



# EnginAir

Connected Engine Data System  
Administrative Portal  
Design Review I  
November 22, 2019



# OUR TEAM



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Honeywell



# INDUSTRY OVERVIEW

## Aerospace & Defense

- Manufacturing, sale, service of aircraft, aerospace parts, space vehicles, and military defense systems
- Largest in the world
- \$838 billion [1]
- Over 2.5 million jobs: 20% of manufacturing [4]

## Top Aerospace Companies (in revenue) [3]

- Boeing
- Airbus
- United Technology Corporation
- Honeywell (13)



[1]



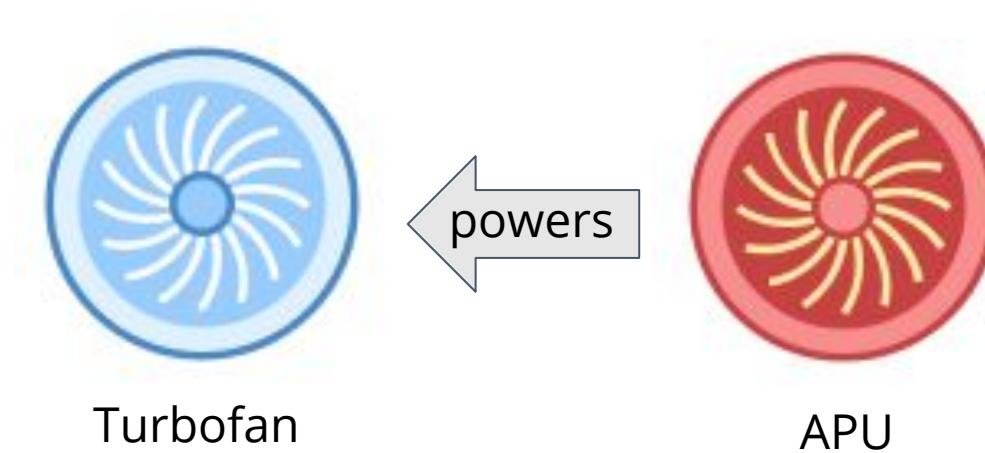
[2]



# PROBLEM STATEMENT

## Turbofan

- type of Jet Engine
- used for aircraft propulsion



## Problem: Hot Start

ensuring airflow  
before fuel [2]

- may cause  
overheating and  
damage

## Auxiliary Power Unit (APU)

- Exhaust gases  
are used to spin  
the turbine  
blades [2]
- serves as an  
additional  
energy source



# SPONSOR OVERVIEW

## Honeywell

- Leading producer in gas turbine APUs
- Applications on helicopters, military jets, and the US Army Abrams Tank

**Honeywell**

## Harlan Mitchell

- Systems Technical Manager
- HTF7K Controls System Integration Unit



## HTF7K Turbofan Engine Family

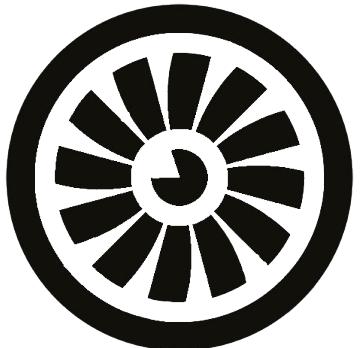
- Primary used on business jets
- Cessna Citation Longitude



[3]



# ORIGINAL DESIGN PROBLEM



HTF7K Engine



USB



Email

**What:** Download and send diagnostic data

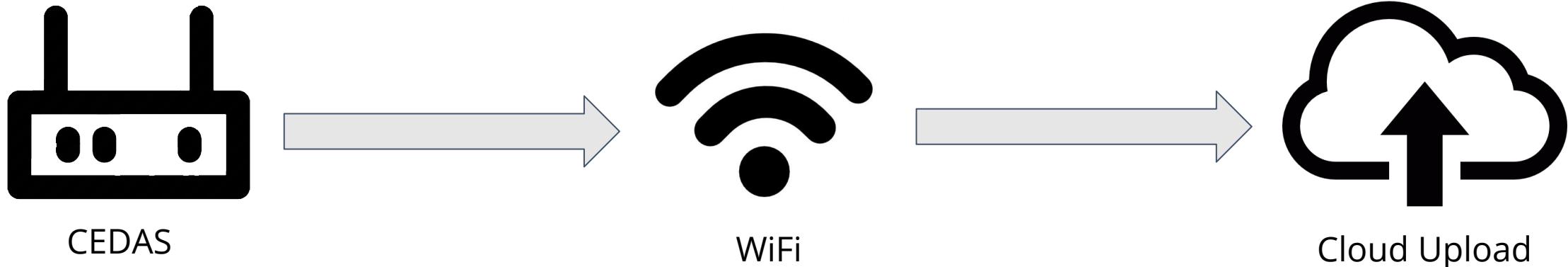
**What's broken?** Process of downloading diagnostic data from the jets

**Why is this bad?**

- Tedious; Small data set = missed maintenance opportunities



# CURRENT PROBLEM



**Honeywell's Solution:** Connected Engine Data Administrative System (CEDAS)

- *But wait!* What if there are WiFi connection issues?

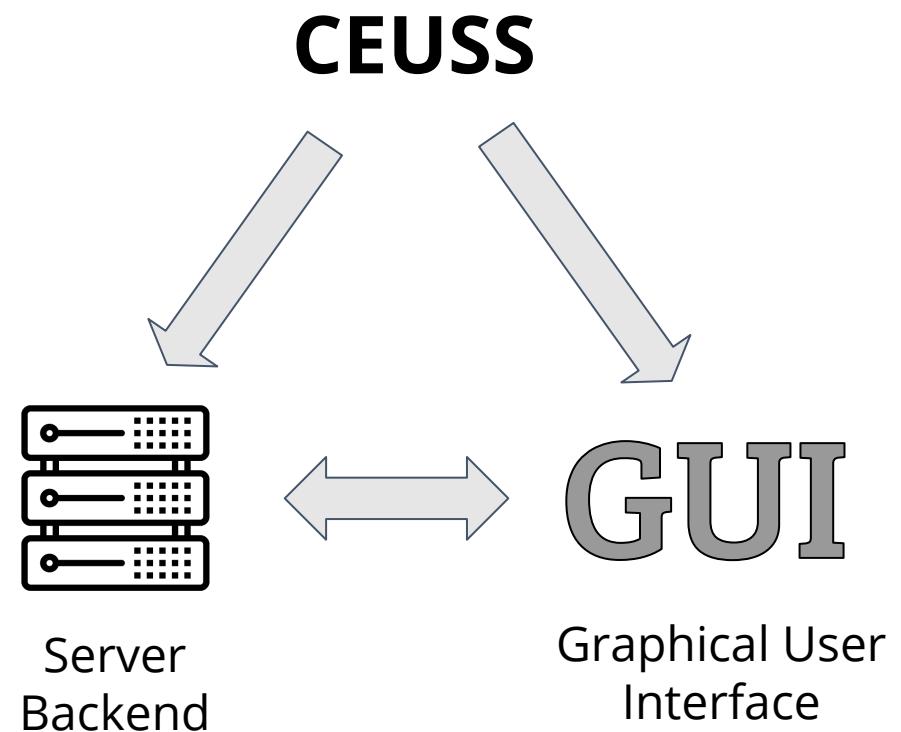
**How can EnginAir fix this?**



# PROPOSED SOLUTION

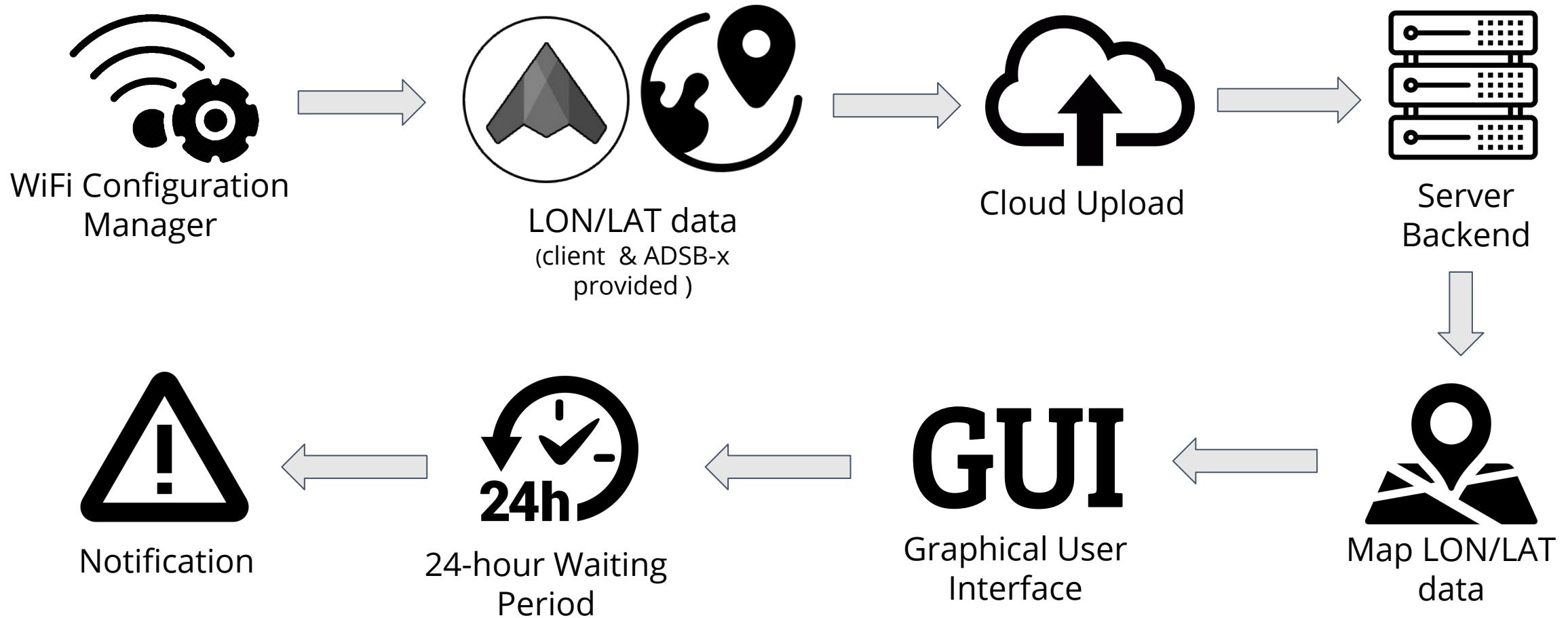
## Connected Engine Upload Status System (CEUSS)

- **Serverside Back End Software**
  - Determine connectivity issues
  - Notifying users of issues
- **GUI Front End Portal**
  - WiFi
  - Airplane landing





# SOLUTION WORKFLOW





# REQUIREMENTS ACQUISITION

**Obtained requirements by...**

- Frequent meetings with client
- Developing user stories



**End users of the system:**

- Engine technician
- Aircraft operators





# KEY REQUIREMENTS

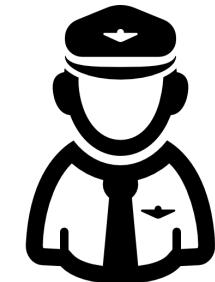
## **As an engine technician, I want to be able to:**

- view all aircraft landing locations, every 24 hours.
- visualize all flights that are currently in progress.
- simulate various locations and their corresponding WiFi configuration.
- know the status of each landing/upload entry.
- visualize the status of each upload entry.
- run a report to determine the cause of a failed upload.



## **As an aircraft pilot/operator, I want to be able to:**

- visualize locations on where to park the aircraft for an upload success.
- simulate locations and their WiFi strength.





# KEY REQUIREMENTS

**As an engine technician, I want to know the status of each landing/upload entry.**

## **Functional Requirements:**

- Generate an upload DB with the following information:
  - Engine roll-down/startup GPS location
  - Engine roll-down/startup time/date
  - Upload GPS location
  - WAP signal strength/ID
  - Airport Code
- Classify upload entry based on the following criteria:
  - Upload successful = green
  - No upload & no other flight started = yellow
  - No upload & another flight has started = red

## **Performance Requirements:**

- DB completes within 24 hours
- Time to First Byte below 200ms with 1 request/min
- Ability to process 100 requests/min

## **Environmental Requirements:**

- Client provided upload data
  - Provided as an Excel file
  - Lacks accuracy



# RISKS & FEASIBILITY

## Excel Import performs all compute-intensive operations

- Issues that arise are likely to be scaling issues
- Reliance on third-party APIs may cause further issues

ISSUE	DESCRIPTION	SEVERITY	LIKELIHOOD
ADSB-x Downtime	Database Corruption, unable to check for upload failures	High	Low
ADSB-x Accuracy	Locations reported by ADSB-x are not always accurate, and are crowdsourced.	Low	Medium
Data Import Inconsistencies	Database Corruption, schema modifications	Medium	Medium

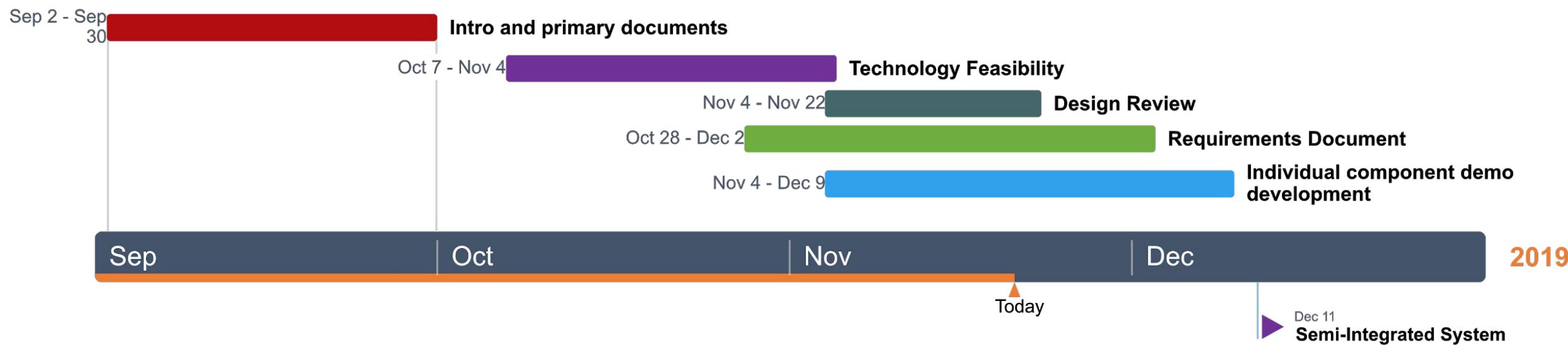
CHALLENGE	DESCRIPTION	SEVERITY	LIKELIHOOD
MongoDB Speed	Indexes could be inefficient in storing our data	Medium	Low
Node.js Scalability	Some operations within Node.js are unable to scale	Medium	Low



# SCHEDULE (SEMESTER 1)

## Milestones

Demo Presentation - Dec. 11, 2019





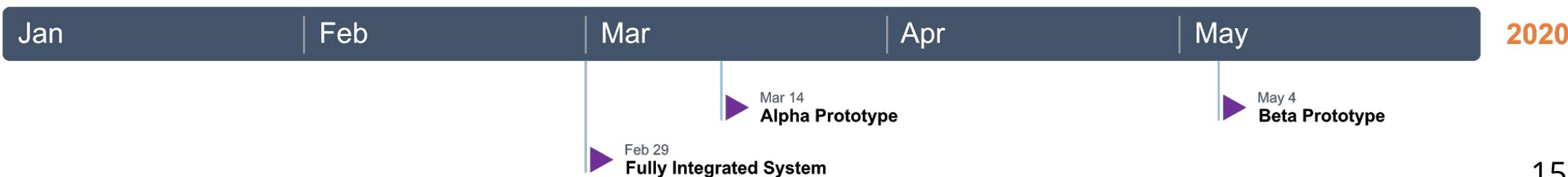
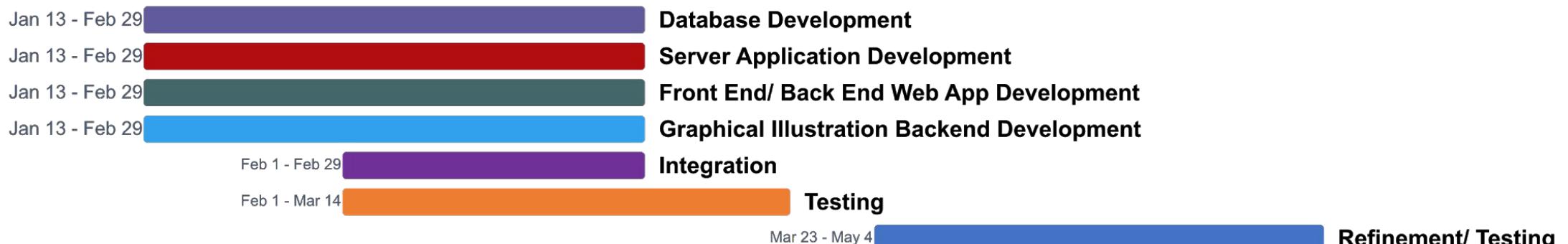
# SCHEDULE (SEMESTER 2)

## Milestones

Fully Integrated System - Feb. 29

Alpha Prototype - Mar. 14

Beta Prototype - May 4





# CONCLUSION

## Aerospace Industry

- \$838 billion [1]
- Over 2.5 million jobs: 20% of manufacturing

## Honeywell

- Largest producer of gas turbine APUs

## Problem

- Data download is tedious
- CEDAS
- Poor WiFi Connectivity

## Solution

- Predicts upload date/location
- Predicts failed upload explanation

## Requirements

- Client provided documents
- User stories → Engineer & Operator
- Risks → Not Severe

## Next Steps

- Semi-integrated demo → Database and Backend Server





# REFERENCES

1. Arbor, Ann. "Global Aerospace Industry Worth \$838 Billion, According to AeroDynamic Advisory and Teal Group Corporation." Home - Teal Group. Teal Group Corporation, July 12, 2018.  
<https://www.tealgroup.com/index.php/pages/press-releases/53-global-aerospace-industry-worth-838-billion-according-to-aerodynamic-advisory-and-teal-group-corporation>.
2. Quora. "How Do Jet Airplanes Start Their Engines?" Forbes. Forbes Magazine, April 14, 2017.  
<https://www.forbes.com/sites/quora/2017/04/14/how-do-jet-airplanes-start-their-engines/#11309fa9ab4b>.
3. "Top Aerospace Companies: Top 50 Lists." AviationOutlook. AviationOutlook.com, October 10, 2019.  
<https://aviationoutlook.com/top-aerospace-companies/#kcmenu>.
4. "2019 STATE OF THE AMERICAN AEROSPACE AND DEFENSE INDUSTRY." AIA Aerospace Industries Association.  
[www.AIA-AEROSPACE.org](http://www.AIA-AEROSPACE.org) . Accessed November 10, 2019.  
<https://www.aia-aerospace.org/wp-content/uploads/2019/06/AIA-2019-Facts-and-Figures.pdf>.



# REFERENCES - PICTURES

- [1] <https://www.istockphoto.com/photos/aerospace-industry?mediatype=photography&phrase=aerospace%20industry&sort=mostpopular>
- [2] <http://www.aeroprobe.com/aerospace-industry/>
- [3] <https://www.aviationtoday.com/2019/09/23/textron-aviation-announces-revolution-in-business-aviation-after-faa-certifies-citation-longitude/>

Last Slide (L-R)

[4] Citation Longitude:

<http://aviationtribune.com/executive-helicopters/netjets-to-buy-up-to-325-citation-longitude-and-citation-hemisphere-jet/>

[5] Bombardier Learjet 40 / 45:

<https://aerospace.honeywell.com/en/learn/supported-platforms/business-jet/bombardier/bombardier-learjet-40>

[6] Praetor 600: <https://www.airway1.com/embraer-praetor-600-receives-certification-in-brazil/>

[7] Embraer Legacy 450/500:

<https://www.safran-nacelles.com/nacelle-systems/nacelle-systems-business-jets/embraer-legacy-450/500-thrust-reversers>

[8] Gulfstream G280: <https://aerospace.honeywell.com/en/learn/supported-platforms/business-jet/gulfstream/gulfstream-g280>

[9] Bombardier Challenger 350: <https://businessaircraft.bombardier.com/en/aircraft/challenger-350#!#bba-pdp-section-4>

[10] Bombardier Challenger 350:

<https://aerospace.honeywell.com/en/learn/supported-platforms/business-jet/bombardier/bombardier-challenger-350>

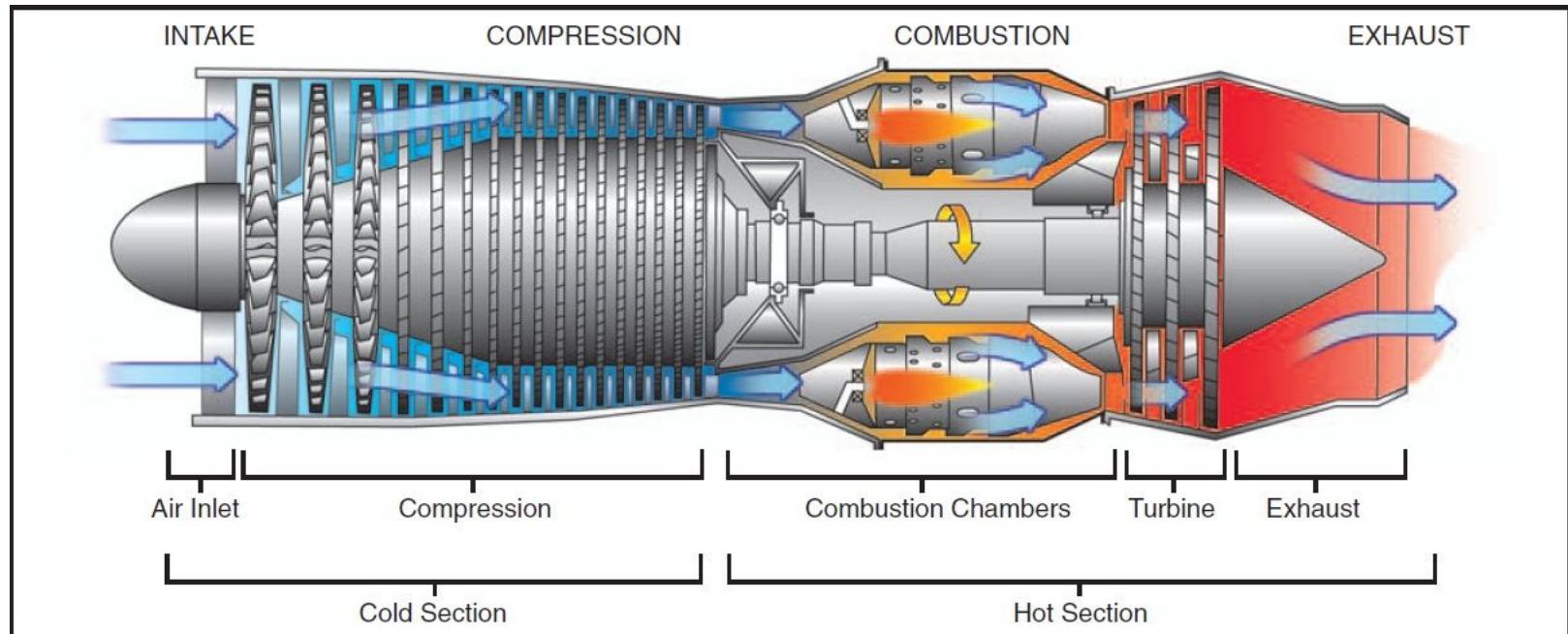


# QUESTIONS?



# WHAT IS A HOT START?

- Improper start technique
- Injecting fuel prior to sufficient airflow
- Engine overheats and causes damage





# CEDAS & ECU

## **Engine Control Unit (ECU)**

- Saves trending and maintenance data in non-volatile memory (NVM) during normal operation

## **HOW DOES Connected Engine Data Administrative System (CEDAS) WORK?**

- Autonomous process
- Data wirelessly uploads to the cloud
- Data is then accessible remotely
- Hosted on a small embedded computer in the aircraft



# ELECTRONIC ENGINE INTERFACE (EEI)

**EEI:** software used to get diagnostic data from the HTF7K engine

## Materials needed:

- Laptop running the EEI software
- EEI download kit

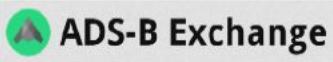
## Diagnostic data download process

1. Connect to the aircraft
2. Perform the download





# PUBLIC FLIGHT DATABASE

	Accessibility	Capability	Compatibility	Cost	Difficulty
	Account, API key	7	10	Dependent on flight data download	3
	Authentication key OR Monetary donation	10	10	About \$1.50-\$3/day	3

## ADS-B Exchange

- Downloadable JSON data file
- Does not anonymize flights
- Archived dataset - first of the month

## JSON File contains:

- ICAO identifier
- Aircraft registration number
- Aircraft longitude and latitude
- Flight grounded information



# SERVER APPLICATION

	Accessibility	Capability	Compatibility	Cost	Difficulty
	Downloadable	9	7	Free	6
	Downloadable	7	7	Free	6

## Java

- Team academic experience
- Familiarity
- Use of Apache API - OS library for Excel files
- Extensive collection of libraries
- Easily integratable



# DATABASE APPLICATION

	Accessibility	Capability	Compatibility	Cost	Difficulty
 mongoDB	Download	7	10	Free	7
 PostgreSQL	Download	9	8	Free	4

## MongoDB

- Compatibility with JSON files
- Java and Node.js “drivers”



# FRONT END WEB APPLICATION

	Accessibility	Capability	Compatibility	Cost	Difficulty
	Package Install (yum, apt, etc)	7	10	Free	3
	Package Install (yum, apt, etc)	10	10	Free	4

## NGINX

- Ability to load balance backend
- Low time-to-first-byte (TTFB)
- Low response overhead
- Caching capabilities



# BACK END WEB APPLICATION

	Accessibility	Capability	Compatibility	Cost	Difficulty
	Package Install (yum, apt, etc)	10	8	Free	6
	<i>pip</i> install	9	4	Free	5
	<i>pip</i> install	9	8	Free	8

## Node.js

- Supports JSON
- Availability of PM2 multithreading library
- ExpressJS - simple routing framework



# GRAPHICAL ILLUSTRATION

	Accessibility	Capability	Compatibility	Cost	Difficulty
Google Maps Platform	Account, API Key	5	5	Free	3
Microsoft   Bing Maps	Account, API Key	4	5	Free	3
mapbox	Account, API Token	3	4	Free	5
OpenLayers	No account	4	5	Free	3

## Google Maps API

- Extensive documentation
- Large library for customizations
- JavaScript compatible API



# CLIENT EXCEL FILE

	A	B	C	D
1	ESN	Latitude	Longitude	GMT date/time
2	136166	17.14	-61.78	1/1/2019 12:52
3	136166	13.08	-59.49	1/1/2019 15:19
4	136202	17.14	-61.78	1/1/2019 14:37
5	136202	34.27	-77.91	1/1/2019 18:35
6	136202	42.96	-87.9	1/1/2019 21:42
7	136399	42.22	-8.63	1/1/2019 7:35
8	136295	37.36	-121.93	1/1/2019 16:59
9	136295	32.4	-111.22	1/1/2019 19:17
10	136295	38.5	-107.9	1/1/2019 21:37
11	118636	18.34	-64.97	1/1/2019 17:48
12	118636	18.46	-66.1	1/1/2019 18:32
13	118468	32.9	-80.03	1/1/2019 12:56
14	118468	19.29	-81.36	1/1/2019 15:59
15	118468	25.91	-97.43	1/1/2019 19:06
16	130274	29.65	-95.27	1/1/2019 19:07

## Contains Engine Startup/Rolldown Data:

- Tail Number
- Latitude/Longitude coordinates
  - accurate to 1.11 km
- Date/time (24 hour)
  - Greenwich Mean Time
  - Not affected by Daylight Savings