RoastRight

The smart coffee roaster

Group 1 Senior Design Project by

Brian Webb, EE | Evan Baytan, CpE

Patrick Sites, EE | Sammy Roman, CpE

Project Overview

What is a coffee roaster?

- Coffee is typically roasted and ground when purchased on store shelves
- Coffee beans are initially green and turn their familiar brown color during the roasting process
- A majority of coffee drinkers brew their own coffee, but some are beginning to experiment with roasting as well
- Coffee roasters typically come in two styles: Air or Drum.

Motivation

- Introduce more consumers to freshly roasted coffee
- Create a convenient solution that will not sacrifice time for quality
- Utilize current technology and design principles to create a friendly and enjoyable user experience
- Provide more home automation options for customers to add to their already existing devices (Nest, Phillips Hue)

Goals & Objectives

- Control and monitoring of the coffee roaster using an iPhone or Apple Watch
- Additional secondary controls through the onboard touchscreen display
- Ability to successfully roast coffee of different roast profiles and types (Light, Medium, Dark)
- Community aspect that will allow the ability to view and add new roast profiles
- Order more coffee beans through iOS/watchOS applications

Specifications and Requirements

Reach temperatures of 244°C

Pull at most, 15A of current

Handle up to 1lbs of coffee at a time

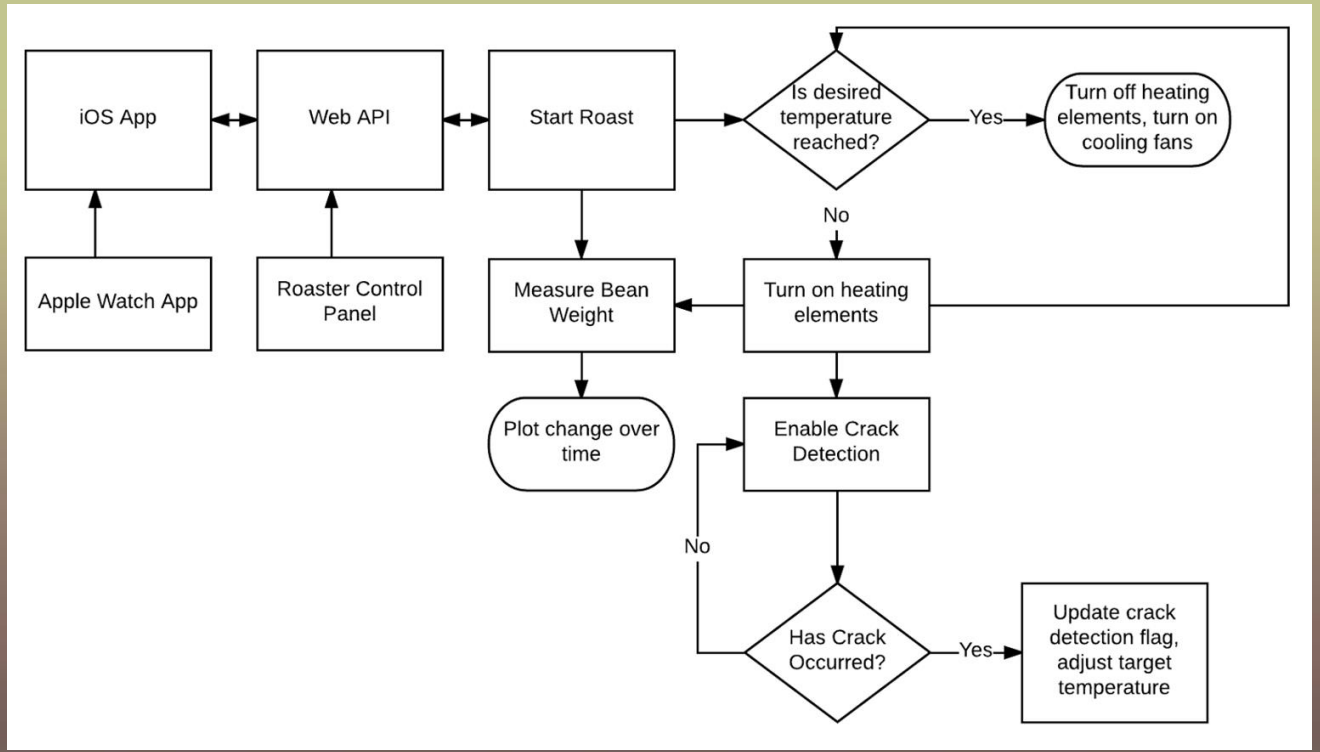
Minimal background app activity to maintain low battery usage

Achieve a French Roast

Automatically scale roasting profile based on amount of coffee that is used

Have feedback from the coffee roaster to determine where it is in roasting process

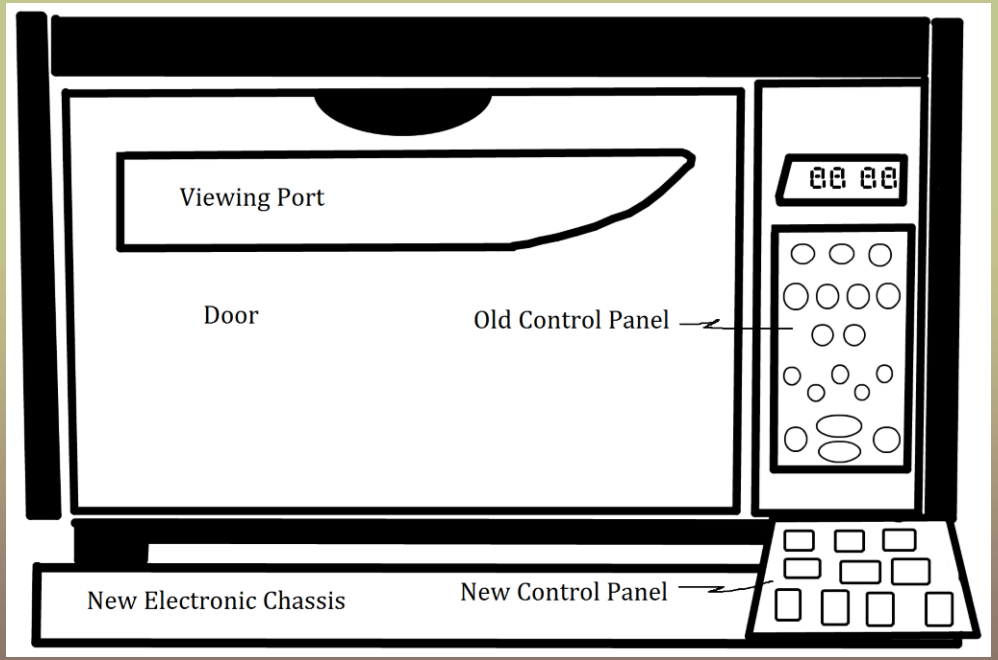
Overall Project Block Diagram



Hardware Design

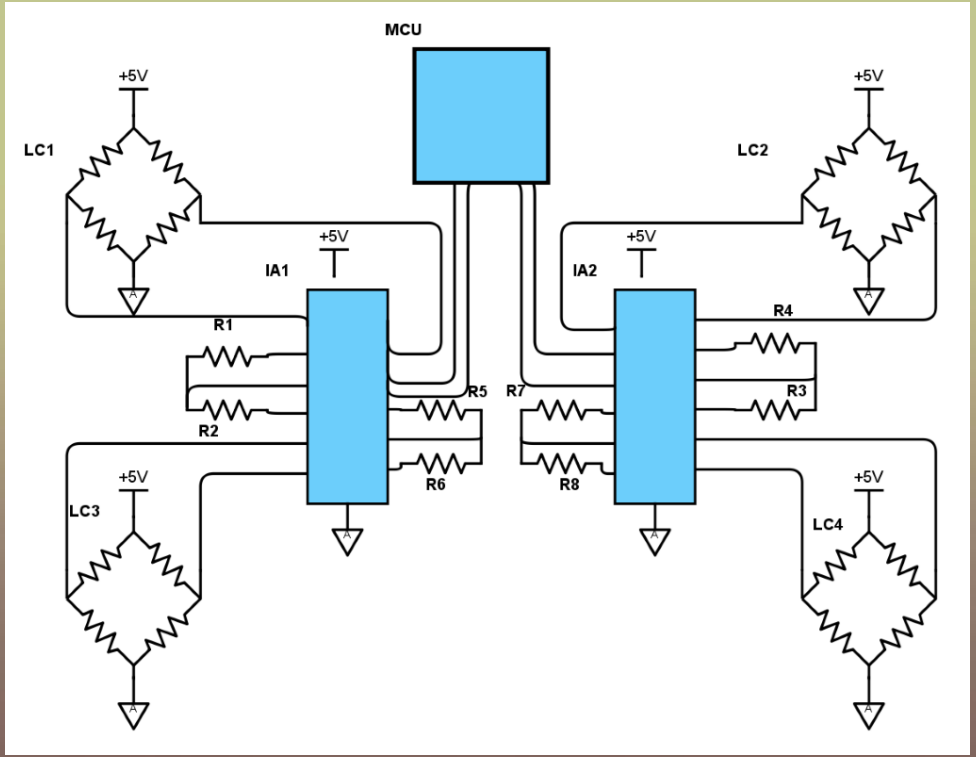
All hardware will appear in added base, as shown.

Provides thermal insulation and easier work area.



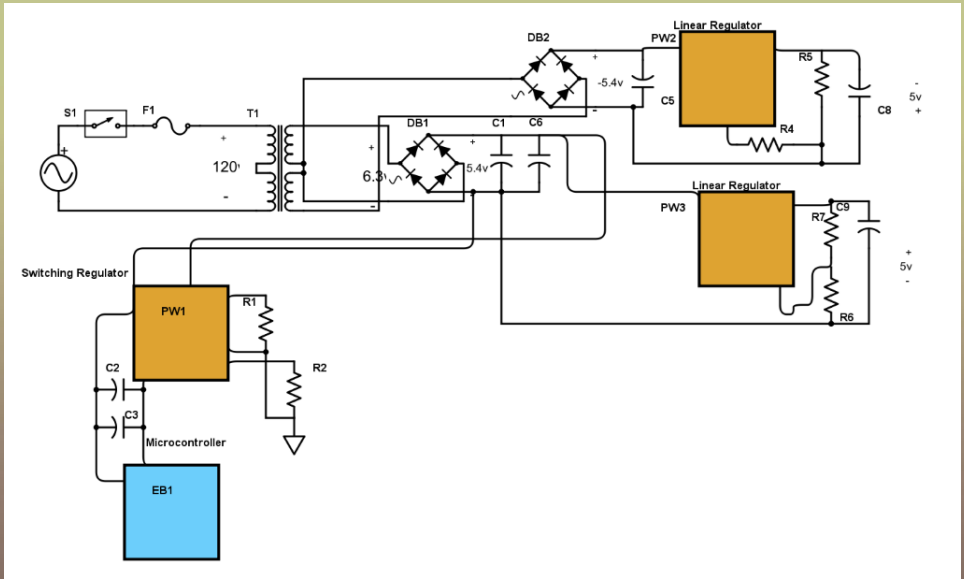
Weight Sensor

- Four load cells, one on each corner
- Load Cells represented as Wheatstone Bridge
- Uses instrumentation amplifier to get reasonable gain



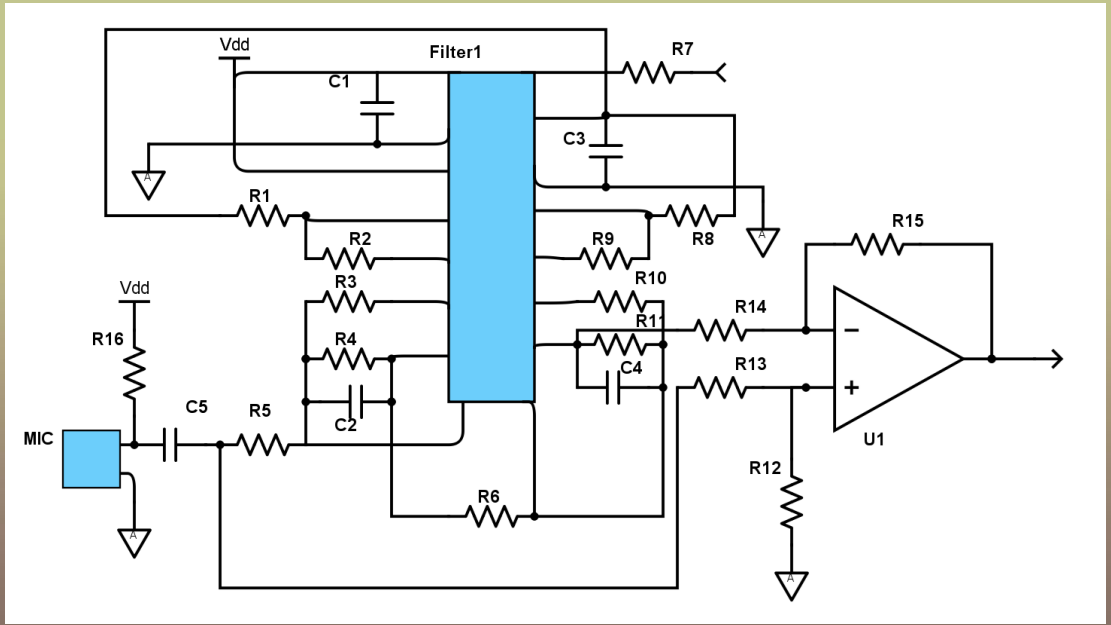
AC to DC Power System

- Regulated power converters
- Switching
- Linear
- Bipolar design
- Power digital and analog circuitry



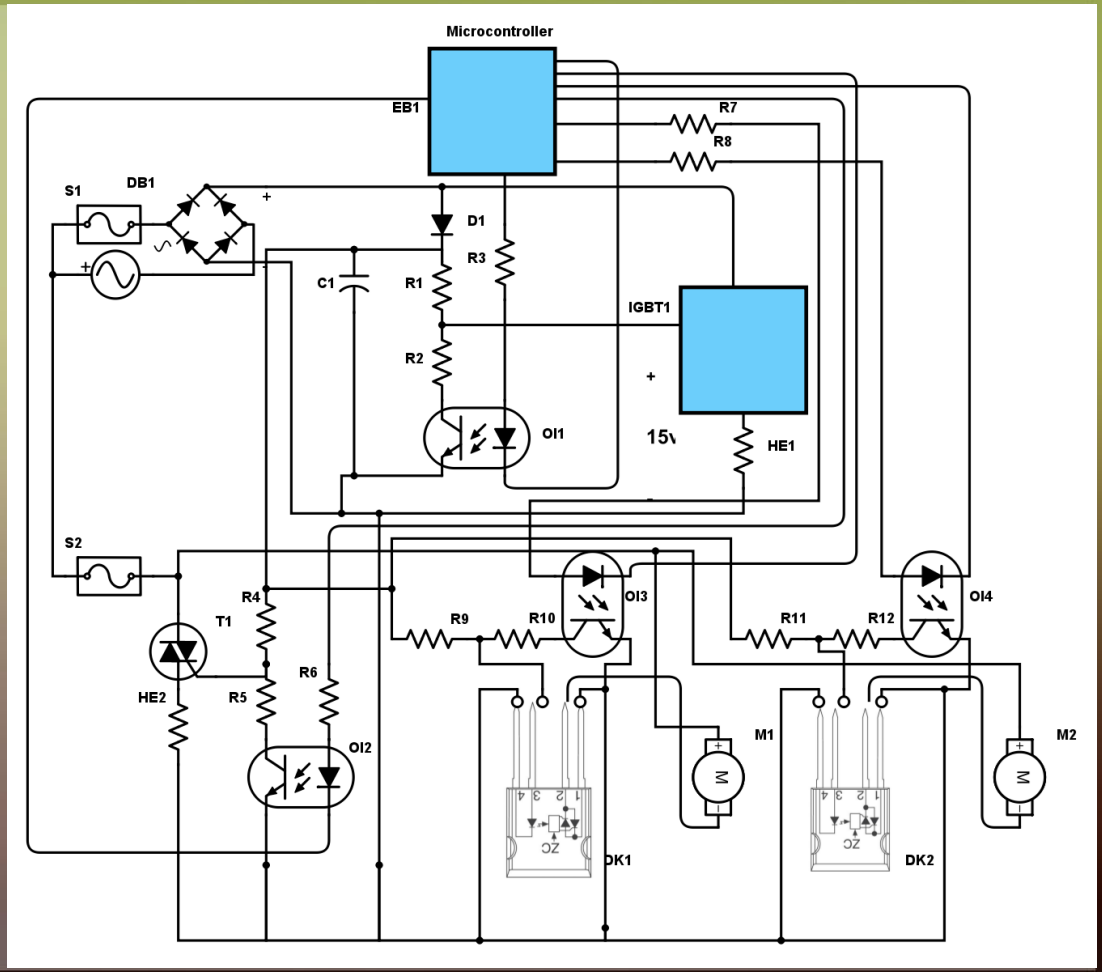
Crack Detection

- Audio based
- Remove noise with analog filter
- Use threshold detection in MCU



Control System

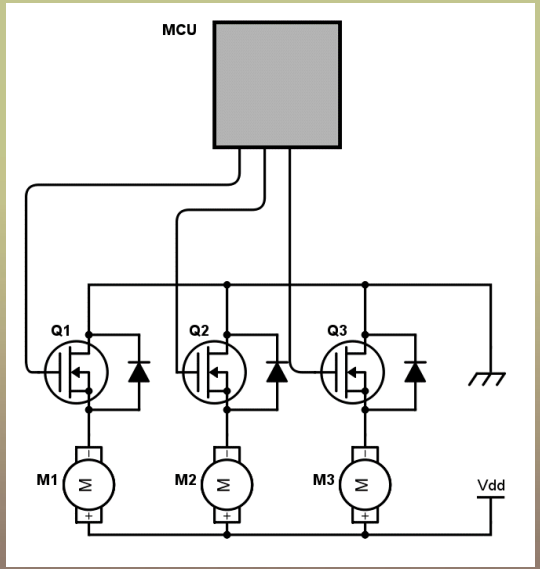
- Controls heating elements and fans
- AC and DC components



Control System

Controls heating elements and fans

AC and DC components



MCU

MSP432P401R

- Up to 48MHz
- 256KB RAM
- 4-pin JTAG support
- Ultra Low Power (90μA/MHz)
- Overall package size 14x14mm
- Built in DC-DC conversion
- Real-time clock
- ADC

WiFi Module

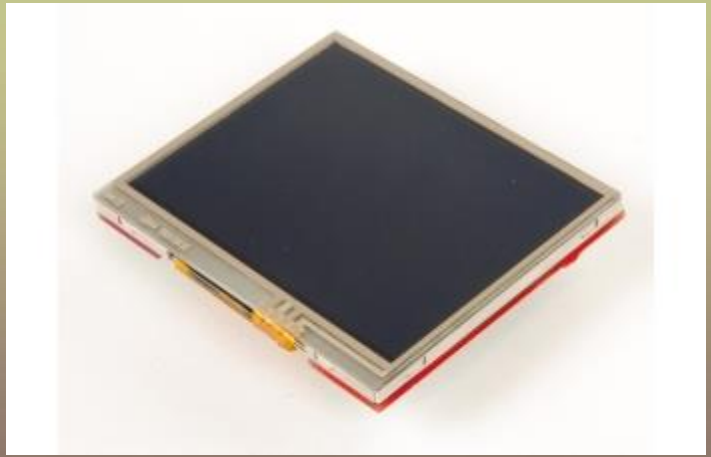
CC3100/3200MOD

- 802.11bgn compatibility
- Fully enclosed external hardware
- Same operational voltage as MCU
- 7μA Hibernate power consumption with RTC
- 140μA standby

LCD Display

BOOSTXL-K350QVG-S1

- 320x240 resolution
- SPI Interface
- Self-contained external components
- 4 wire resistive touch capacity



Software Design Approach

General

- Modularize the software
- Test Driven Development (TDD)

Web API

- Intuitiveness & Consistency
- Security
- Documentation

Web API

What will it do?

Will facilitate communication between front end applications and the coffee roaster

Store user data, such as:

- User credentials
- Roast profiles
- User's favorites roast list
- Provide Authentication/Security

What is your Web API stack?

- MongoDB, ExpressJS, NodeJS

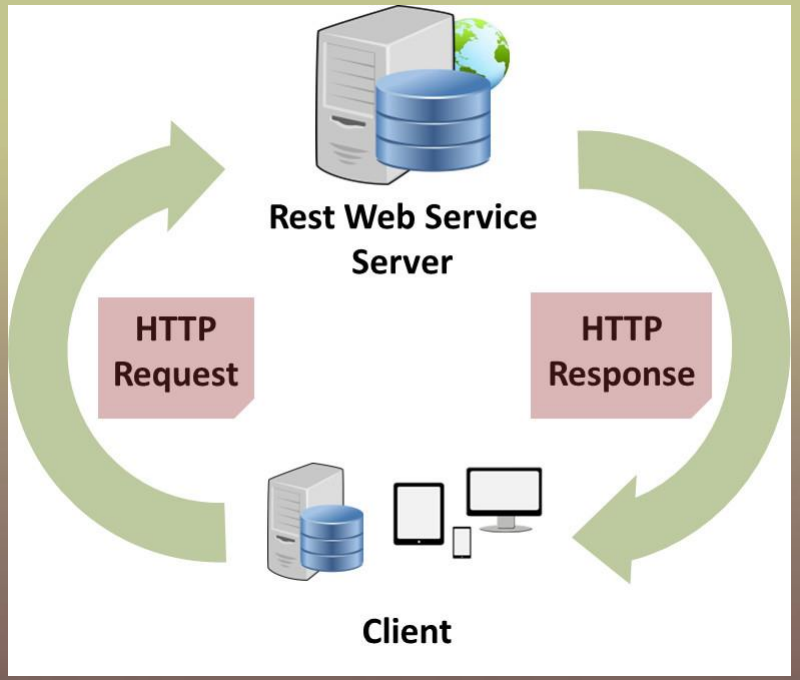
Representational State Transfer aka REST

What is REST?

Architectual style for networked hypermedia applications. Primarlily Used for building Web services that are lightweight, maintainable, and scalable.

Constraints:

- Uniform Interface
- Stateleness
- Client-Server
- Cachable
- Layered System
- Code on Demand (optional)



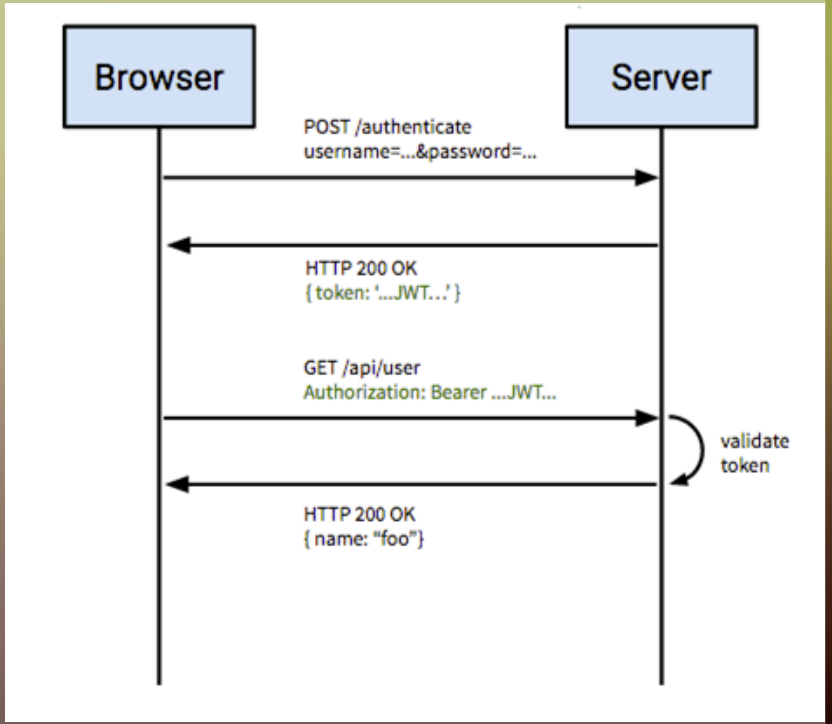
Security - JWT

What is JWT?

An open standard that defines a compact and self-contained way of securely transmitting data via a JSON object.

How will you use JWT within your Web API?

It will allow us to authenticate who the user is and what roaster should be receiving the data.



Routing

TYPE		POST
URI		/api/roast
Description		Create a roasting profile.
Payload		POST /api/roast Set Header: Authentication = “JWT dkafjkEefkFSjfk.afakjAWer”

Response	Success	200 - application/json
		{
		“roastname”:”French Roast”,
		“beanType”:”Peruvian”,
		“roastType”:”Dark”,
		“roastingData”: ”(0,150,20),(39,200,44),
		(400, 225, 10),(500,0,0)”
		}

	Failure	200 - application/json
		{
		“Success”:false,
		“msg”:”No roasts found.”
		}

TYPE		POST
URI		/api/user/authenticate
Description		Used when logging in a user

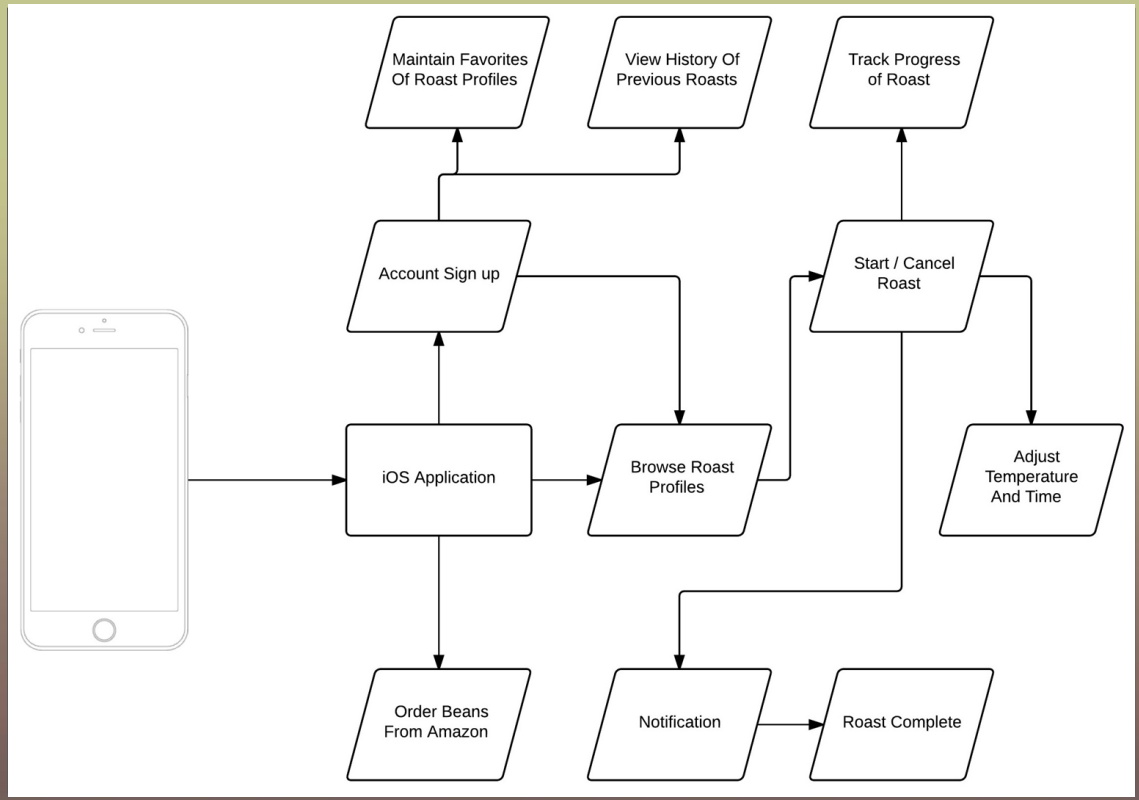
Payload		POST /api/user/authenticate
		{
		“username”:”RoastMaster5000”,
		“password”:”1337Roaster”
		}

Response	Success	200 - application/json
		{
		“Success”:true,
		“token”:”JWT
		dkafjkEefkFSjfk.afakjAWer”
		}

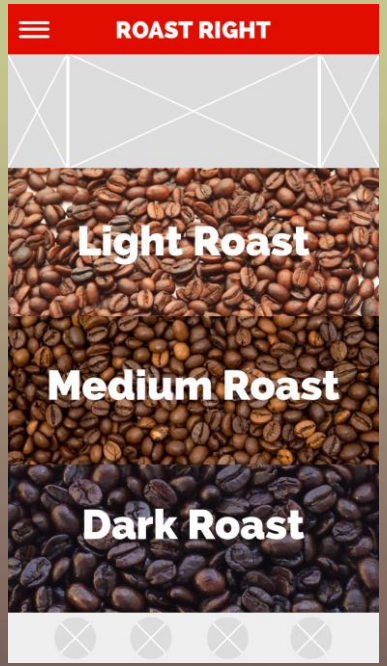
	Failure	200 - application/json
		{
		“Success”:false,
		“msg”:”Authentication failed:
		User not found.”
		}

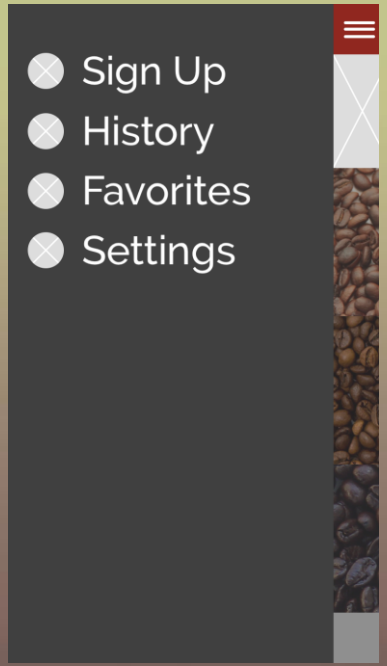
iOS Block Diagram

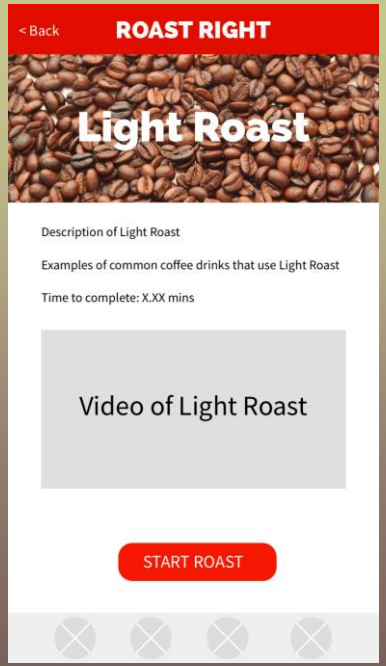
- Full control of coffee roaster
- Begin and track a roast in progress
- Notification when roast is complete
- Browse & Add new roast profiles

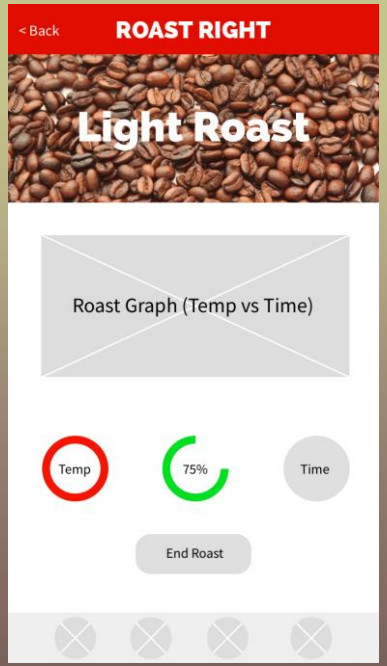


iOS Application



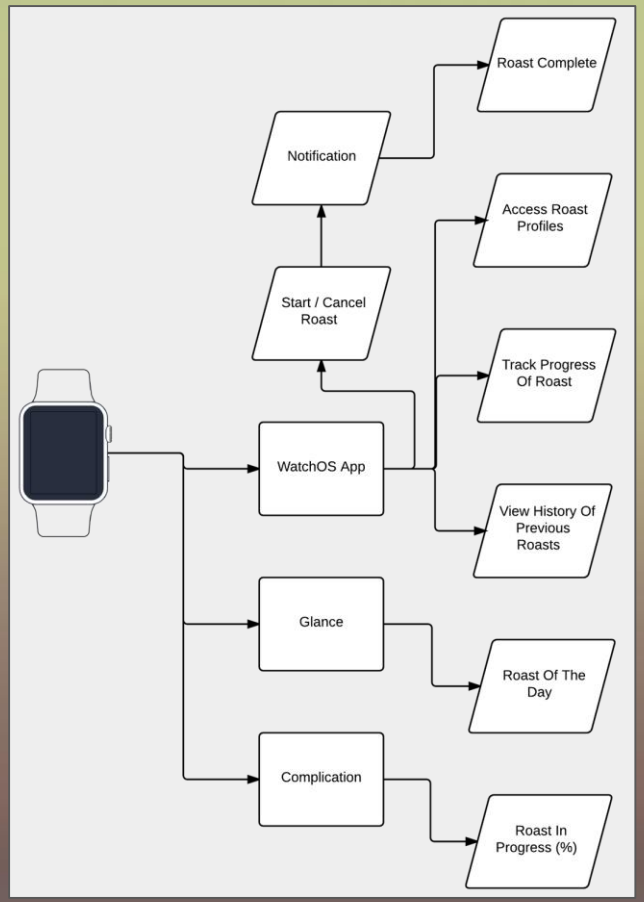






watchOS Block Diagram

- The watchOS application is comprised of 3 major components:
  - watchOS Application
  - Glance
  - Complication



Project Successes & Concerns

Success

- Hardware
  - Meets design requirements
  - Produces the best coffee you've ever had

Concerns

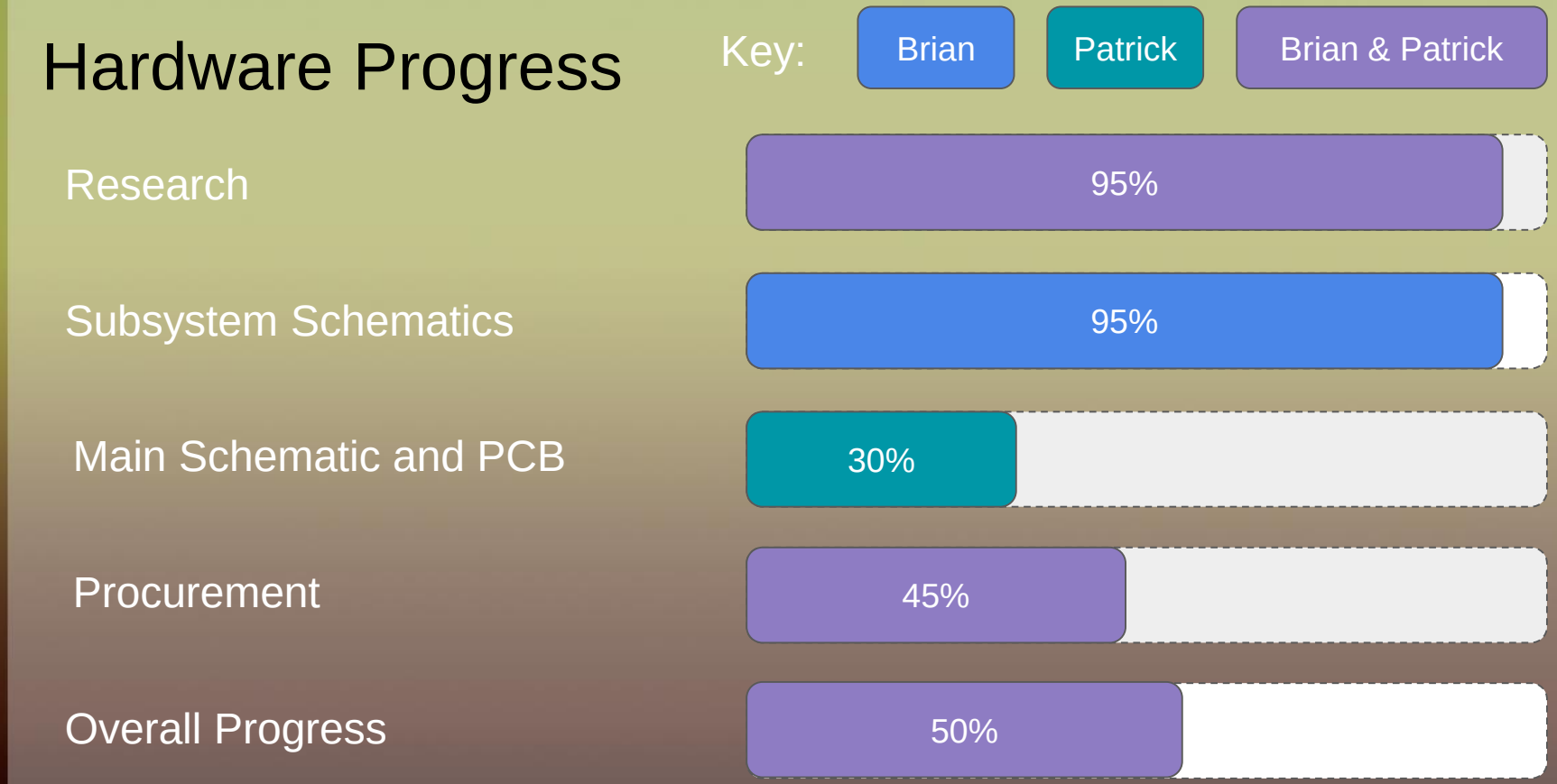
- Hardware
  - Problems in high power circuitry
  - Crack detection misfires
- Software
  - Latency between iOS/watchOS applications communicating with coffee roaster in a timely manner
  - Intuitive design due to using familiar UI and functionality from popularly used apps

Budget and Financing

- Project is largely self-funded with minor funding coming from external sponsors including
  - Sweet Maria's Coffee
    - 8 LBs of unroasted coffee of several varieties
  - Blessed Beans Coffee
    - 25 LBs of unroasted coffee from a single source
  - Texas Instruments
    - $100 eStore funded by TI Innovation Challenge

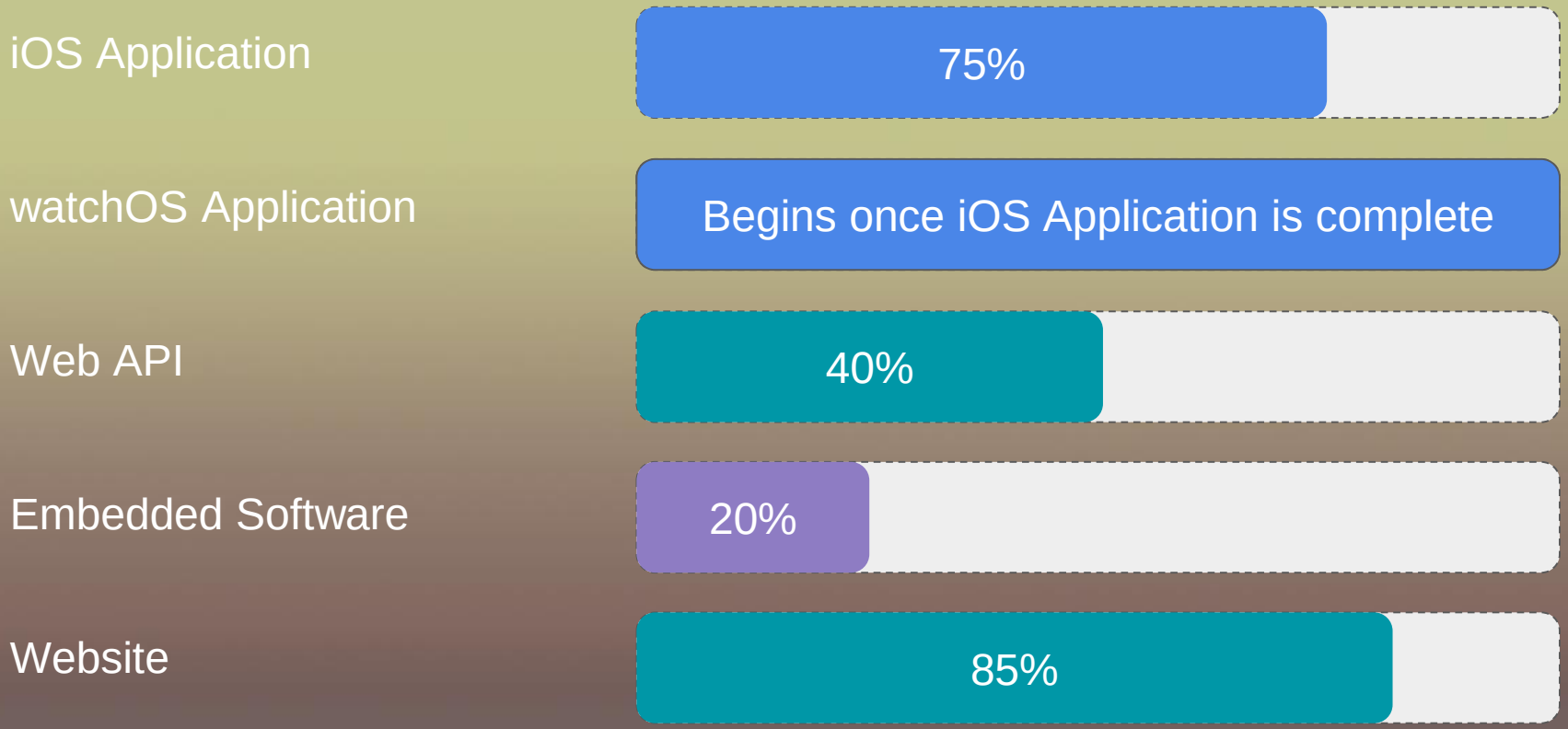
Behmor Coffee Roaster	$395.89
PCB Manufacturing	$250.00
AC Power Control System	$75.73
Equipment	$45.00
DC Power System	$25.57
PCB Placement	$25.00
Crack Detection	$18.14
Miscellaneous Expenses	$15.00
DC Power Control System	$2.19
Total	$852.32

Hardware Progress



Software Progress

Key: Evan | Sammy | Evan & Sammy



Immediate Plans for Project

Hardware

- Finish procurement of components
- Begin breadboard testing
- Complete Main System
  - Verify schematic is accurate and passes ERC
  - Route PCB and verify it passes ERC

Software

- Finalize iOS application and begin watchOS application
- Begin testing of iOS application and Web API

Questions?