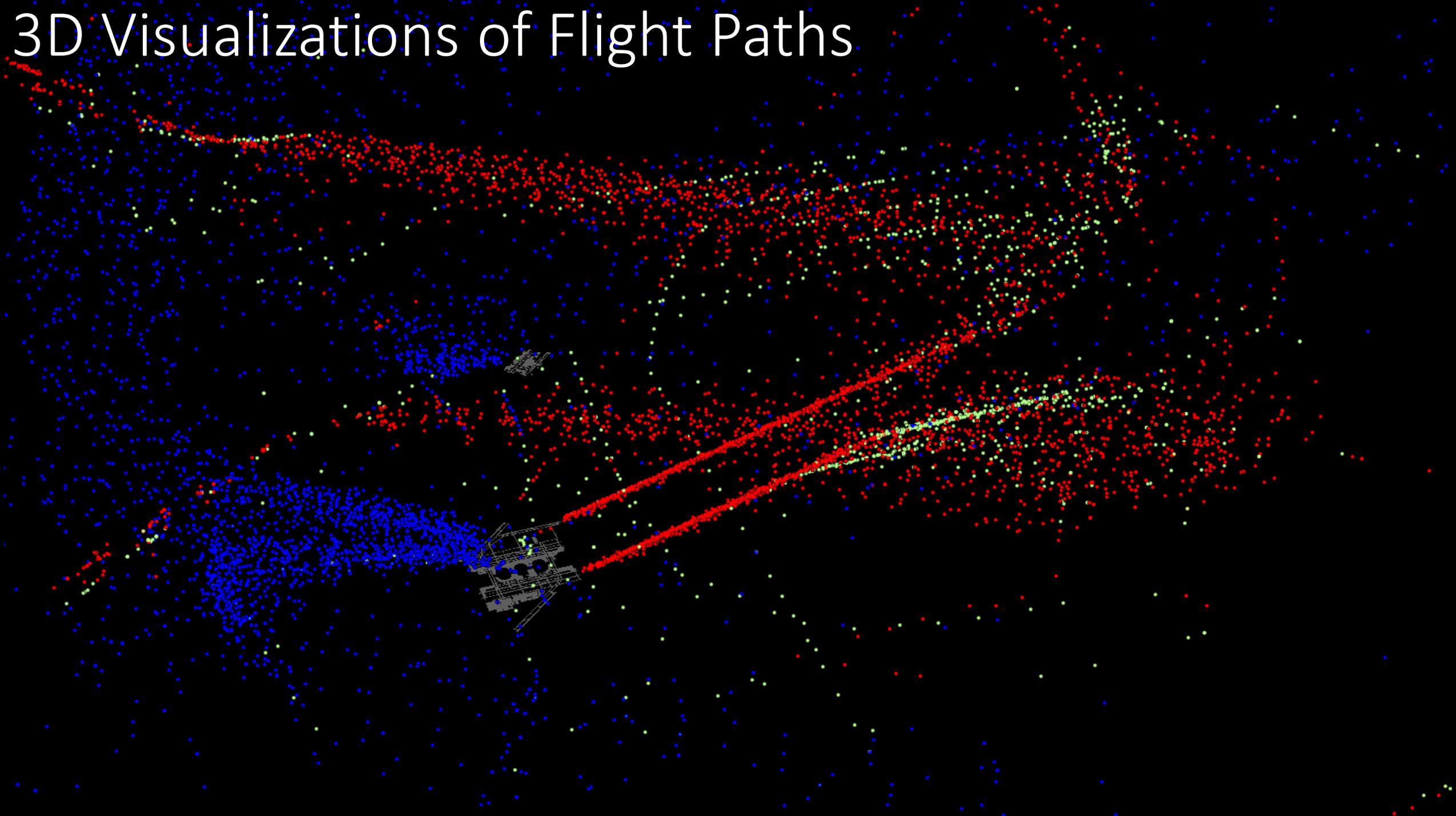
- Retirements of American's MD-80 fleet over time



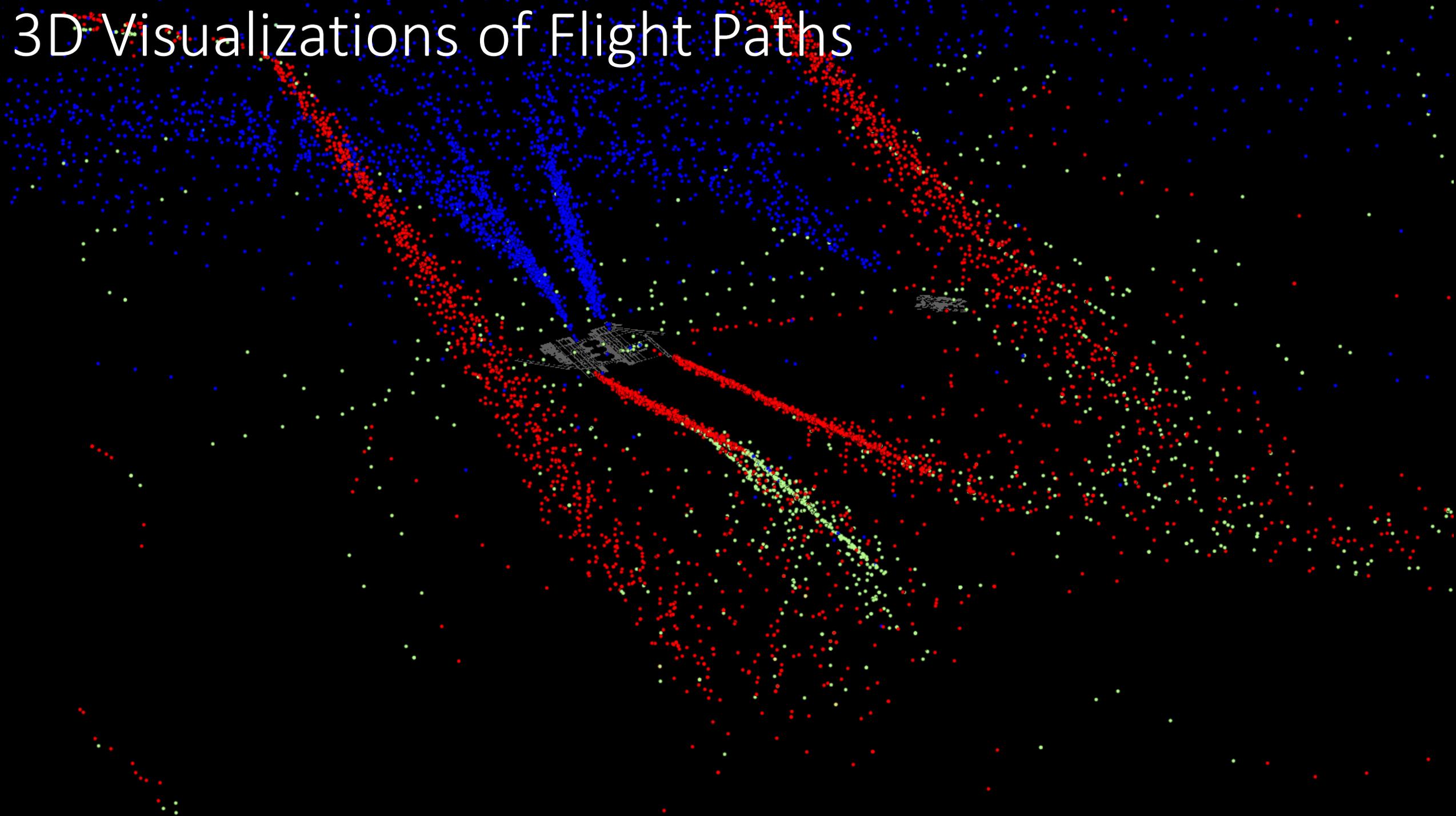
# 3D Visualizations of Flight Paths



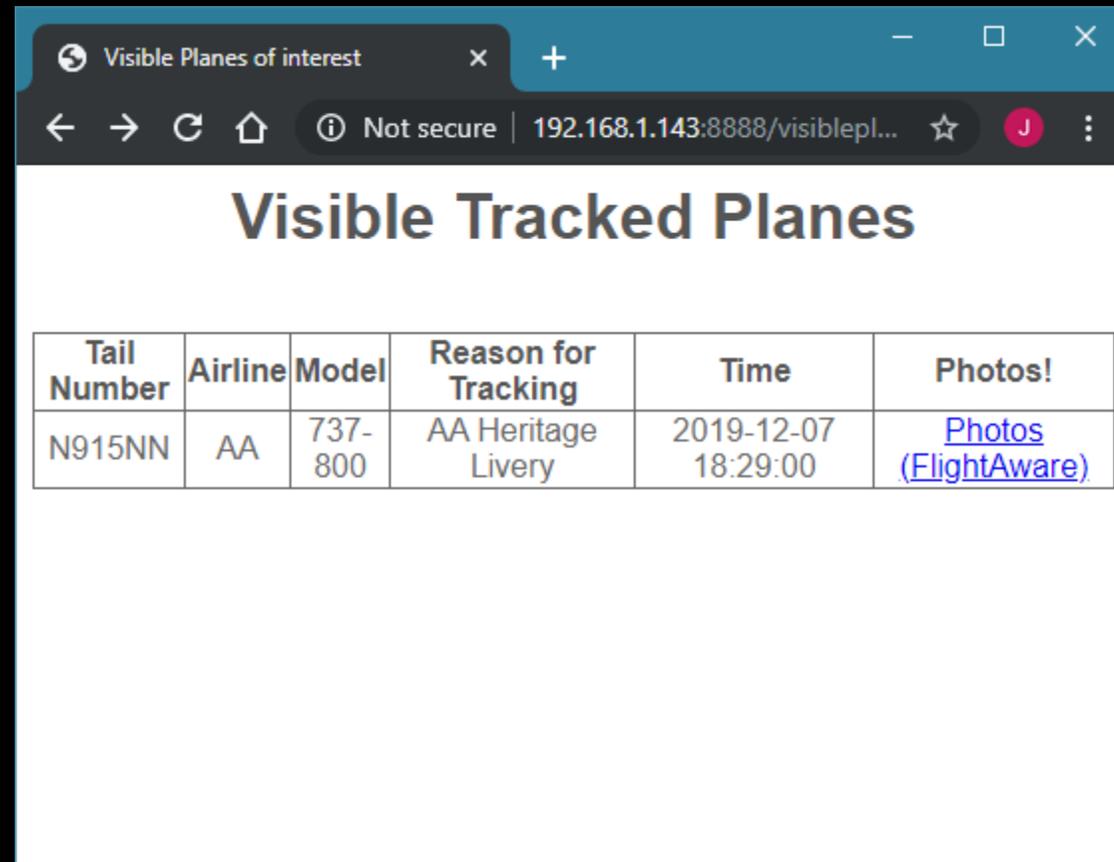
# 3D Visualizations of Flight Paths



# 3D Visualizations of Flight Paths



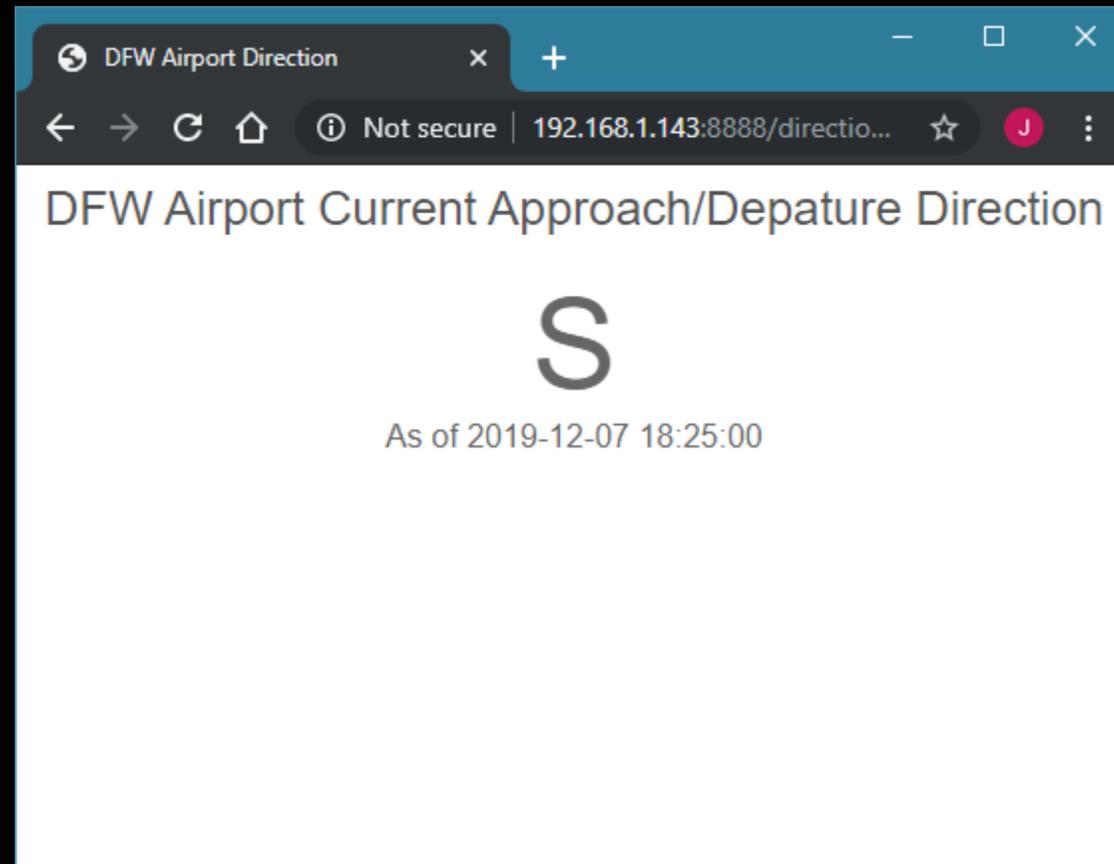
# PHP – Reading from MySQL



The image shows a web browser window with a single tab titled "Visible Planes of interest". The address bar shows "Not secure | 192.168.1.143:8888/visiblepl...". The main content area displays the heading "Visible Tracked Planes" above a table with the following data:

Tail Number	Airline	Model	Reason for Tracking	Time	Photos!
N915NN	AA	737-800	AA Heritage Livery	2019-12-07 18:29:00	<a href="#">Photos (FlightAware)</a>

# PHP – Reading from MySQL



# What's Next

- More web products
- Better antenna and location
- Potentially modifying Skyview JSON on a live basis and exposing it as a GeoJSON or another service to be consumed in my own online applications
- Continuously logging all aircraft movements
  - Better data infrastructure needed

# Endorsements

- FlightAware/PiAware
  - Useful software package that recognizes that its users value extensibility
- Raspberry Pi
  - Handles continuous radio decoding tasks, data submission, and my additional overhead smoothly
- ArcGIS Personal Use license
  - Opportunity to practice and get exposure to newer versions of ESRI software (Pro)

# Questions?

**James McLane**

Senior Information Analyst

North Central Texas Council of Governments

[jmclane@nctcog.org](mailto:jmclane@nctcog.org)

