Spectrogram Webapp

Omar and Griffin

July 2022

geon Technologies, LLC

Introduction

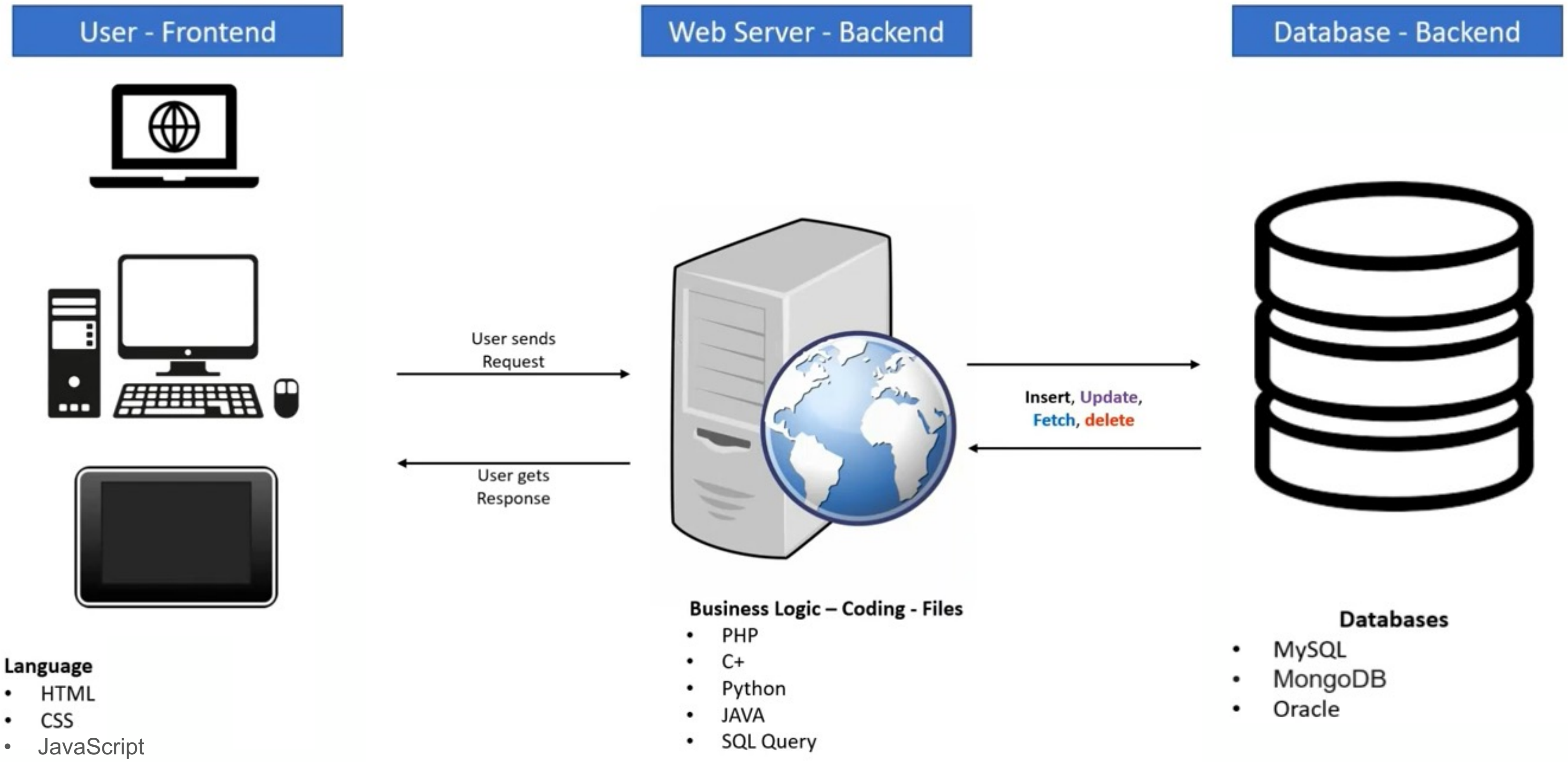
Purpose

Graphically display RF data from the drone in real time on a website accessible by the lab computer

Introduction

What is needed for a web server

Data Flow in Software



User - Frontend

Web Server - Backend

Database - Backend

User sends Request

User gets Response

Insert, **Update**, **Fetch**, **delete**

Language

- HTML
- CSS
- JavaScript

Business Logic – Coding - Files

- PHP
- C+
- Python
- JAVA
- SQL Query

Databases

- MySQL
- MongoDB
- Oracle

Introduction

Requirements

- Read IQ data from drone/file
- Display intensity plot and waterfall graph
- Show frequency and bandwidth
- Provide pan and zoom functionality
- Allow frequency and bandwidth retuning
- Handle user and connection errors
- Run on lab computer
- Stream IQ data from server to client

Introduction

Dependencies

- Docker
- Docker Compose
- Node.js
- ESLint
- mongoDB
- gRPC
- Vue
- Plotly
- Express
- Axios

Spectrogram Progression

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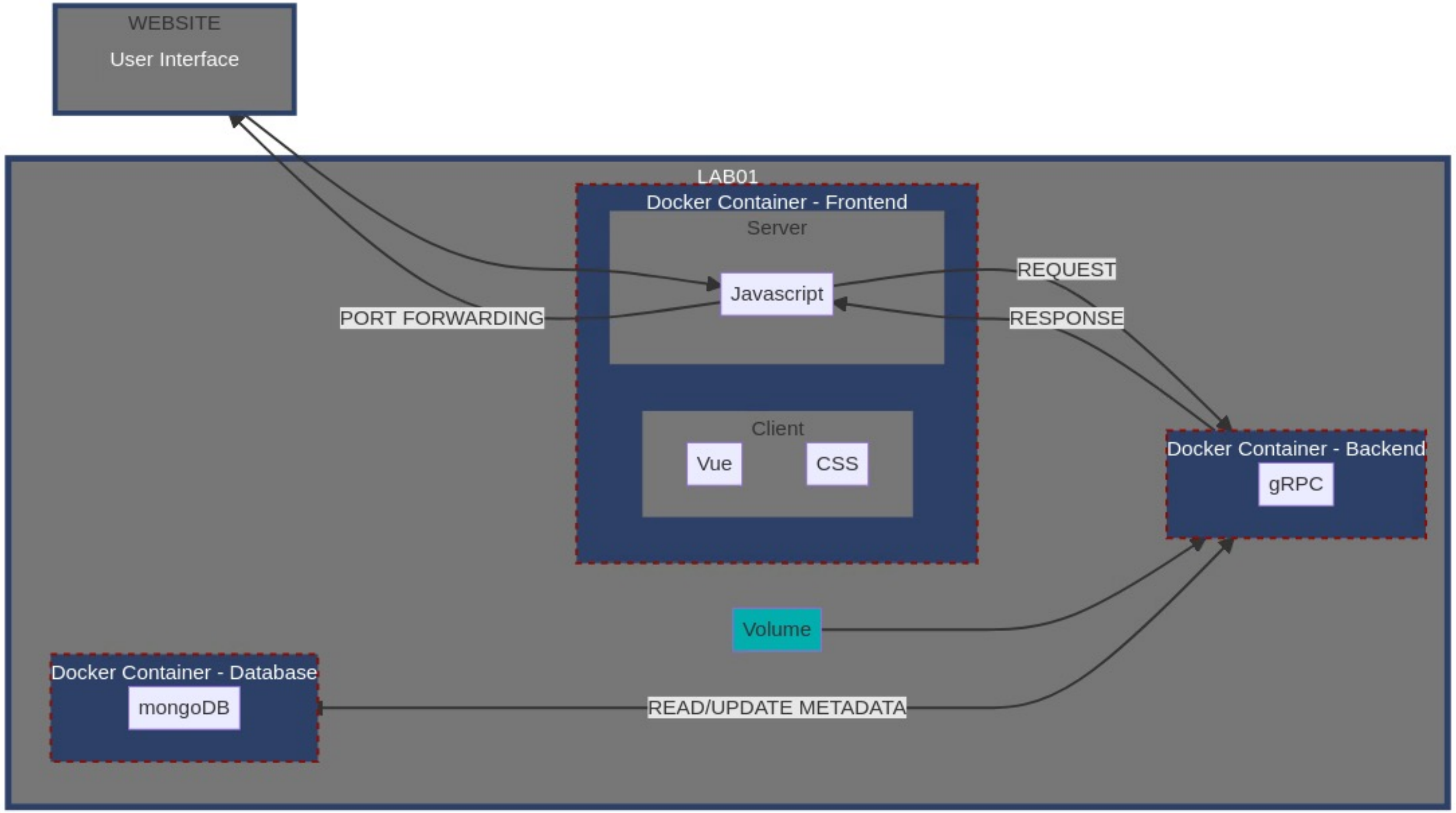
Progression

Design Review Recap

- Docker containers setup for frontend, backend, and database
- Mongo database configured to store data and be accessed upon gRPC's (remote procedure calls) in the backend
- Client able to pull and display data from the mongo database

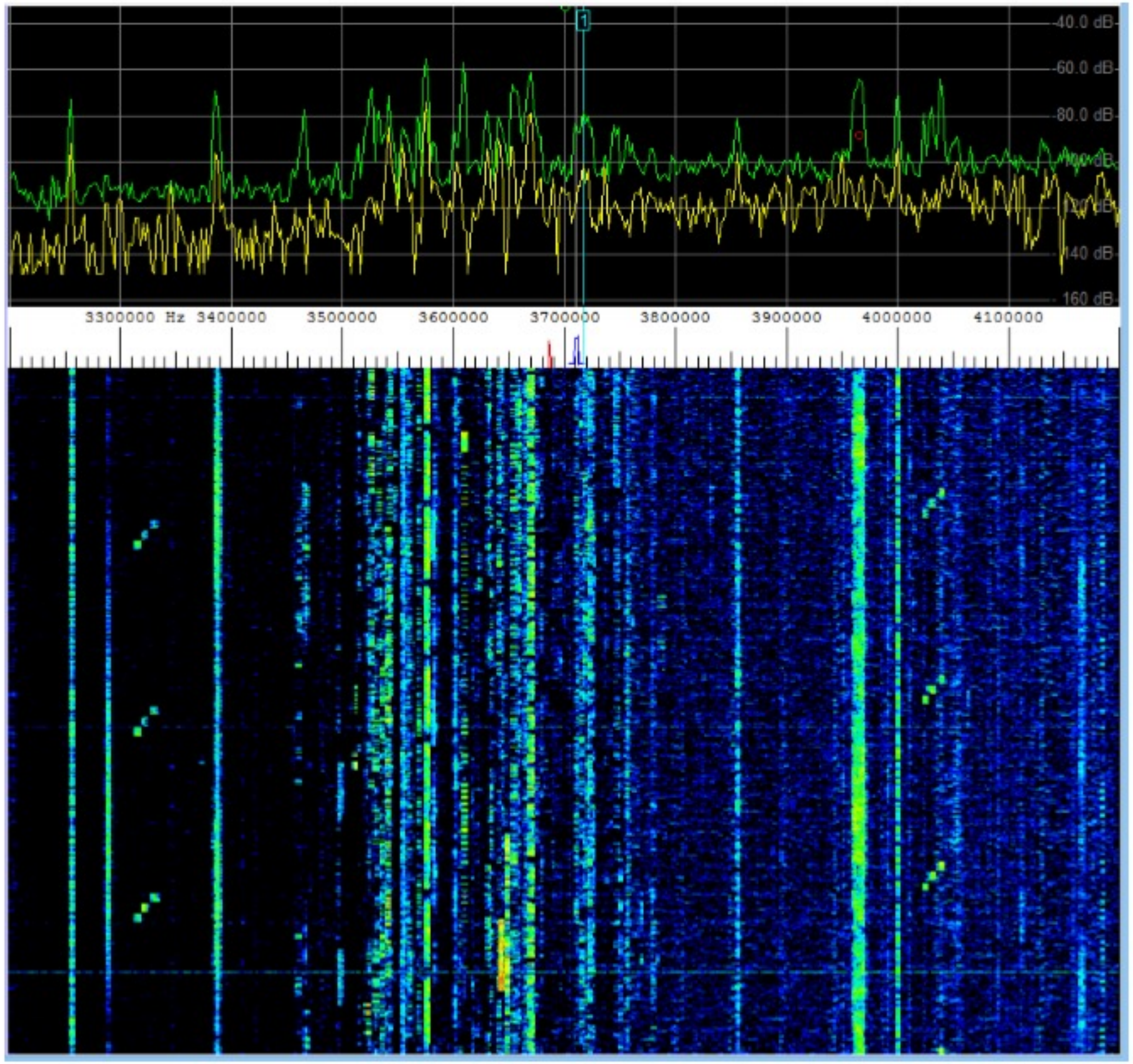
Progression

First Iteration



Spectogram Webapp

FREQUENCY VS TIME



SETTINGS

Center Frequency

250 Hz | Hz

Bandwidth

10 mHz | mHz

Time

10 Sec | Sec

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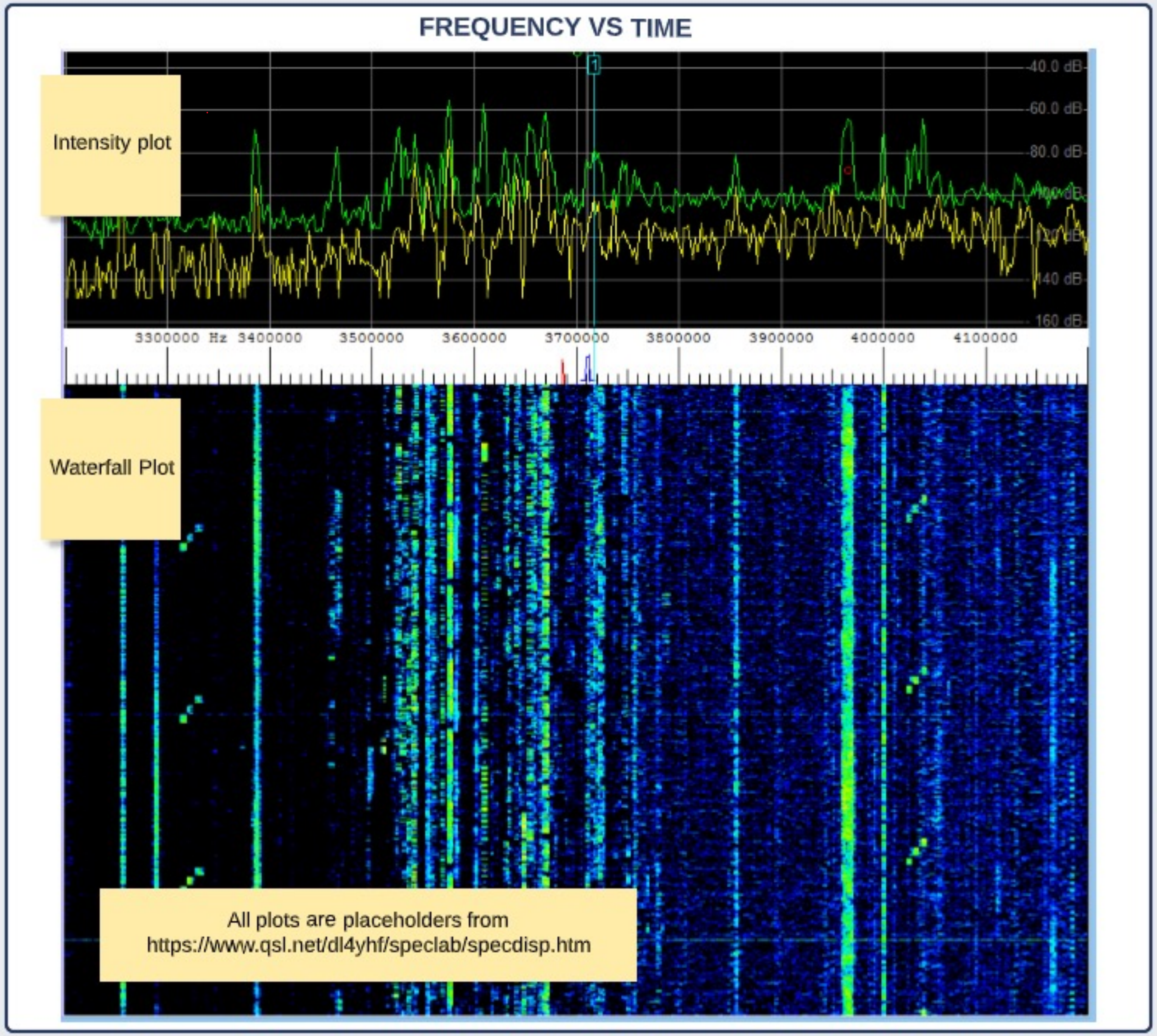
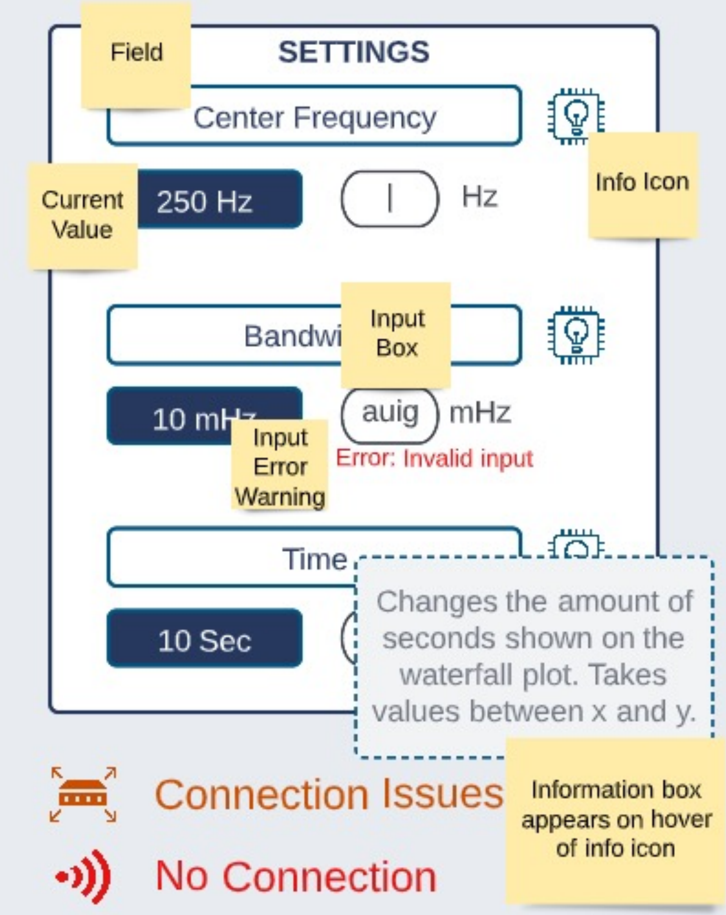


Intensity plot

Waterfall Plot

All plots are placeholders from https://www.qsl.net/dl4yhf/speclab/specdisp.htm



Field

Current Value

Info Icon

Input Box

Input Error Warning

Error: Invalid input

Changes the amount of seconds shown on the waterfall plot. Takes values between x and y.

Information box appears on hover of info icon

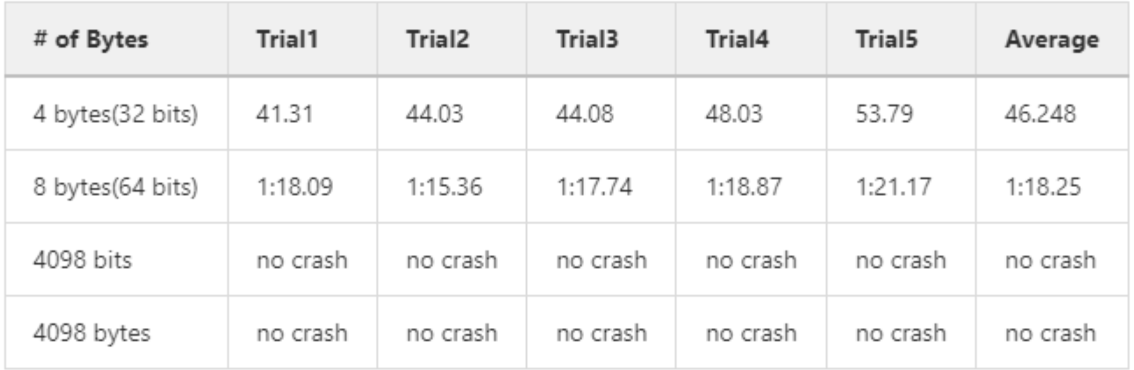
Connection issues warning persists while there is spotty connection between drone and lab computer (spotty data stream). Does not indicate any other type of connectivity issue.

No connection warning shows up while connection between drone and lab computer is gone (no data stream). Does not indicate any other type of connectivity issue.

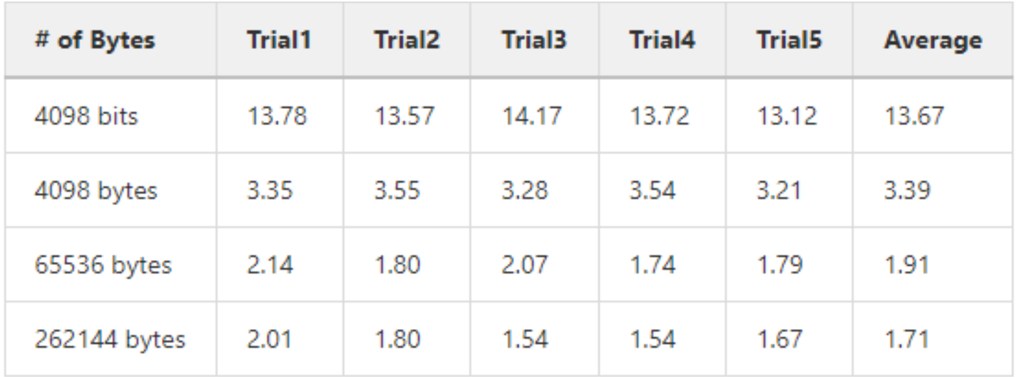
Progression

Backend Development

- Stream IQ file (complex short)
  - gRPC streaming options through proto3 protocol
    - uint32
    - uint64
    - String (2^32 bytes)



# of Bytes	Trial1	Trial2	Trial3	Trial4	Trial5	Average
4 bytes(32 bits)	41.31	44.03	44.08	48.03	53.79	46.248
8 bytes(64 bits)	1:18.09	1:15.36	1:17.74	1:18.87	1:21.17	1:18.25
4098 bits	no crash	no crash	no crash	no crash	no crash	no crash
4098 bytes	no crash	no crash	no crash	no crash	no crash	no crash



# of Bytes	Trial1	Trial2	Trial3	Trial4	Trial5	Average
4098 bits	13.78	13.57	14.17	13.72	13.12	13.67
4098 bytes	3.35	3.55	3.28	3.54	3.21	3.39
65536 bytes	2.14	1.80	2.07	1.74	1.79	1.91
262144 bytes	2.01	1.80	1.54	1.54	1.67	1.71

Progression

Backend Development

- FFT(Fast Fourier Transform)
  - FFT Calculation
    - Computed by taking the fft of both the I and the Q of the original data which then are combined using the equation below to produce the final fft

$$X_c(m) = \mathrm{real}[X_r(m)] - \mathrm{imag}[X_i(m)] + j\{\mathrm{imag}[X_r(m)] + \mathrm{real}[X_i(m)]\}$$

  - Scaling the result
    - Average a specified number of samples across the length of the fft in order to shorten the amount of data points down to 2048 samples
  - Log the result
    - Supposed to make the peaks more visible

Progression

Frontend Development

- Client Setup
  - Vue Cli
  - Webpack
  - ESLint
- Server to Client Connection
  - Express
  - Axios
- Client Features
  - Layout
  - Settings Box
  - Graphs

Progression

Challenges

Griffin

- Performing FFT of IQ data
- Streaming data at higher transfer rates

Omar

- Connecting Frontend Server to Client
- Increasing refresh rate of plots

Progression

What We Would Do Differently

- Implement Express sooner
- Look into different options for the API
- Learn more about Axios
- Research web sockets and compare to gRPC
- Develop data stream before database

Spectrogram

Results

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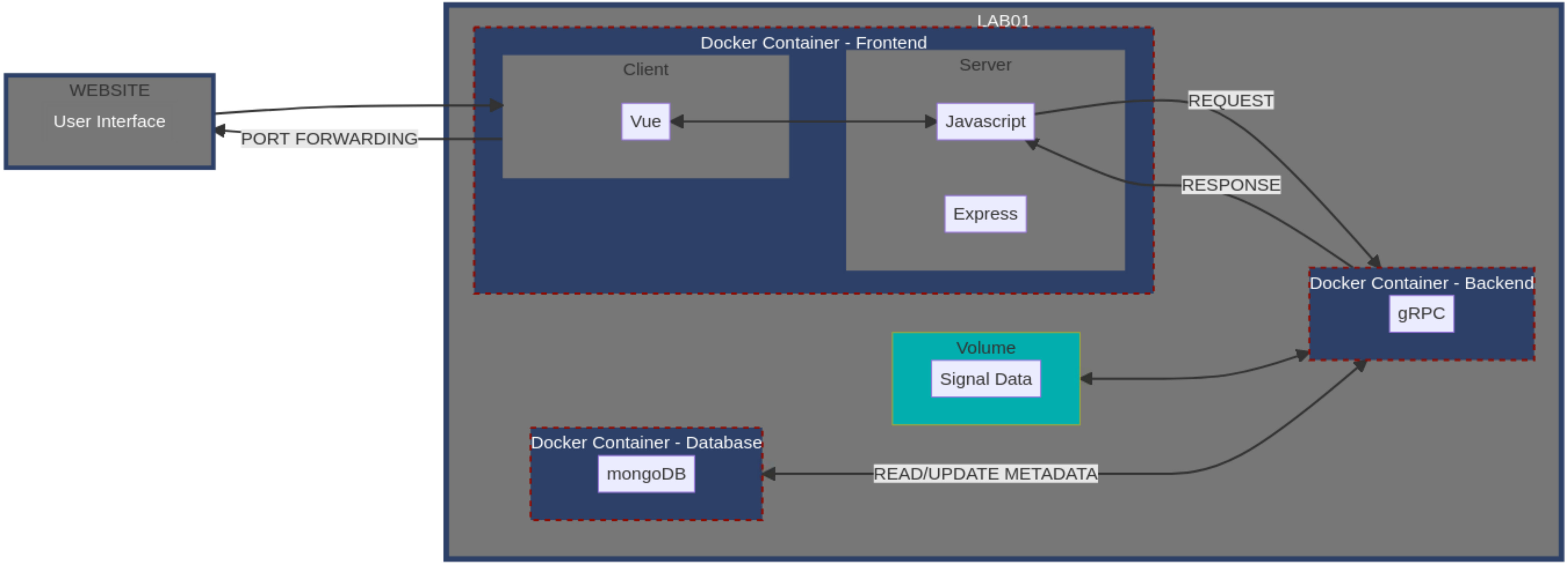
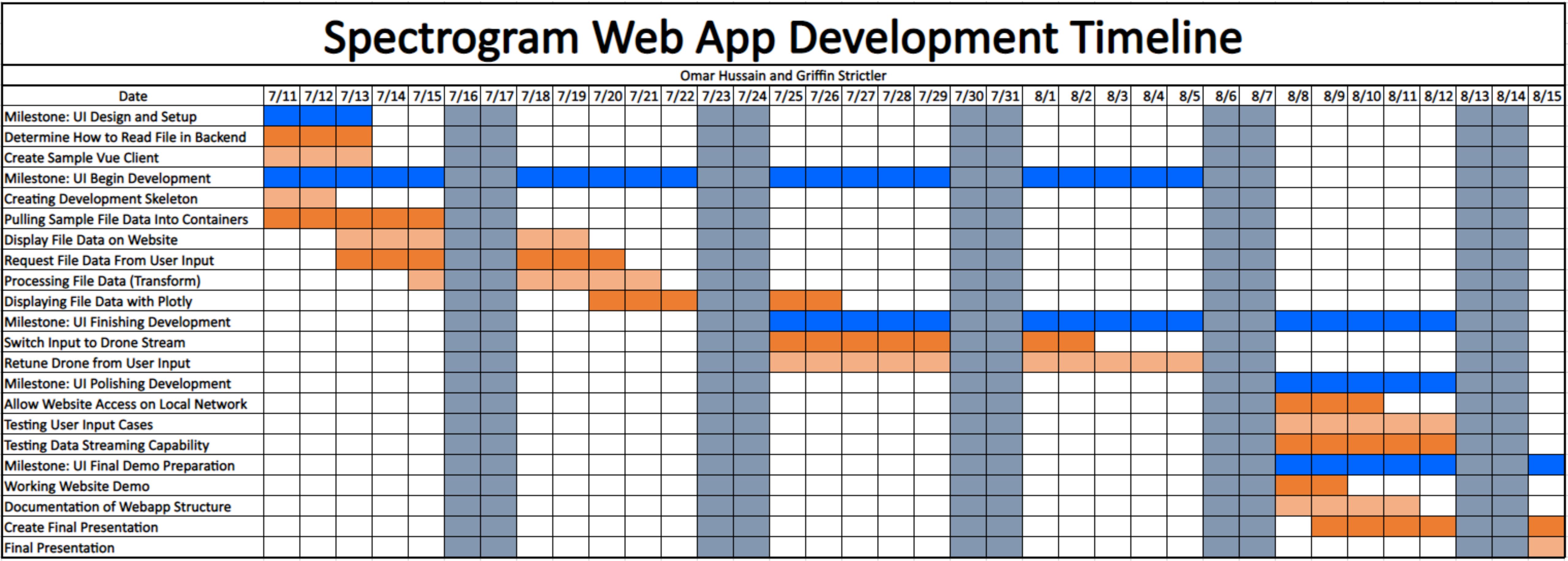
Infrastructure

File Input Diagram



Progression



Spectrogram Web App Development Timeline

Omar Hussain and Griffin Strictler

Date	7/11	7/12	7/13	7/14	7/15	7/16	7/17	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30	7/31	8/1	8/2	8/3	8/4	8/5	8/6	8/7	8/8	8/9	8/10	8/11	8/12	8/13	8/14	8/15
Milestone: UI Design and Setup	🟦	🟦	🟦			▨	▨						▨	▨						▨	▨						▨	▨						▨	▨	
Determine How to Read File in Backend	🟧	🟧	🟧			▨	▨						▨	▨						▨	▨						▨	▨						▨	▨	
Create Sample Vue Client	🟨	🟨	🟨			▨	▨						▨	▨						▨	▨						▨	▨						▨	▨	
Milestone: UI Begin Development	🟦	🟦	🟦	🟦	🟦	▨	▨	🟦	🟦	🟦	🟦	🟦	▨	▨	🟦	🟦	🟦	🟦	🟦	▨	▨	🟦	🟦	🟦	🟦	🟦	▨	▨						▨	▨	
Creating Development Skeleton	🟨	🟨				▨	▨						▨	▨						▨	▨						▨	▨						▨	▨	
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Display File Data on Website			🟨	🟨	🟨	▨	▨	🟨	🟨				▨	▨						▨	▨						▨	▨						▨	▨	
Request File Data From User Input			🟧	🟧	🟧	▨	▨	🟧	🟧	🟧			▨	▨						▨	▨						▨	▨						▨	▨	
Processing File Data (Transform)					🟨	▨	▨	🟨	🟨	🟨	🟨		▨	▨						▨	▨						▨	▨						▨	▨	
Displaying File Data with Plotly						▨	▨			🟧	🟧	🟧	▨	▨	🟧	🟧				▨	▨						▨	▨						▨	▨	
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Milestone: UI Final Demo Preparation						▨	▨						▨	▨						▨	▨						▨	▨	🟦	🟦	🟦	🟦	🟦	▨	▨	🟦
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Documentation of Webapp Structure						▨	▨						▨	▨						▨	▨						▨	▨	🟨	🟨	🟨	🟨		▨	▨	
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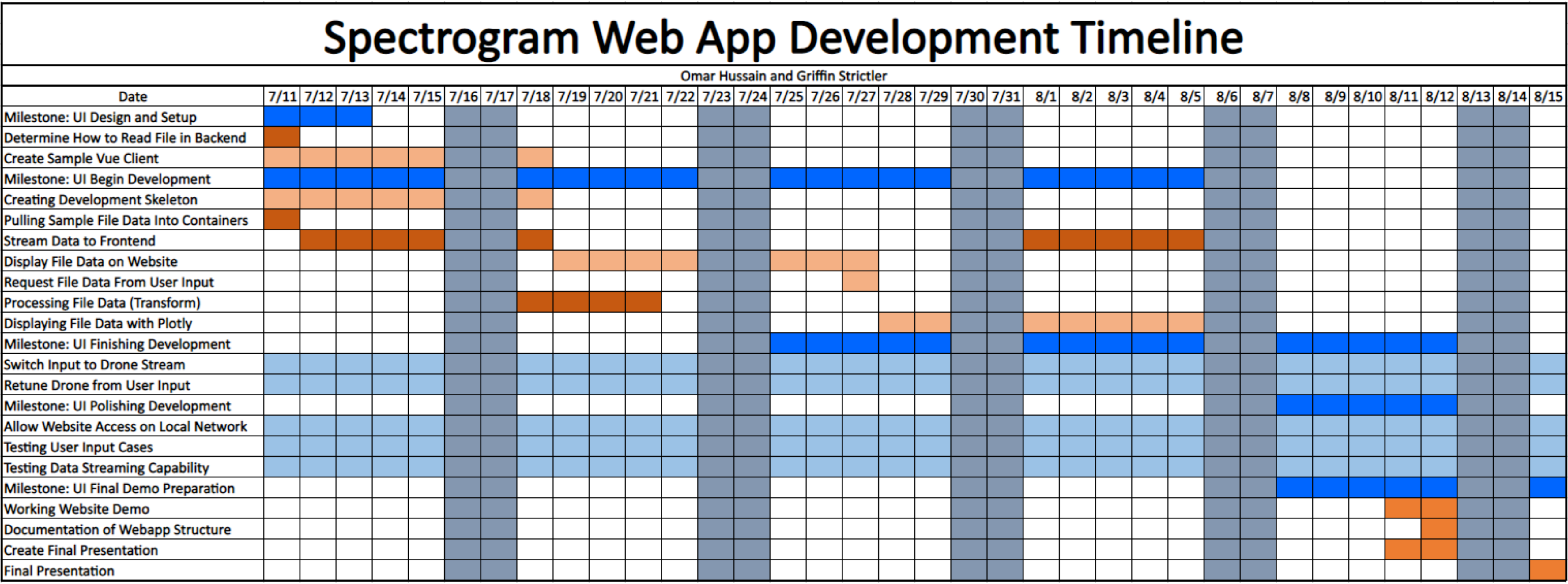
Integrity. Agility. Results.

Infrastructure

Goals Accomplished

- ✓ Read IQ data from drone/file
- ✓ Display intensity plot and waterfall graph
- ✓ Show frequency and bandwidth
- ✓ Provide pan and zoom functionality
- ✓ Stream IQ data from server to client
- ❑ Allow frequency and bandwidth retuning
- ❑ Handle user and connection errors
- ❑ Run on lab computer

Progression



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Testing Data Streaming Capability	▨	▨	▨	▨	▨			▨	▨	▨	▨	▨			▨	▨	▨	▨	▨			▨	▨	▨	▨	▨			▨	▨	▨	▨	▨			▨
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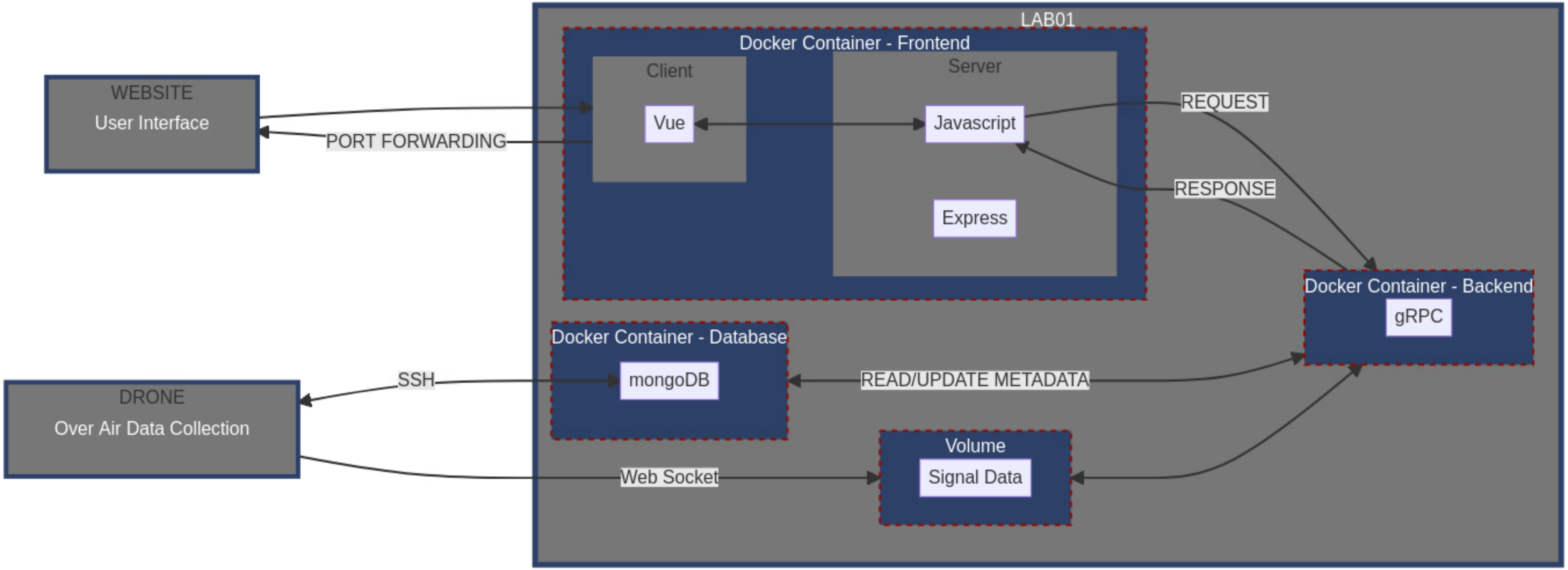
Infrastructure

Moving Forward

- CI/CD
- Testing
- Perform more efficient FFT
  - In C or C++
  - Overlapping
- Optimize connection between frontend server and client
- Handle gRPC stream better in frontend
- Build Client
- Drone integration
  - Retune requests
  - Live data stream

Infrastructure

Stream Input Diagram



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Demo

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