Senior Design Project: WaterMainia

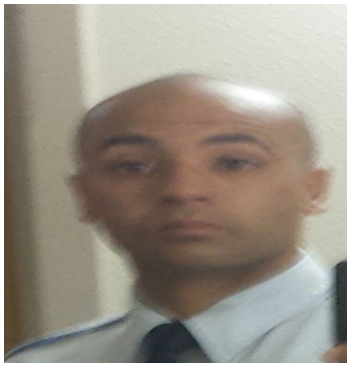
October 21, 2016

WaterMainia

Greg Boudreau

Team Manager

Michael Moran



Jon McAvoy

Professor Hollot

Advisor

What is the Problem?

Water Conservation

Water Pipe Damage

How Significant is the Problem?

According to the US EPA

- The average household leaks 10,000 gallons of water per year
- Approximately 1 trillion gallons of water leaked worldwide per year

Effects on Individuals

- Basement floods are a persistent and costly issue in our society
- Even a small leak is incredibly costly over time
- In early 2014 there was a burst pipe over the winter break in Marcus Hall
- Could have ruined research projects years in the making

Effects on Groups

- Water conservation is a serious issue and affects millions
- On the heels of a large drought and water ban by the Umass administration
- Detecting and stopping leaks can save massive amounts of water

Existing Solutions

Leak/Pipe Burst Detection:

- Visual Inspection
- Audio-sonar listening
- Thermal imaging
- Water meter monitoring
- Water detection sensor

Damage Mitigation:

- Sump Pumps
- Drainage systems
- Flood/Homeowner's Insurance

LeakDefense

Key Features

- Meter and shutoff placed on the main water line
- System can only be accessed from a single wall unit
- Programmable
- Sets off audible alarm on detection

Advantages to our System

- Remote access
- Alert sent to phone

WaterHero

Key Features:

- Electronic motor for water shutoff
- Works over wifi
- Magnetic field flow sensor
- Cost $199
- Integrated with phone application

Advantages to our system:

- Potential for networking
- Works wider variety of plumbing systems

Our Solution - WaterMainia

Sense

Detect

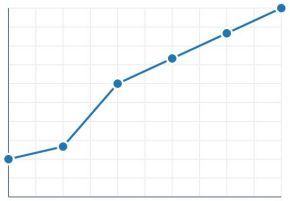
Alert

Requirements Analysis: Specifications

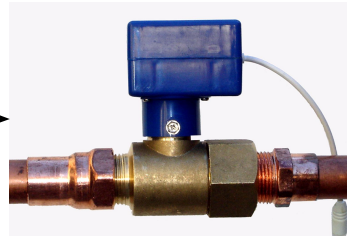
1. Must be implemented using 3/4” pipe
2. Water flow data is metered and recorded
3. Store data for previous two years
4. Display water consumption data in tables, line charts and pie charts
5. Close water main & notify owner within one minute from pipe burst
6. Alerts owner of any sized leaks
7. Power < 50W
8. Cost <$500 budget

Input/Output

Main Water In



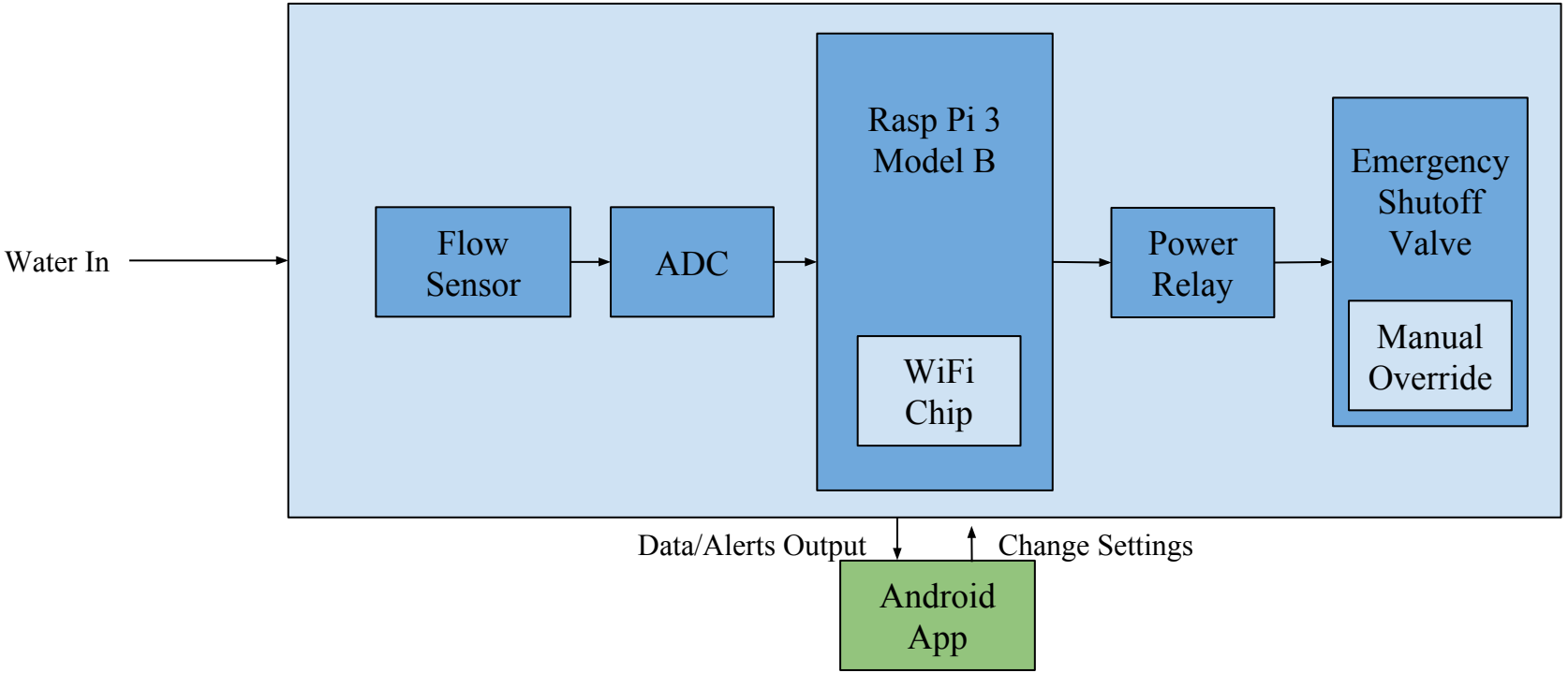
Water Usage Data



Emergency Shutoff Valve

Android Notification

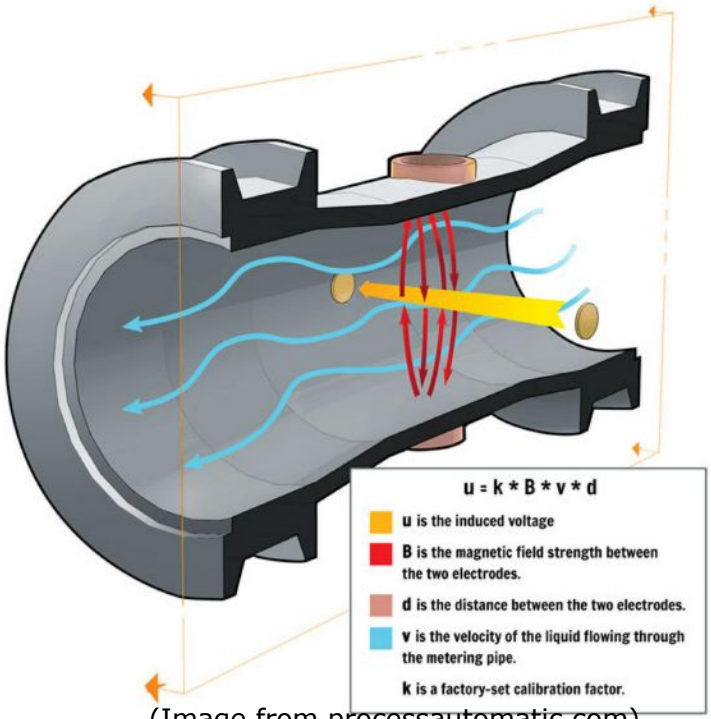
Block Diagram



Block 1: Flow Control Subsystem

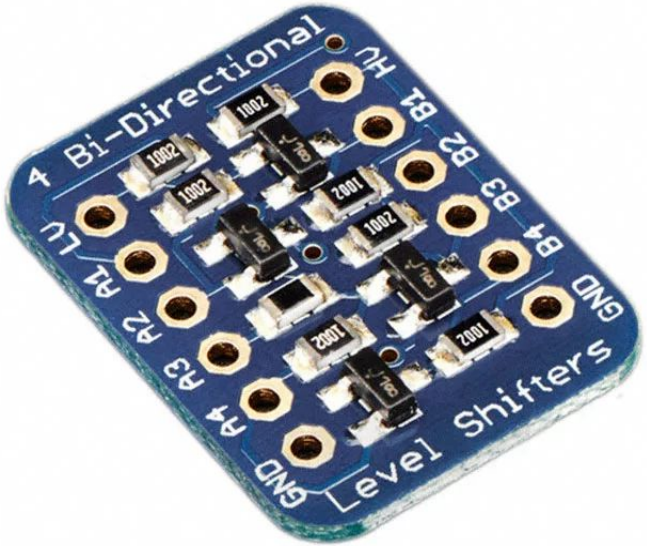
Electromagnetic Flow Meter

- Pipe addon constructed by student to save money (commercial EM flow control will cost upwards of $750+)
- Water flow in pipe will be measured
- Flow data sent to Pi for analysis
- Aiming to construct device for under $100



(Image from processautomatic.com)

Block 2: Analog to Digital Converter



MCP3008

- Converts DC Voltage to Digital Signal for Raspberry Pi GPIO
- 10 bit accuracy
- Sample Rate: 200 ksps
- Passes voltage difference between channel 0 and 1 to SBC
- Reading Range, 0-3.3V
- Cost: $3.75

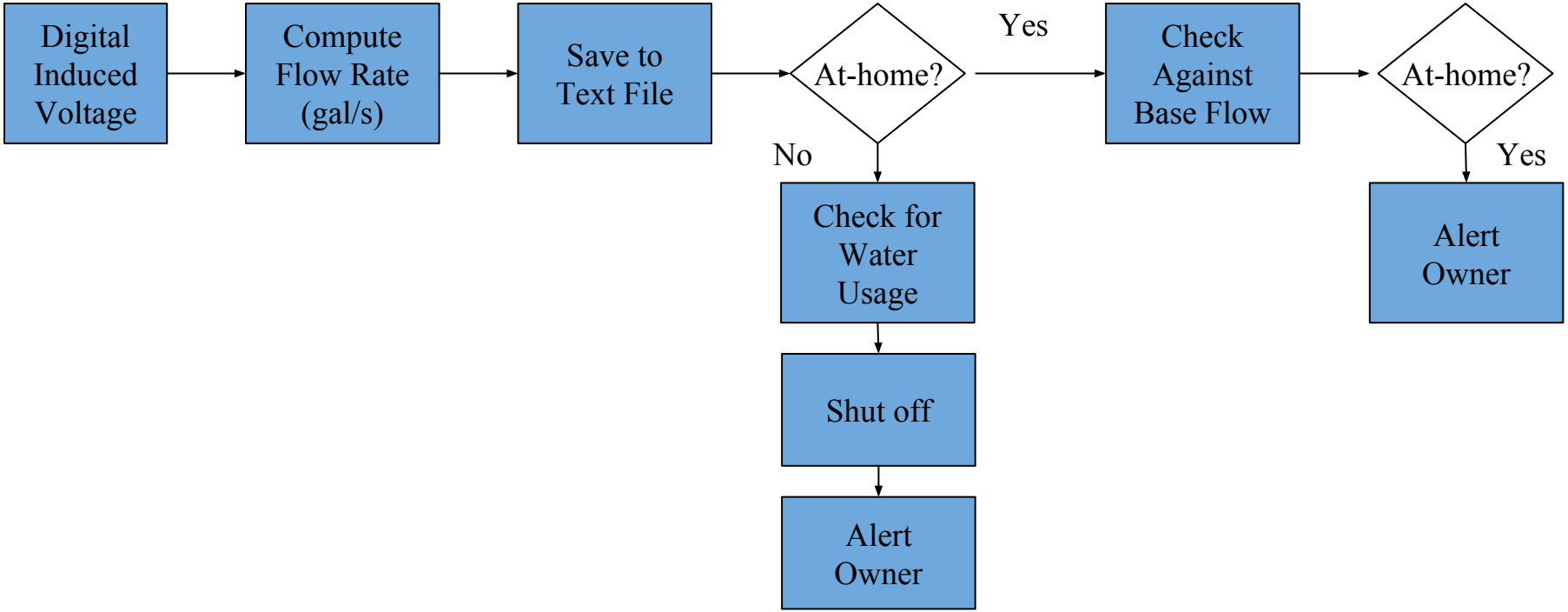
Block 3: Single Board Computer

Raspberry Pi 3 Model B

- Broadcom Quad Core Processor @ 1.2GHz
- 1 GB RAM
- WiFi built in
- Raspbian OS
- 12.5W
- Cost $35

https://www.adafruit.com/products/3055?gclid=CjwKEAjwm_K_BRDx5o-sxq6ouXASJAC7TsFLKFYRwXA7RyYsVxsNd9OL1xkN3FL86K0PKrQd9ysLeBoCAG3w_wcB

Block 3: Software



Block 4: Emergency Shut off Valve

110V AC Solenoid Valve:

U.S. Solid Solenoid valve-

- Stops/prevents waterflow
- 18W power rating
- Temperature Range: -10°C - 120°C (14° F - 248°F)
- 1.6 lbs
- Cost $26.99
- 110 volts AC; voltage range + or - 10%
- Lifespan: ~200,000 switches

Block 5: Android App

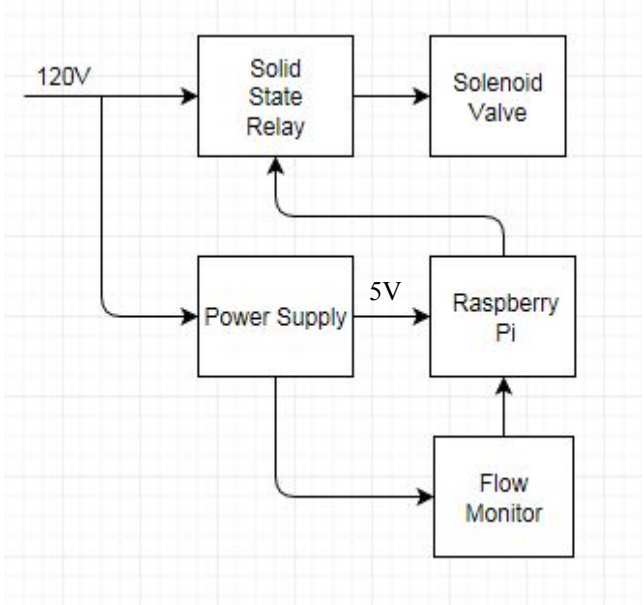
- Display water usage data to users with parameters including flow rates, usage rates, et al
- Receive notifications from Raspberry Pi
- Allow user to switch between Vacation and At-Home modes
- Allow user to override the shut-off valve

Power

Requirements:

- Input=120V AC
- ~ 12.5W for cpu
- ~ 18W for motor
- ~ <15W for flow monitor

- Overall goal <50W power consumption



*If power fails Emergency shutoff fails in the closed position and will have to be manually opened

Subsystem Alternatives

Flow Monitor Alternative:
UltraSonic Sensor

Advantages:

- Easier fabrication
- Easier installation (clamp on)

Disadvantages

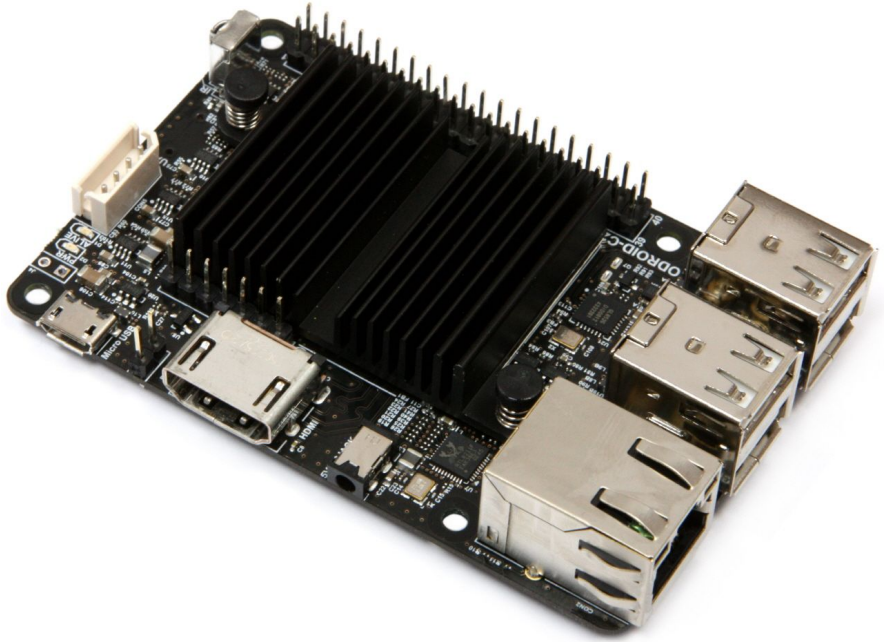
- Subject to interference from pipe wall or air between sensor and pipe
- Built in acoustic discontinuities in pipe
- Requires liquid contaminants: 100 parts per million of 100 micron or larger suspended particles, or bubbles

Subsystem Alternatives

Single Board Computer Alternative:

ODROID-C2:

- Cost- $59.99
- 1.5Ghz quad core CPUs
- 2Gbyte DDR3 SDRAM
- Memory-MicroSD Card/Flash Drive
- Power- 2.5A@5V= 12.5W
- I/O- 40pin GPIOs + 7pin I2S
- Wifi / Bluetooth built it



Subsystem Alternatives

Emergency shutoff Alternative:

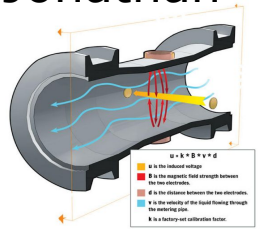
Duda Diesel Solenoid valve

- 12V DC
- Stops or opens waterflow in one direction
- Max power consumption =30W
- lifespan= ~200,000 switches
- Temperature Range: -5°C - 80°C (29°F - 176°F)
- 2.08 lbs
- Dimensions: L=99mm H=135 mm
- Cost $69.64

MDR Deliverables

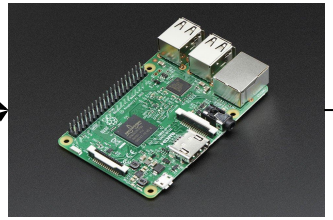
Goal: Have the vacation mode functionality implemented

Jonathan



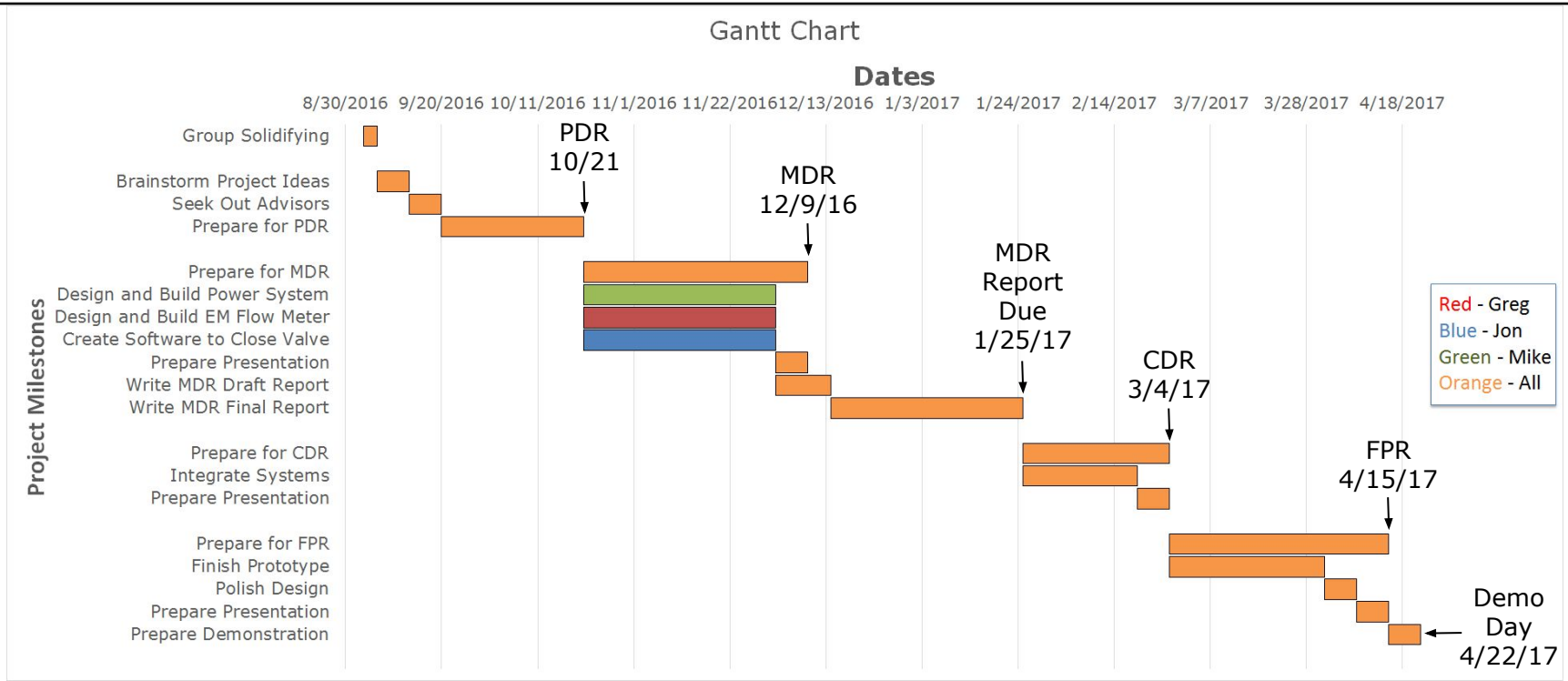
Mike

Greg



Mike

Gantt Chart


Gantt Chart
Dates
8/30/2016 9/20/2016 10/11/2016 11/1/2016 11/22/2016 12/13/2016 1/3/2017 1/24/2017 2/14/2017 3/7/2017 3/28/2017 4/18/2017
Project Milestones
Group Solidifying
Brainstorm Project Ideas
Seek Out Advisors
Prepare for PDR
Prepare for MDR
Design and Build Power System
Design and Build EM Flow Meter
Create Software to Close Valve
Prepare Presentation
Write MDR Draft Report
Write MDR Final Report
Prepare for CDR
Integrate Systems
Prepare Presentation
Prepare for FPR
Finish Prototype
Polish Design
Prepare Presentation
Prepare Demonstration
PDR 10/21
MDR 12/9/16
MDR Report Due 1/25/17
CDR 3/4/17
FPR 4/15/17
Demo Day 4/22/17
Red - Greg
Blue - Jon
Green - Mike
Orange - All

Thank You

Questions