MICHIGAN STATE UNIVERSITY

Project Plan: Project Rumble

The Capstone Experience

Team Vectorform

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From Students…
…to Professionals

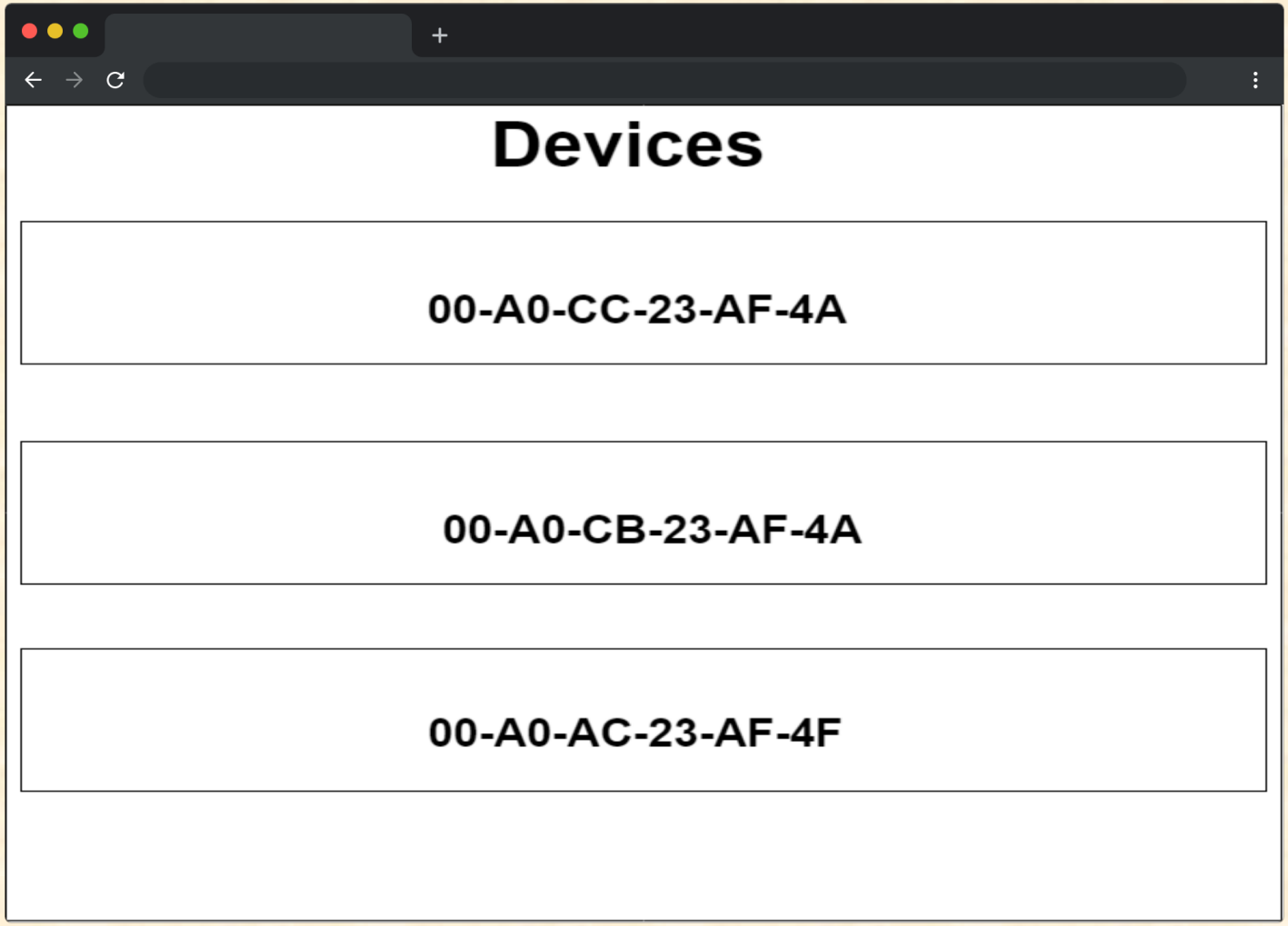
Functional Specifications

- Goal is to use an accelerometer-equipped device to determine whether a washing machine is on or off.
- On/off determinations must be accurate regardless of placement of device or brand of washer.
- Longer-term aims of Project Rumble are to be able to observe different parts of wash cycles on a finer-grain timescale and determine whether any washer issues were detected.
- If the process is easily replicable, Vectorform hopes to expand support to other high-vibration appliances, such as driers and dishwashers.

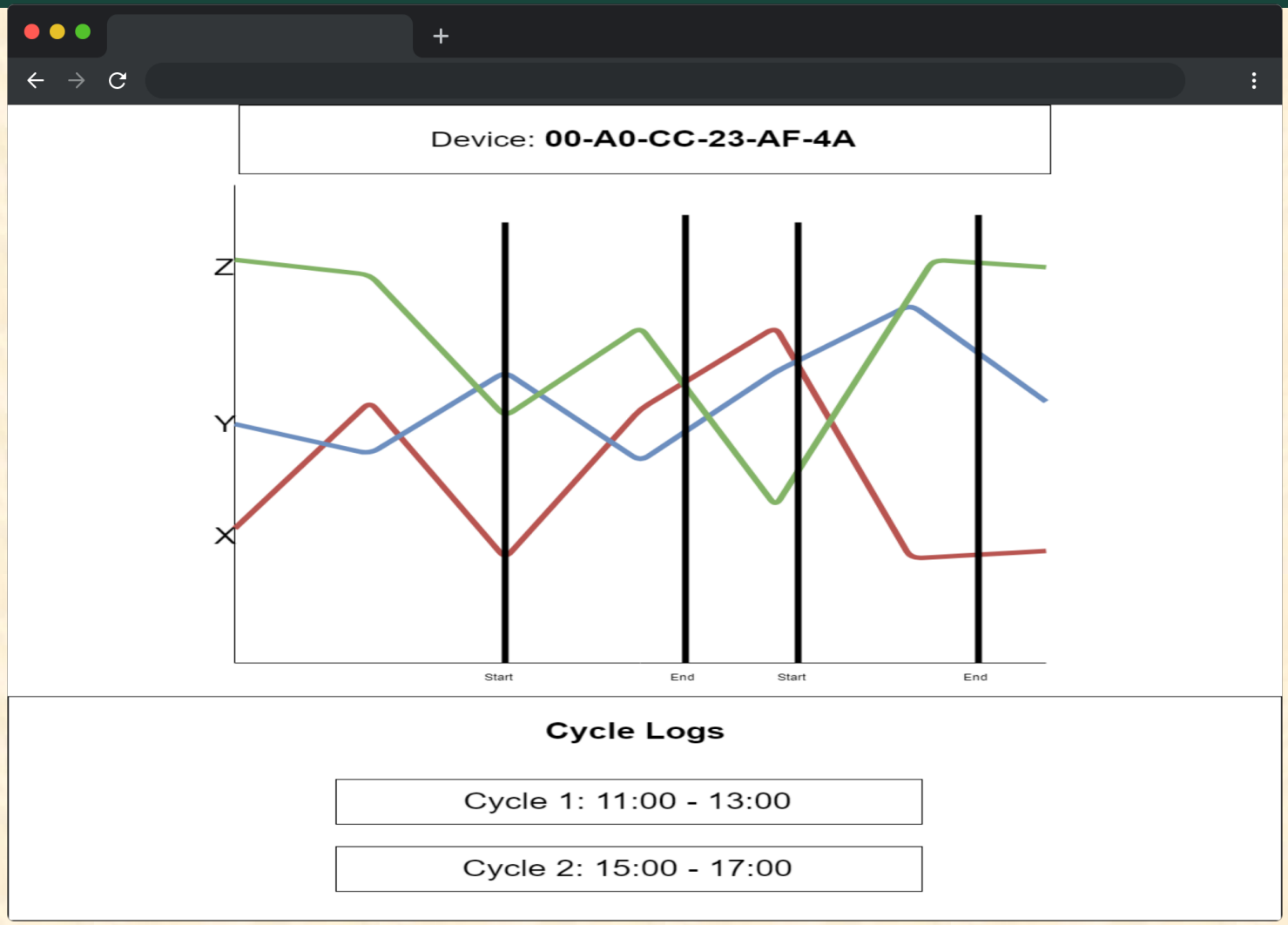
Design Specifications

- ESP32 Feather will…
  - Record data from connected accelerometer to connected SD card reader
  - Use trained neural net to predict whether washer is on or off
  - Push data, prediction, and device MAC address to server using MQTT
- Server will host...
  - A MySQL database storing the data for every device
  - A web app that will allow the user to select a MAC address from a list and view the current/historical accelerometer data and predictions for the device associated with the selected address

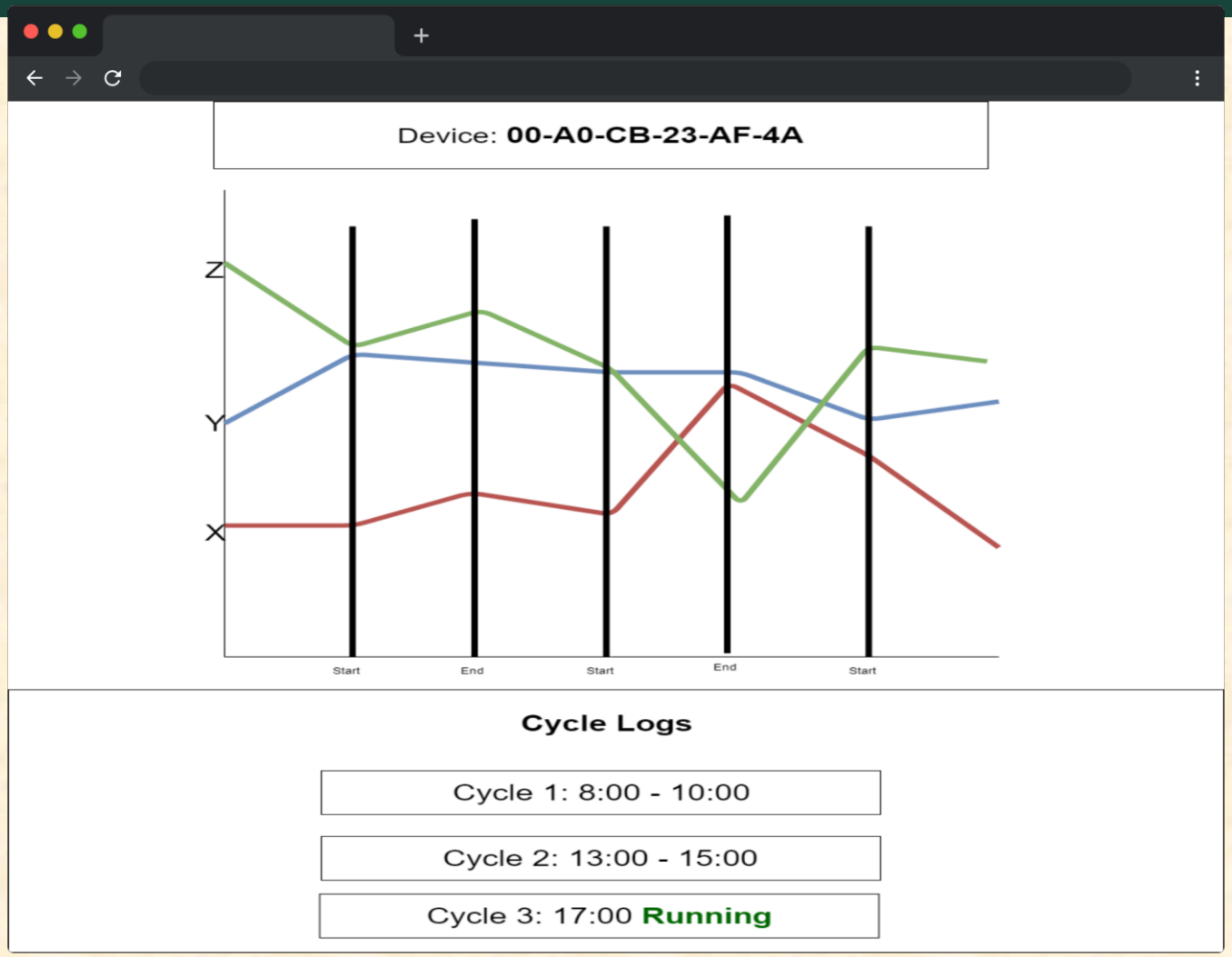
List of Devices



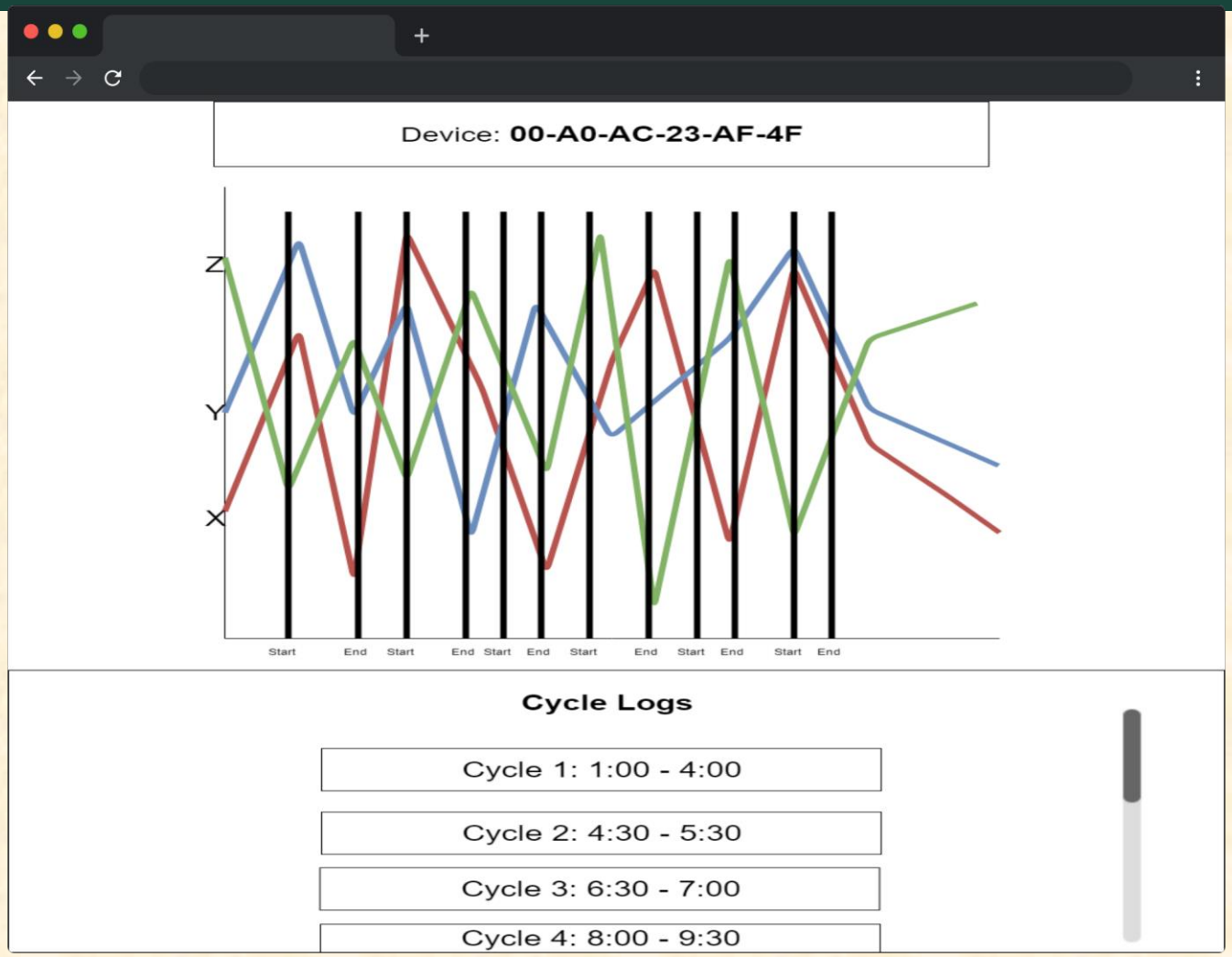
Device Details Example 1



Device Details Example 2



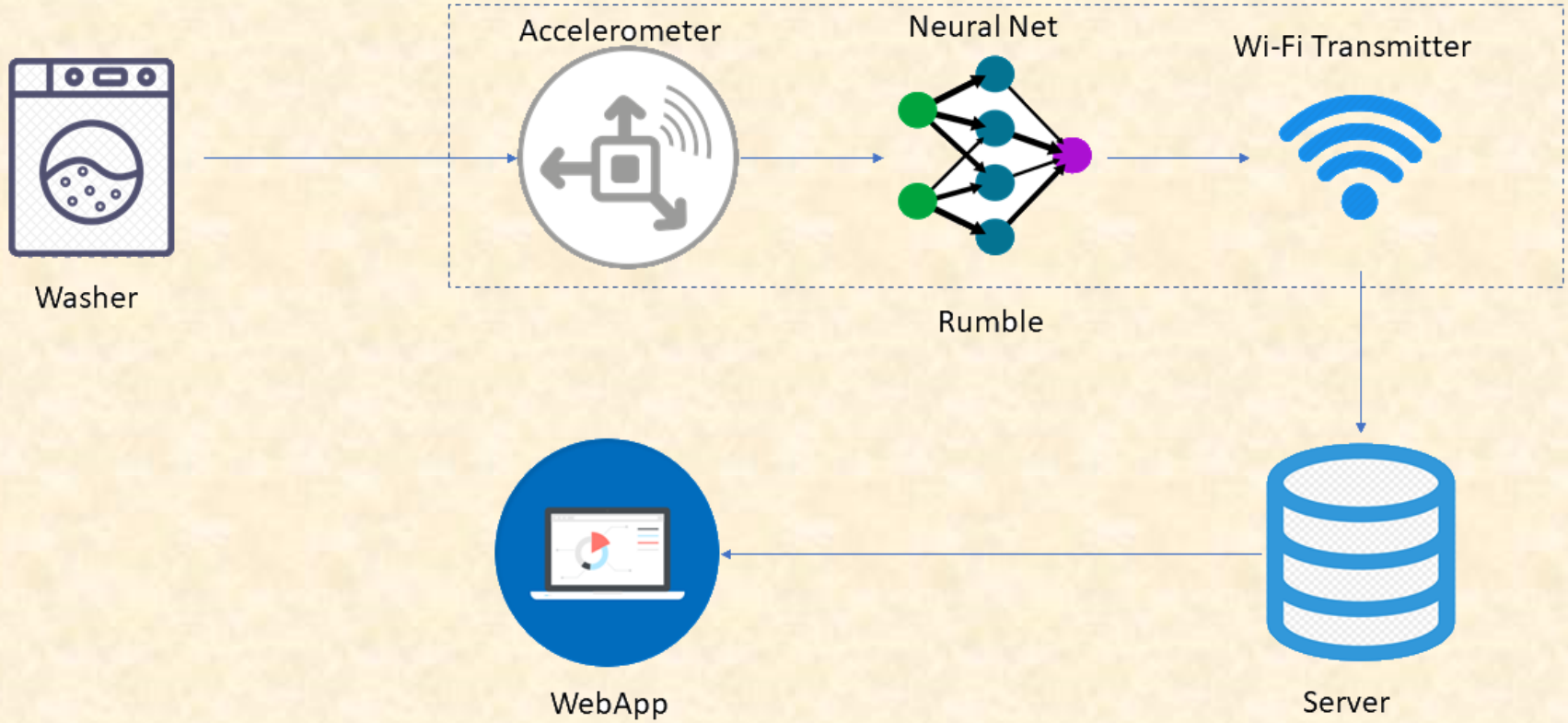
Device Details Example 3



Technical Specifications

- Server-side
  - Rackmount server running a MySQL database
  - Receives data from ESP32 via MQTT
- Equipment
  - Adafruit ESP32 feather with accelerometer and SD card reader/writer attached.
- Software
  - Microsoft Visual Studio – C++ to write the neural net
  - Arduino IDE for programming and flashing the ESP32
  - React.js
  - Victory
- Neural Net
  - Multilayer Perceptron neural net with a single hidden layer
  - Uses gradient descent and backpropagation to optimize the network
- Front End Web App
  - Uses JavaScript library React.js and incorporates HTML models and CSS descriptions.

System Architecture



System Components

- Hardware Platforms
  - Adafruit HUZZAH32 ESP32 Feather
  - Adafruit Adalogger FeatherWing
  - Adafruit ADXL343 + ADT7410 Sensor FeatherWing
- Software Platforms / Technologies
  - Ubuntu Server 18.04
  - MySQL Server
  - Python 3.6 / MySQL-Connector/Python
  - MQTT
  - Arduino IDE
  - JavaScript / React.js / Victory React
  - PHP / HTML
  - Visual Studio C++

Risks

- ESP32 Capacity
  - Currently uncertain whether the 4MB onboard flash memory on the ESP32 is large enough to hold a pre-trained neural net.
  - If 4MB is too little storage space, we will have to consider doing signal processing without the use of machine learning, using quick/efficient algorithms to determine when a washer is running.
- Accelerometer Corrections
  - Will need to develop a strategy to correct the raw accelerometer readings for both gravitational acceleration and drift over time.
  - possible mitigation would be to record the ‘base’ accelerometer readings any time the washer is confirmed to be off
- Accessing Server Data
  - Server containing both raw data and the MySQL database currently resides on a rackmount that’s within MSU’s private subnet. We will need to have a way to make server data available off campus
  - Either host the server through an external VSP provider, or have Vectorform employees access a system within the MSU subnet using a trusted VNC application
- Sufficient Training Data
  - Uncertain if there's enough accelerometer data to train a neural network to accurately determine whether a washer is running a cycle or off.
  - Obtain more/longer datasets from sensors set up on real washing machines (we will have received approximately double the data we currently have from Vectorform by September 30)

Questions?