

How to Design and Create a Commercial Aircraft Radar Receiver and Decryptor

Nicholas Pease

What is ADS-B

- Automatic Dependent Surveillance – Broadcast
- FAA Replacement for Radar Stations
- Federally required since January 2020
- Provides location and position updates to ground stations and other aircraft

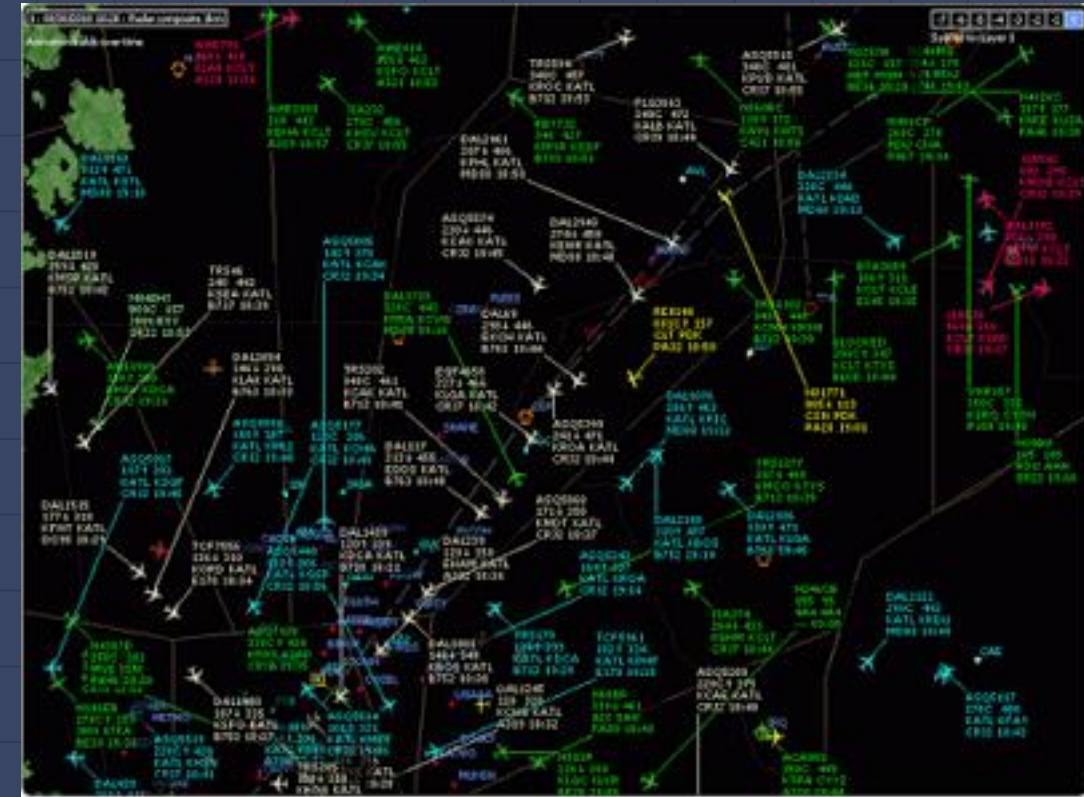
nBits	Bits	Abbr.	Name
5	1 - 5	DF	Downlink Format
3	6 - 8	CA	Capability (additional identifier)
24	9 - 32	ICAO	ICAO aircraft address
56	33 - 88	DATA	Data
	[33 - 37]	[TC]	Type code
24	89 - 112	PI	Parity/Interrogator ID

Type Code	Content
1 - 4	Aircraft identification
5 - 8	Surface position
9 - 18	Airborne position (w/ Baro Altitude)
19	Airborne velocities
20 - 22	Airborne position (w/ GNSS Height)
23 - 27	Reserved
28	Aircraft status
29	Target state and status information
31	Aircraft operation status

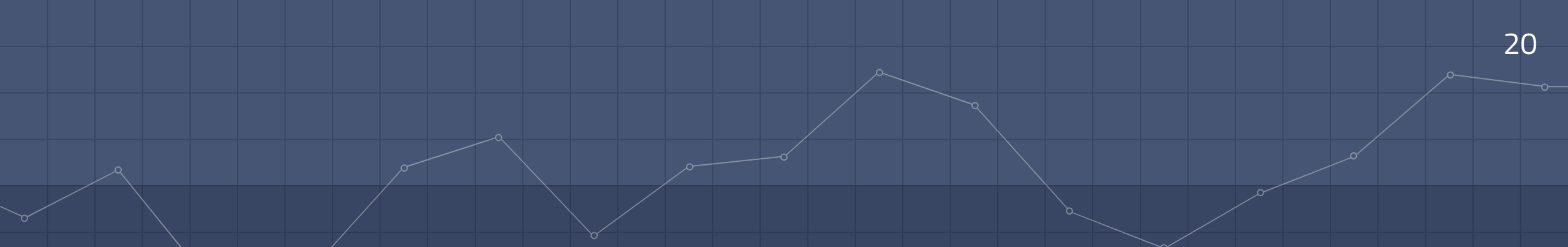
ADS-B Downlink Format and Type Codes

What does ADS-B Do?

- Replacement for conventional radar systems
- Provides regional airports and ARTCC with position data
- Allows airports and air traffic control accurate timely data
- Cheaper services for rural airports



Example Air Traffic Control Screen



"...that effective January 1, 2020, aircraft operating in airspace defined in 91.225 are required to have an Automatic Dependent Surveillance – Broadcast (ADS-B) system that includes a certified position source capable of meeting requirements defined in 91.227."

- FAA Regulation 14 CFR 91.225

ADS-B Reception and Display

- Takes the output from the dump1090 software and put it on a map
- Gathers information from flight such as country of registration, speed, track and position
- Multiple map types available including aviation navigation maps, street maps, and satellite maps

The screenshot shows the ADS-B Radar app interface. At the top, there are navigation icons (home, back, forward), menu options (RADAR, METAR, LIVEATC), battery level (41%), and volume control (Volume - 103 %). The main display is a map of the Bangor, Maine area with several aircraft icons. A specific aircraft, SWR14, is selected, and its details are shown on the right side of the screen.

SWR14 ⇒ **4B1917**
Country of registration: Switzerland
Altitude: 36000 ft | 10973 m Squawk: 2421
Speed: 465 kt | 861 km/h RSSI: -20.6 dBFS
Track: 219° (Southwest) Last seen: 7.9s
Position: 43.914°, -69.187° (9.3s)
Distance from Site: n/a

ICAO	Flight	Squawk	Altitude	Speed	Track	Msgs	Ag
aa6ccb	AAL105	0713	38000	456	225	872	
406d7b	BAW243	2424	40000	465	229	79	
49599a	JME911Z	7203	37250	459	205	2651	
4b1917	SWR14	2421	36000	465	219	4004	

ADS-B Radar Screen with Aircraft in Range

The screenshot shows the ADS-B Radar app interface with the 'Aircraft Radar' screen selected. The top navigation bar is similar to the previous screenshot, but the battery level is now 59%. The main display is a map of the Bangor, Maine area with a single aircraft icon. The right side of the screen shows the 'Aircraft Radar' details.

Aircraft Radar
No aircraft selected
Aircraft (total): 2 Messages: 0.1/sec
(with positions): 1 History: 2 positions

ICAO	Flight	Squawk	Altitude	Speed	Track	Msgs	Ag
3c6564		7261	39000	487	61	90	
ae07c4						3	

METAR Weather Information

- METAR: Meteorological Aerodrome Report.
- Gets the closest METAR report to the station in the middle of the map.
- Parses one line report into specific fields.
- Services provided by AVWX.rest

Local METAR Reporting Station:
KMCO
Orlando International Airport
KMCO 072353Z 16007KT 10SM FEW047
BKN180 17/12 A2995 RMK AO2 SLP140
T01720122 10233 20172 51004

62.6 °F	98 Feet	10 Miles
Temperature	Altimeter	Visibility
8 MPH	SSE	N/A

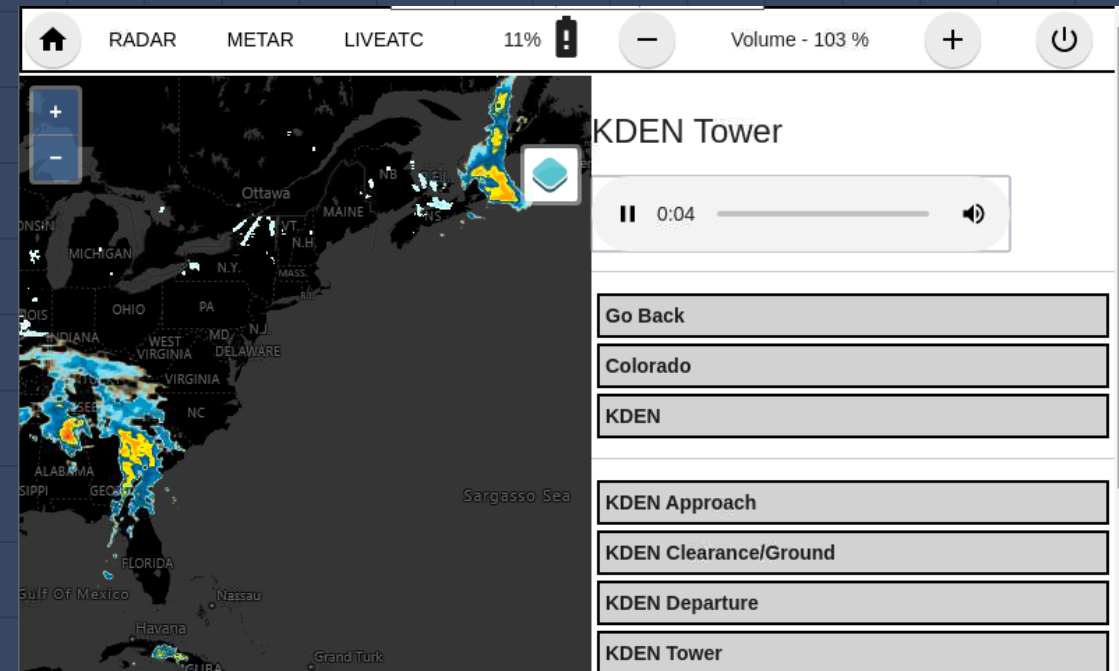
METAR Information Screen

Local METAR Reporting Station:
KBGR
Bangor International Airport
KBGR 072353Z 31010KT 10SM FEW200
M02/M08 A2993 RMK AO2 SLP138 4/005
T10221083 10011 21022 51010

28.4 °F	98 Feet	10 Miles
Temperature	Altimeter	Visibility
12 MPH	NW	N/A

Live Aircraft Audio by LiveATC

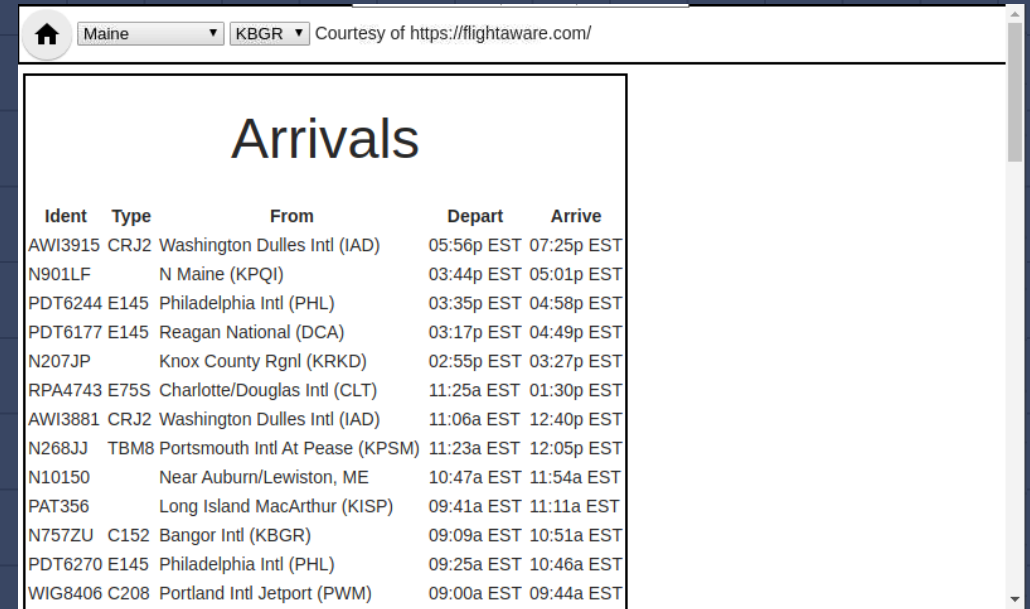
- Draws information from custom generated file
- Fetches audio streams from liveatc.net
- Wrote the file generation script, the web crawler, and the interface all myself



Live Air Traffic Control Screen
(Audio Excerpt from KDEN Tower)
1/7/2021

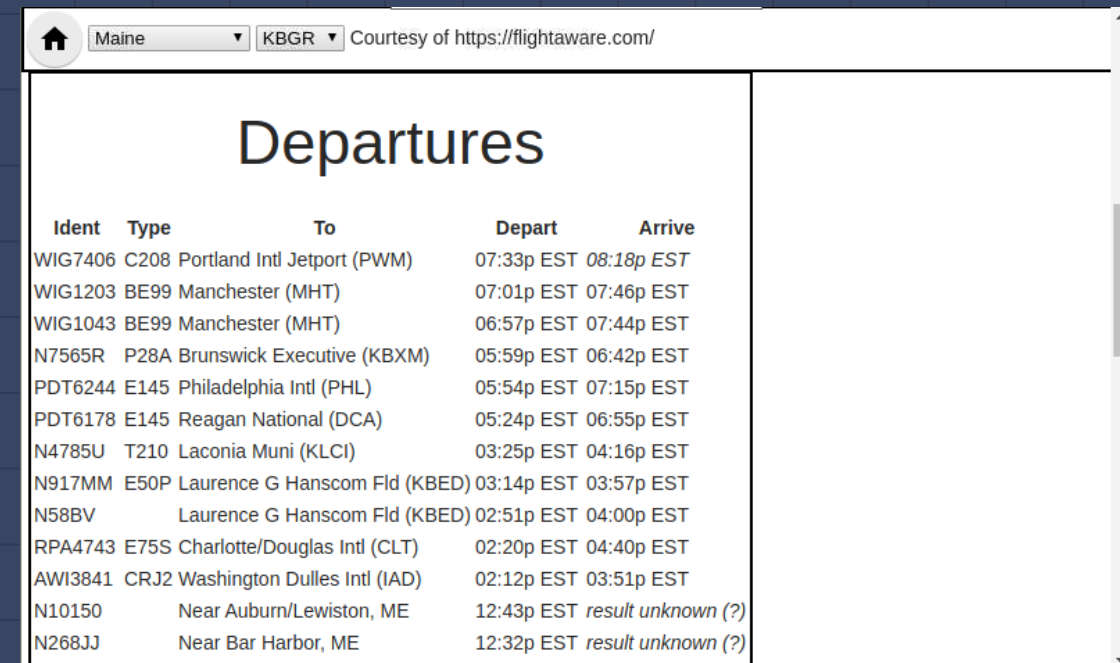
Airport Arrivals and Departures

- Pulls airport arrivals and departures from selected airport
- Created the api and generated the lookup file
- Data fetched from flightaware.com



Ident	Type	From	Depart	Arrive
AWI3915	CRJ2	Washington Dulles Intl (IAD)	05:56p EST	07:25p EST
N901LF		N Maine (KPQI)	03:44p EST	05:01p EST
PDT6244	E145	Philadelphia Intl (PHL)	03:35p EST	04:58p EST
PDT6177	E145	Reagan National (DCA)	03:17p EST	04:49p EST
N207JP		Knox County Rgnl (KPKD)	02:55p EST	03:27p EST
RPA4743	E75S	Charlotte/Douglas Intl (CLT)	11:25a EST	01:30p EST
AWI3881	CRJ2	Washington Dulles Intl (IAD)	11:06a EST	12:40p EST
N268JJ	TBM8	Portsmouth Intl At Pease (KPSM)	11:23a EST	12:05p EST
N10150		Near Auburn/Lewiston, ME	10:47a EST	11:54a EST
PAT356		Long Island MacArthur (KISP)	09:41a EST	11:11a EST
N757ZU	C152	Bangor Intl (KBGR)	09:09a EST	10:51a EST
PDT6270	E145	Philadelphia Intl (PHL)	09:25a EST	10:46a EST
WIG8406	C208	Portland Intl Jetport (PWM)	09:00a EST	09:44a EST


Example Arrivals and Departures Screens



Ident	Type	To	Depart	Arrive
WIG7406	C208	Portland Intl Jetport (PWM)	07:33p EST	08:18p EST
WIG1203	BE99	Manchester (MHT)	07:01p EST	07:46p EST
WIG1043	BE99	Manchester (MHT)	06:57p EST	07:44p EST
N7565R	P28A	Brunswick Executive (KBXM)	05:59p EST	06:42p EST
PDT6244	E145	Philadelphia Intl (PHL)	05:54p EST	07:15p EST
PDT6178	E145	Reagan National (DCA)	05:24p EST	06:55p EST
N4785U	T210	Laconia Muni (KLCI)	03:25p EST	04:16p EST
N917MM	E50P	Laurence G Hanscom Fld (KBED)	03:14p EST	03:57p EST
N58BV		Laurence G Hanscom Fld (KBED)	02:51p EST	04:00p EST
RPA4743	E75S	Charlotte/Douglas Intl (CLT)	02:20p EST	04:40p EST
AWI3841	CRJ2	Washington Dulles Intl (IAD)	02:12p EST	03:51p EST
N10150		Near Auburn/Lewiston, ME	12:43p EST	result unknown (?)
N268JJ		Near Bar Harbor, ME	12:32p EST	result unknown (?)

Planning and Research

- Drew quick sketches to get general flow down
- Researched current technologies and capabilities
- Identified offline maps as primary concern

 Gmail Nicholas Pease <npease21@rsu19.net>

[FlightAware] Closing your FlightAware inquiry
1 message

FlightAware Support <support@flightaware.com> Sat, Apr 21, 2018 at 1:03 PM
Reply-To: FlightAware Support <support@flightaware.com>
To: Nicholas Pease <gaminglax18@gmail.com>

Stephen Maciolek (FlightAware)
Apr 11, 13:05 CDT

Hello Nicholas,

This seems like it would be possible. I have found a few posts on our discussion board about making a portable PiAware. <https://discussions.flightaware.com/search?q=portable%20piaware%20category%3A9>

More specifically a post here might be helpful. <https://discussions.flightaware.com/t/using-piaware-as-portable-ads-b-tracker/18295>

Please let me know if you have any questions. The community on the discussion board are very active and helpful if you would like to post there as well.

Regards,
Stephen

FlightAware

--
Learn about FlightAware Global and Premium Accounts: <http://flightaware.com/commercial/>

Stephen Maciolek (FlightAware)
Apr 10, 14:38 CDT

Hello Nicholas,

Thank you for contacting FlightAware. This would not make the PiAware inoperable, but you would have times that you would not be receiving or sending data. There is an option to have an ethernet cable run to your Pi if thats an option for you. But overall, you would still be contributing greatly to the FlightAware community and enjoy the benefits when your PiAware is online.

Let me know if you have any questions.

Regards,
Stephen

FlightAware

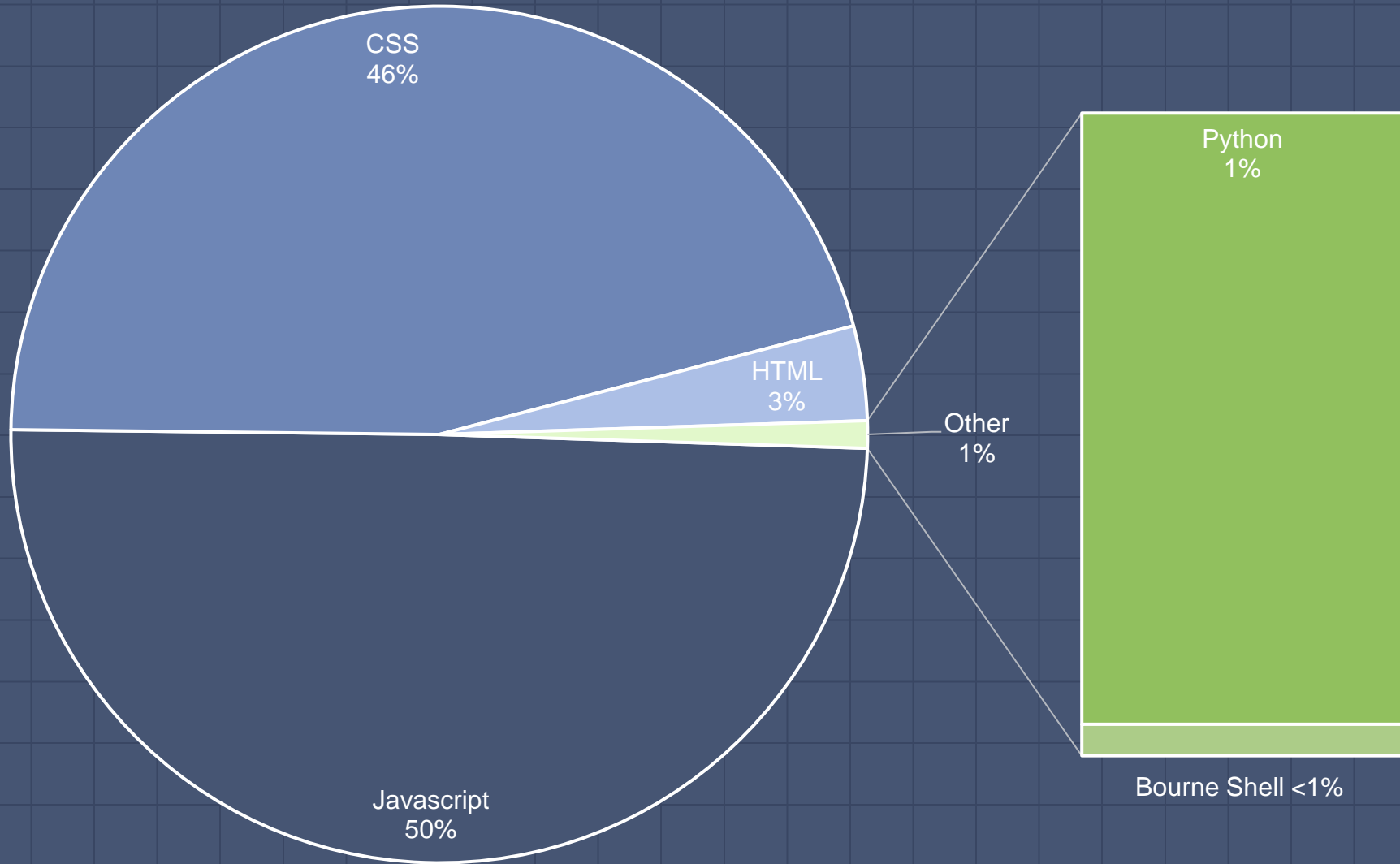
--
Learn about FlightAware Global and Premium Accounts: <http://flightaware.com/commercial/>

Nicholas Pease
Apr 10, 13:03 CDT

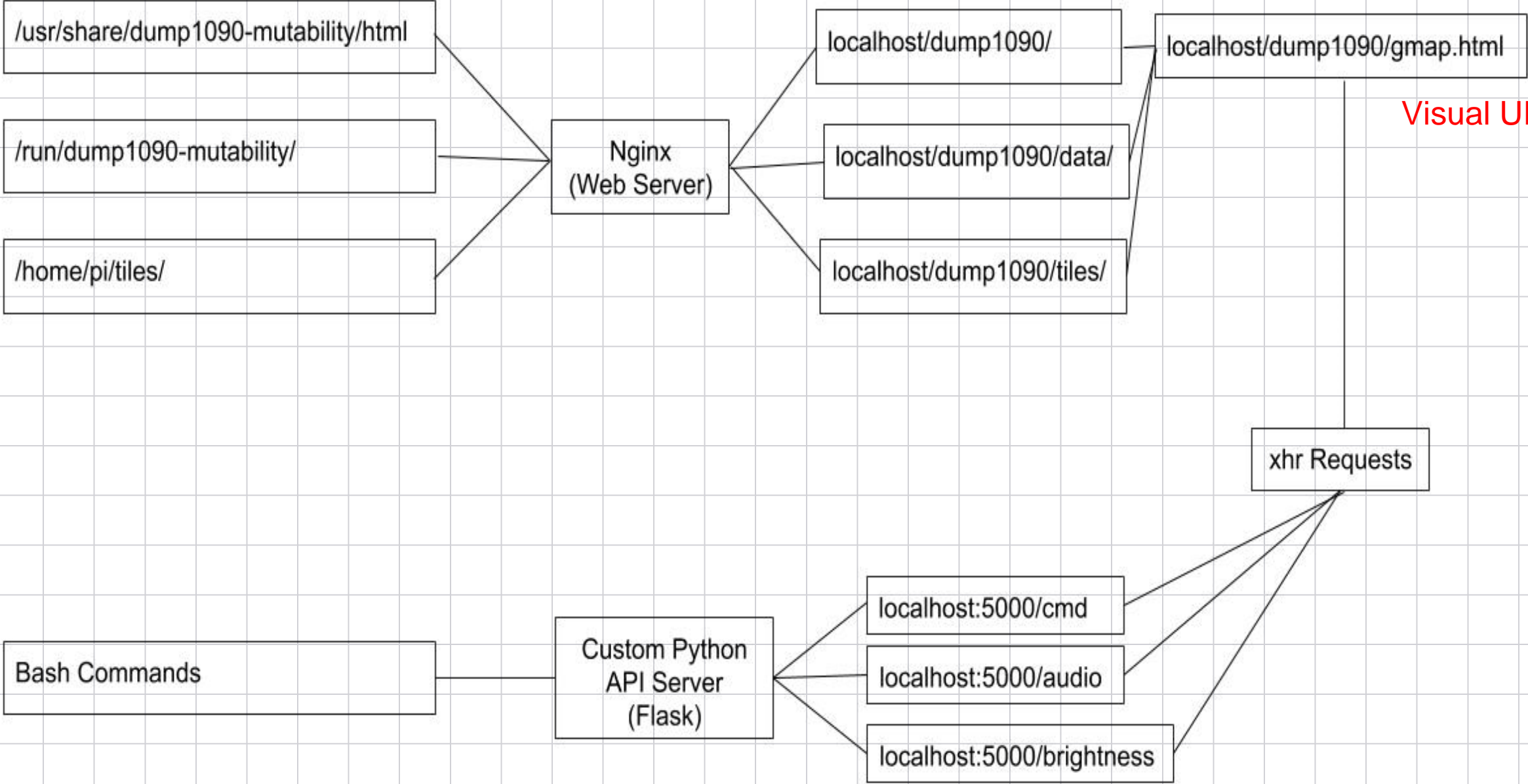
I am thinking of setting up a PiAware system, but the setup I am thinking about may not have WIFI connection constantly. Would this make the system inoperable?

This email is a service from FlightAware.

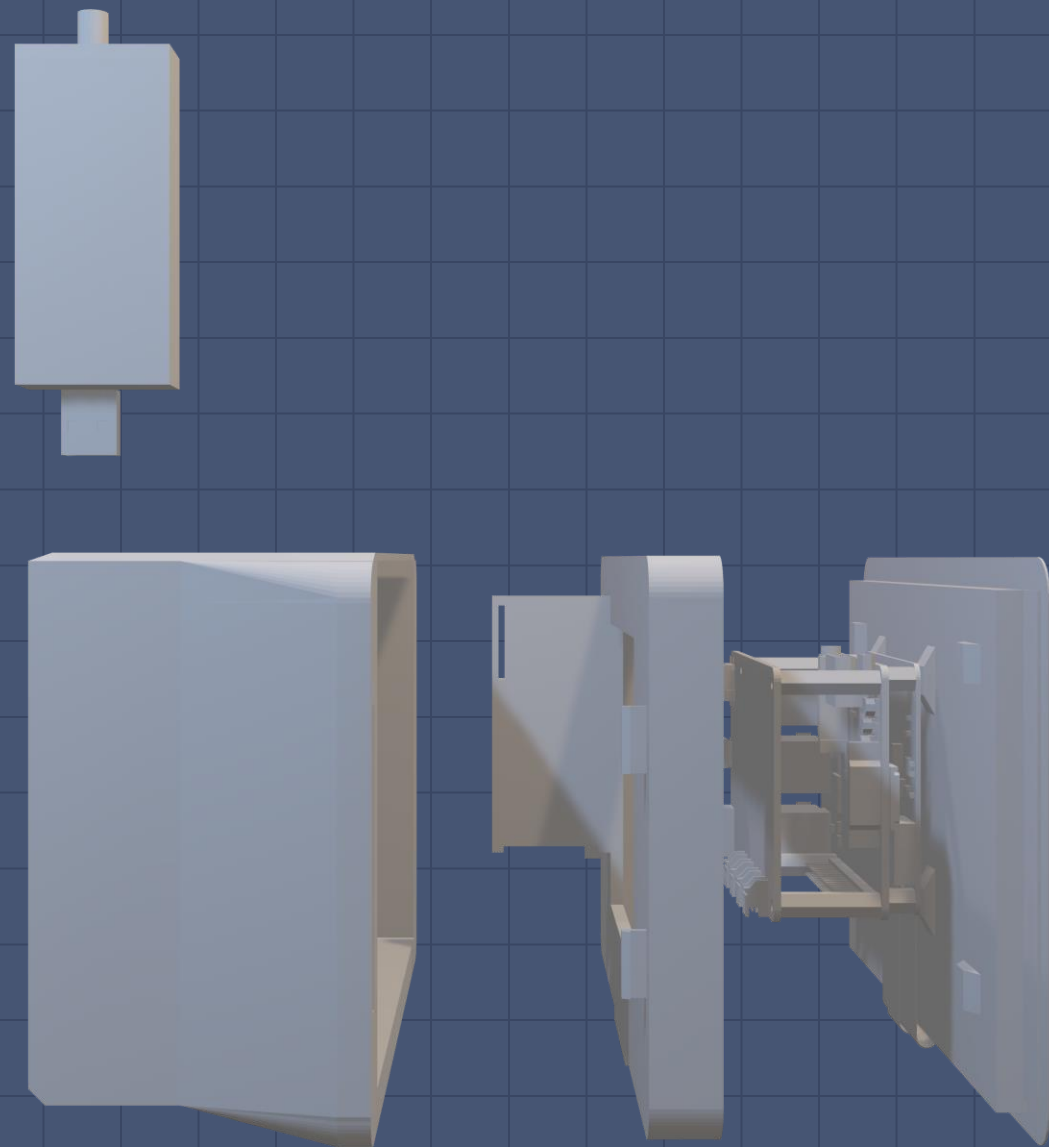
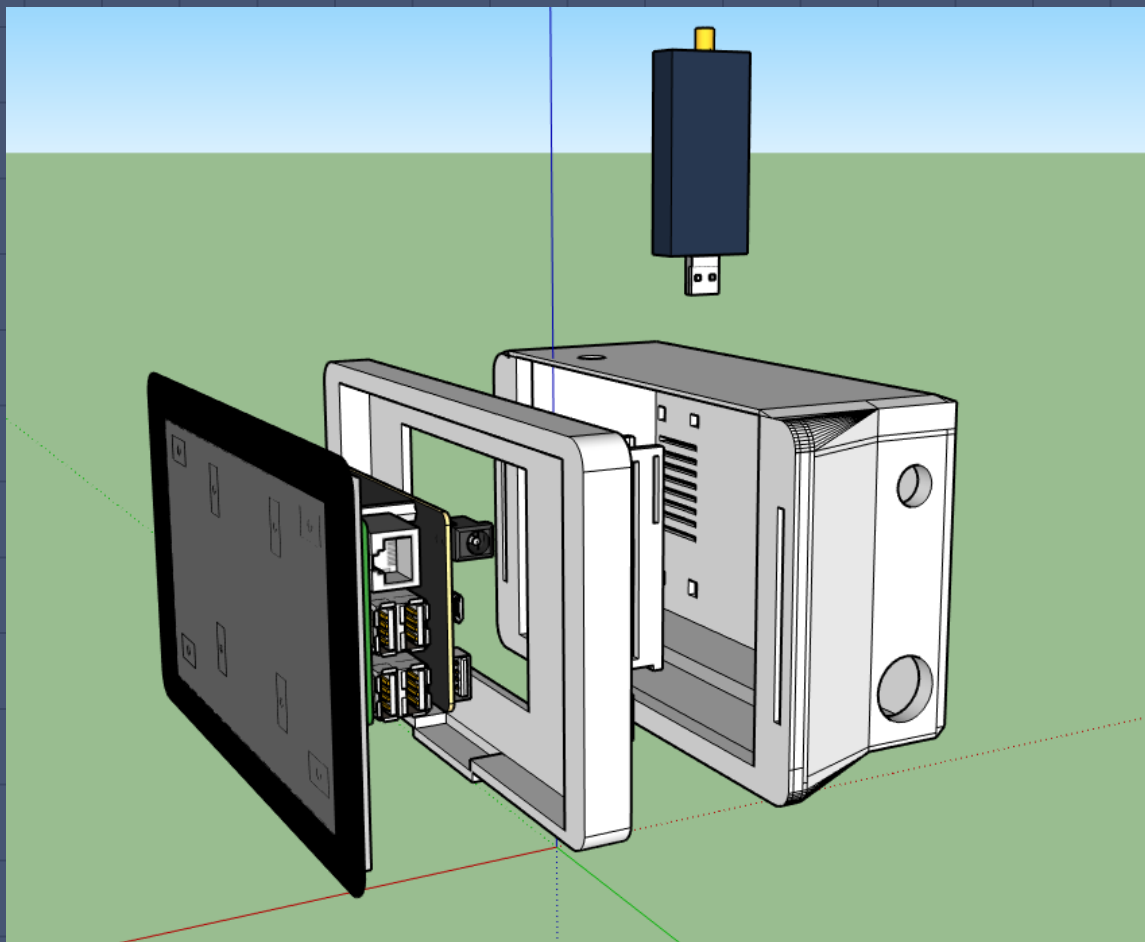
Code Makeup By Language



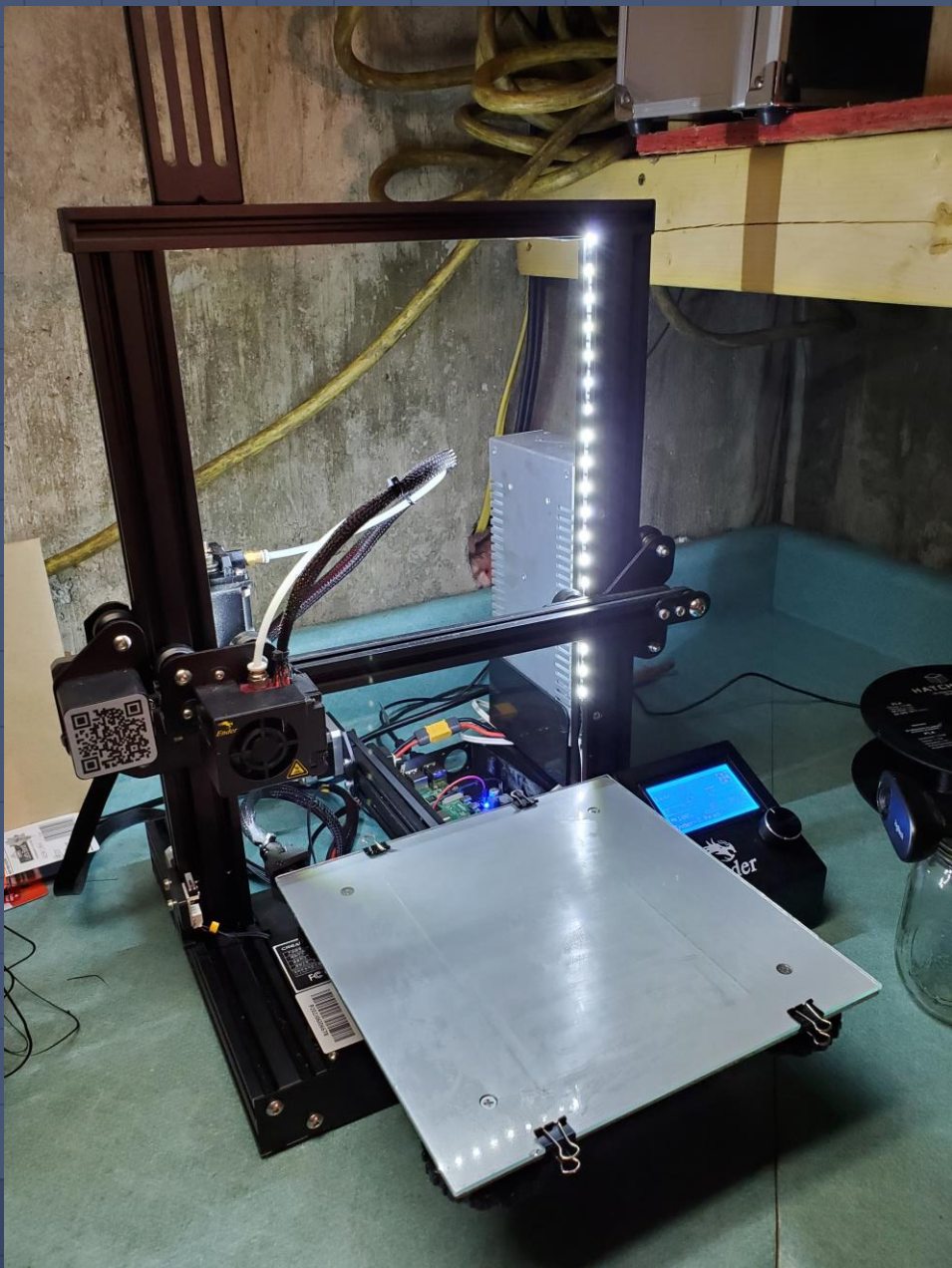
□ Javascript □ CSS □ HTML □ Python □ Bourne Shell



Software Diagram

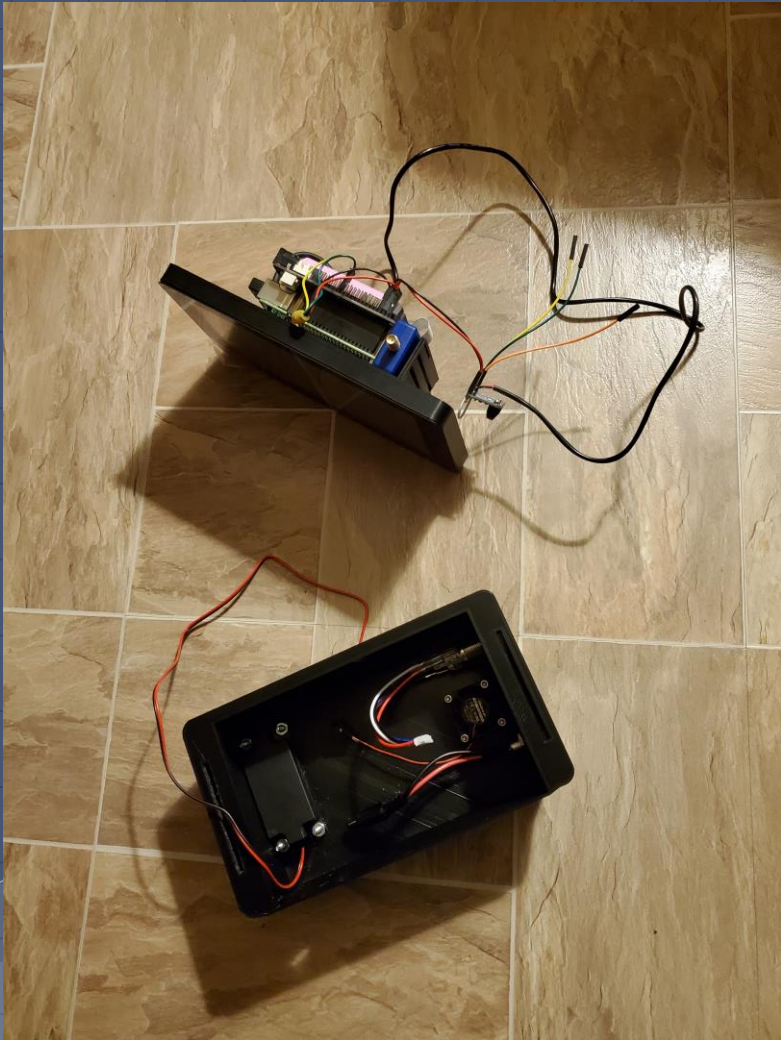


3D Modeling



3D Printing

Assembly



Final Result

