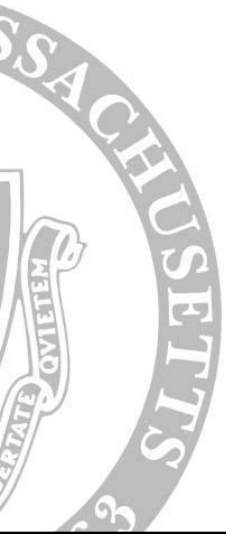


Senior Design Project: WaterMainia

December 5th, 2016



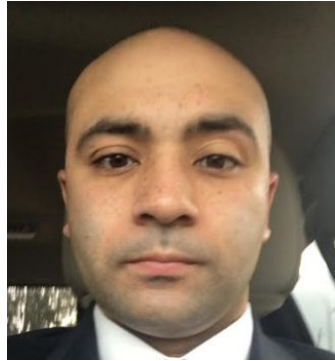
WaterMainia

Greg
Boudreau



Team
Manager

Michael
Moran



Jon
McAvoy



Professor
Hollot



Advisor

What is the Problem?

Water Conservation

**Water is
wealth**
It's time to save!



Water Pipe Damage



Our Solution - WaterMainia

Sense



Detect



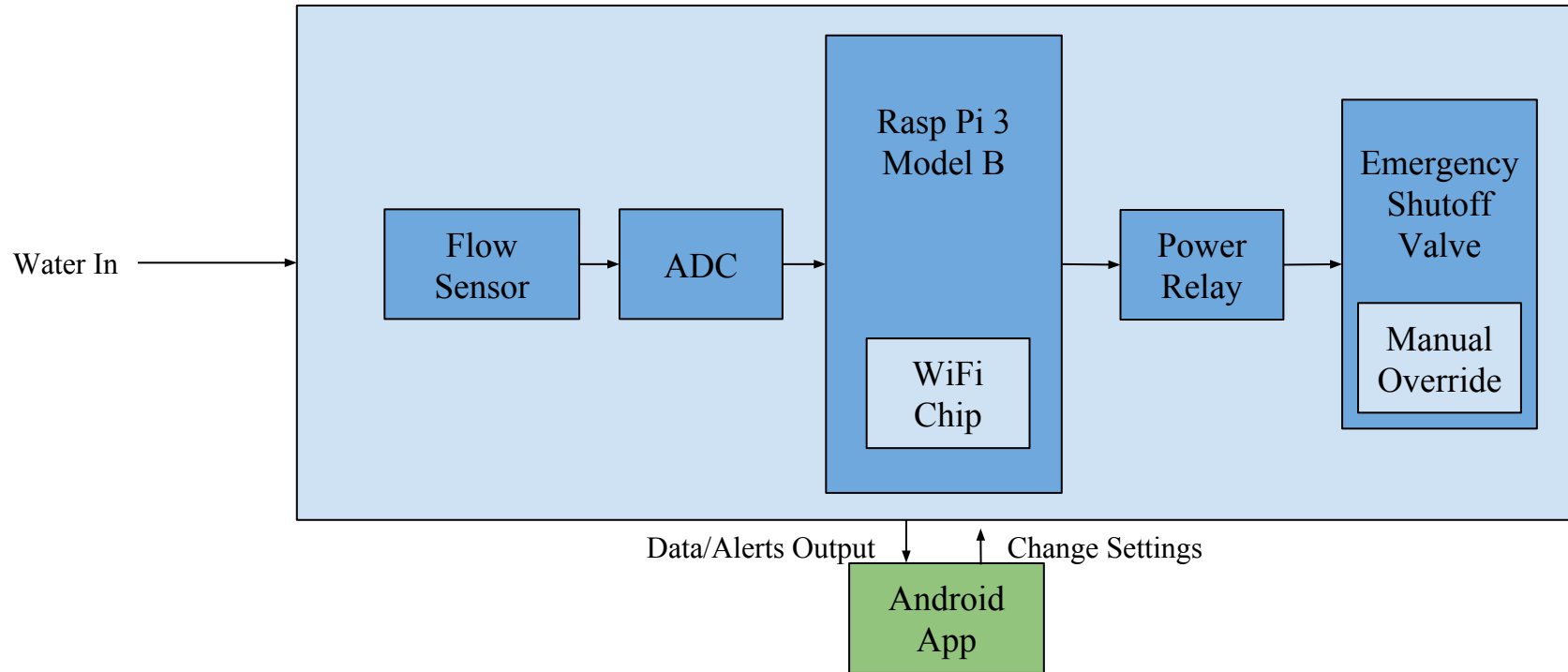
Alert



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

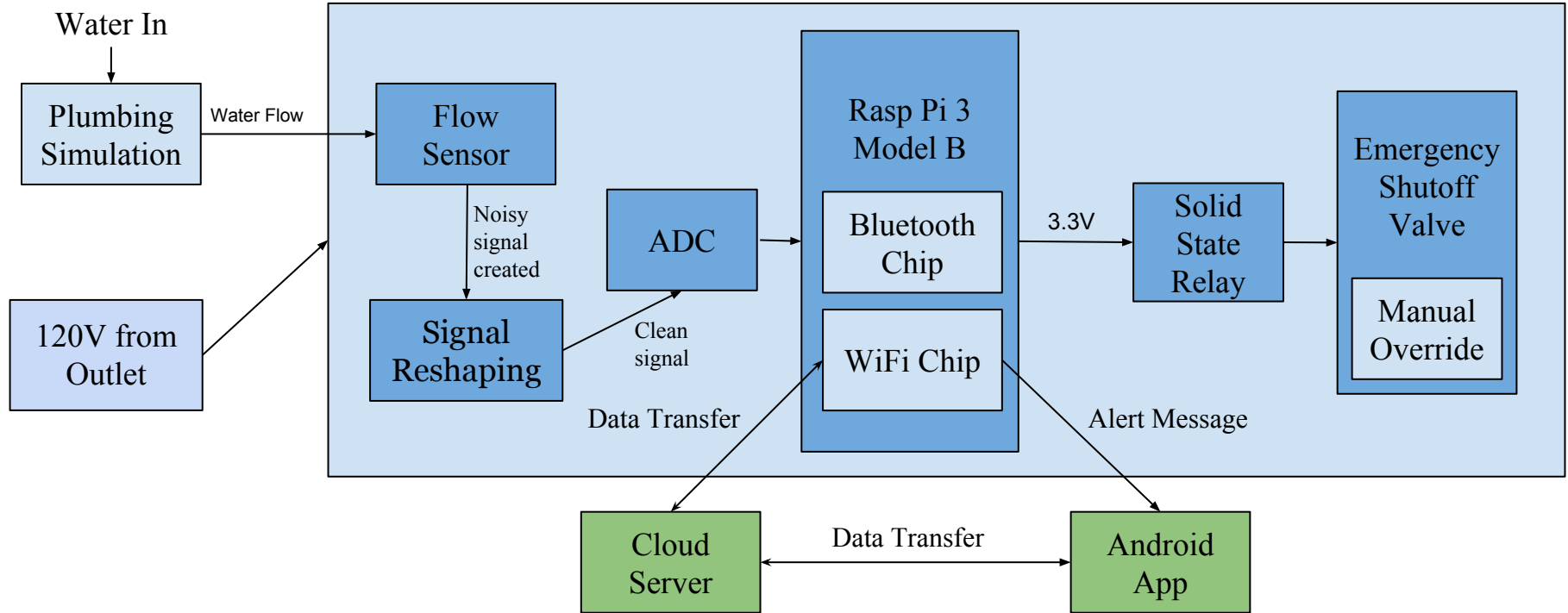
PDR Block Diagram



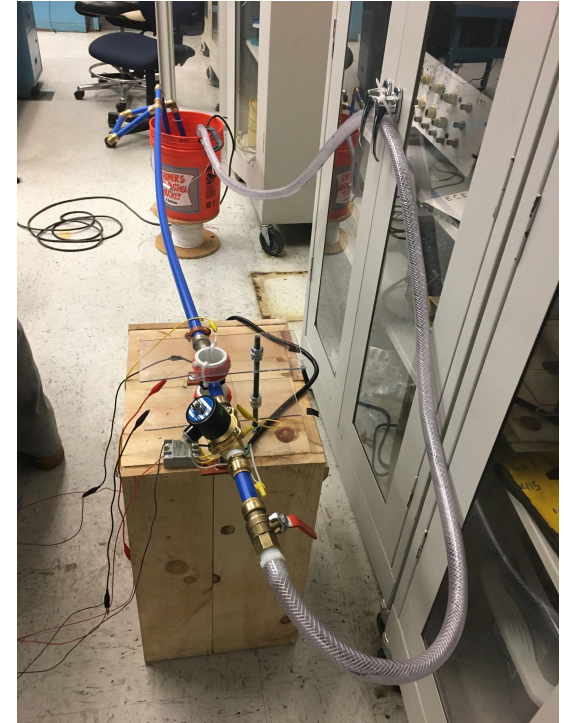
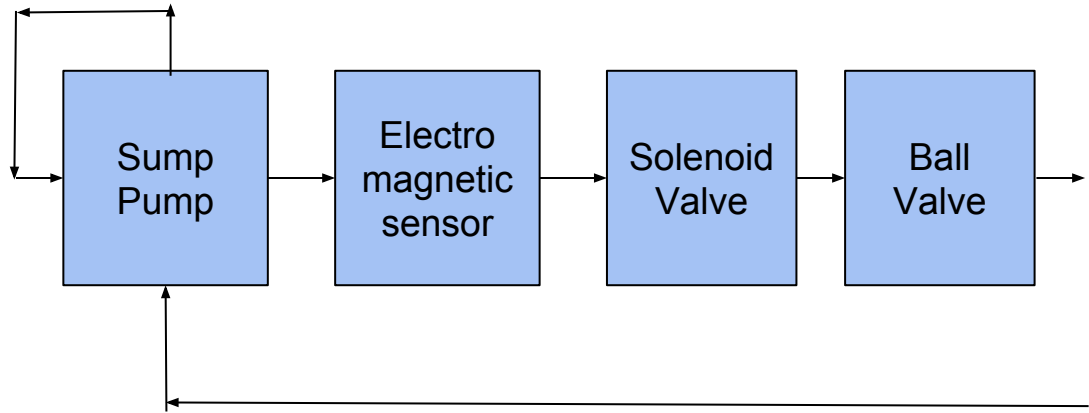
MDR Deliverables

- Goal: Have the vacation mode functionality implemented
 - Investigate and if possible implement the electromagnetic flow meter
 - Investigate and if possible implement the ultrasonic flow meter
 - Implement emergency shutoff system
 - Have emergency shutoff alert user via an app

Block Diagram



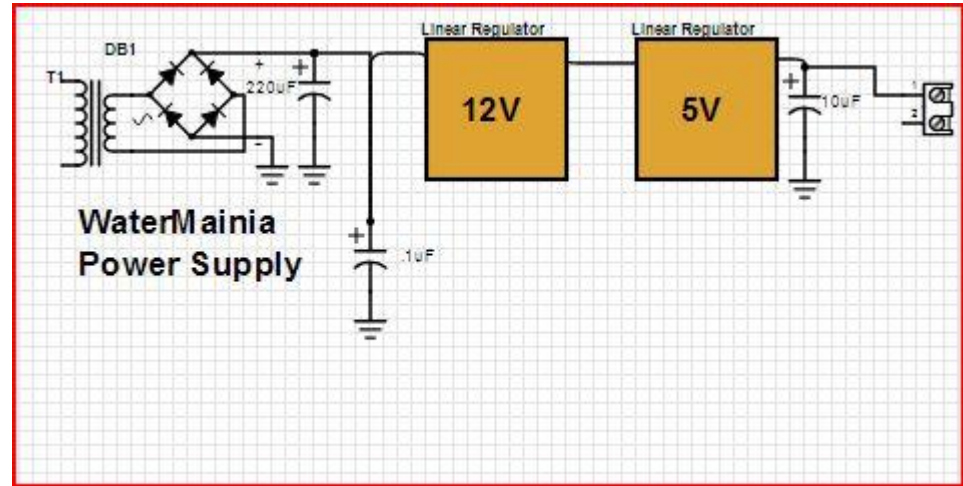
WaterFlow Detection



Power

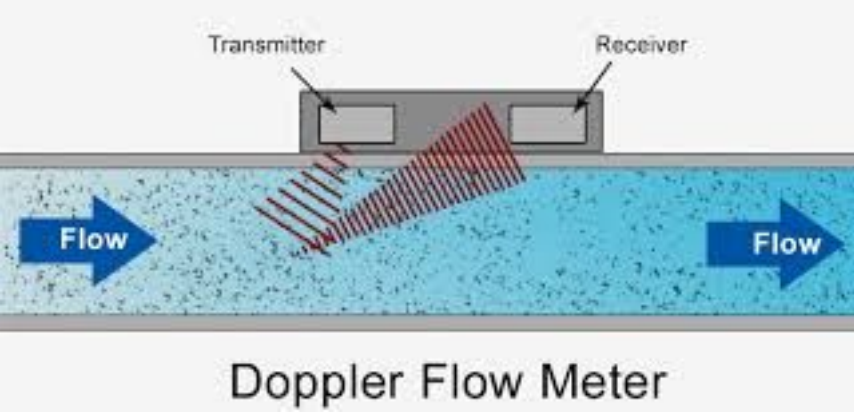
Requirements:

- Input=120V AC
- ~ 12.5W for cpu
- ~ 18W for motor
- ~ <15W for flow monitor
(.6W for the coils)
- Overall goal <50W power consumption



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

Ultrasonic Sensor





Doppler Ultrasonic Flow meters - FD613
\$1,715.00 from OMEGA Engineering ★★★★★ 1,224 seller reviews
 Portable Doppler Ultrasonic Flow meters - The FD613 Series ultrasonic flow meter features advanced Trans-Phase measuring technology, providing ...



Ultrasonic Doppler Flowmeter - FD-423
\$2,565.00 from OMEGA Engineering ★★★★★ 1,224 seller reviews
 Ultrasonic Doppler Flowmeter - The FD-400 Series ultrasonic doppler flowmeters measure the flow of liquids that contain sound reflectors ...

Complicated build	+	Not as accurate	+	Costly \$\$	=	Not worth implementation
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Electromagnetic Coil Design

Faraday's Law

$$u = Bvd$$

Magnetic Field Strength

$$B = NI$$

Time Varying Voltage Equation

$$V(t) = I(t)((\omega L)^2 + R^2)^{1/2}$$

Coil Self-Inductance

$$L = 2\pi^2 k N^2 r^2 / l$$

B = Mag Field Strength

v = velocity of liquid

d = diameter of pipe

N = turns

ω = angular frequency

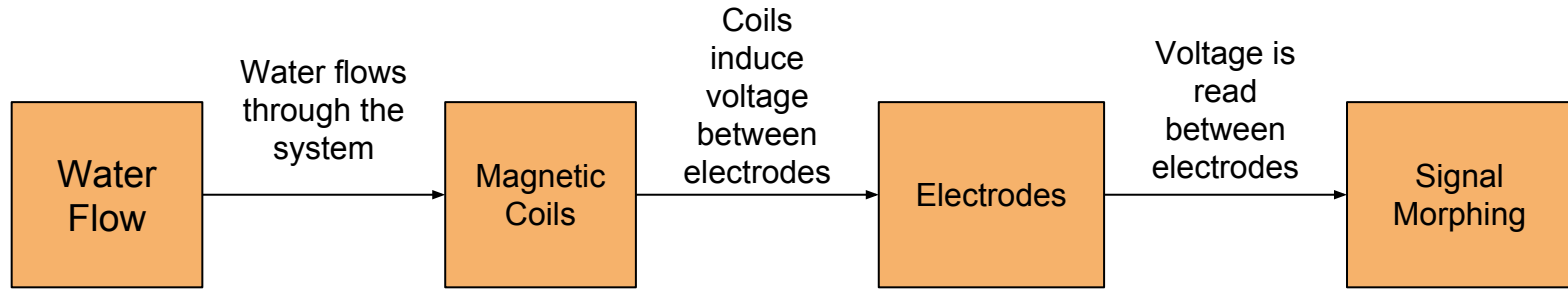
L = Inductance

r = radius

k = coeff of air

l = length

Electromagnetic Sensor



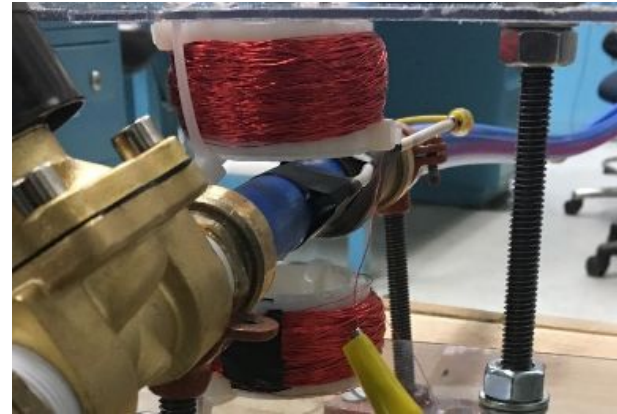
Electromagnetic Flow Meter | Magmeter PVDF

\$765.00 from OMEGA Engineering ★★★★★ 1,224 seller rev
ELECTROMAGNETIC FLOWMETER With PVDF and 316L Construc
...



Flanged Magmeter - FMG-2108

\$4,305.00 from OMEGA Engineering ★★★★★ 1,224 seller r
Flanged Magmeter - The FMG-2000 Series is the most economic



Amplification and Filtering Stage

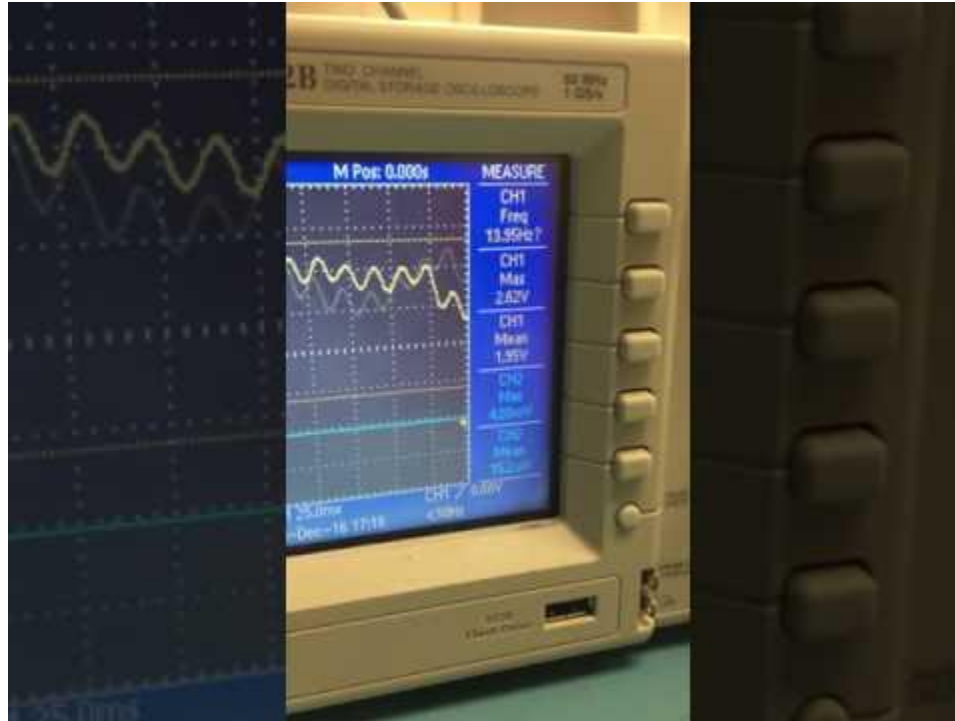
Amplification

- Two Stage Amplification
- 2 RC4558P IC
- Input Impedance: 5M
- CMRR: 90db
- Instrumentation Amplifier
 - 20db Gain (10x)
- Non-Inverting Op-Amp
 - 40 db Gain (100x)

Filtering

- 4 Stage Butterworth Filter
- -10db Drop at 100Hz
 - 4 RC4558P IC
- Further Low Pass Filtering Anything Over 10Hz
 - RC Filters

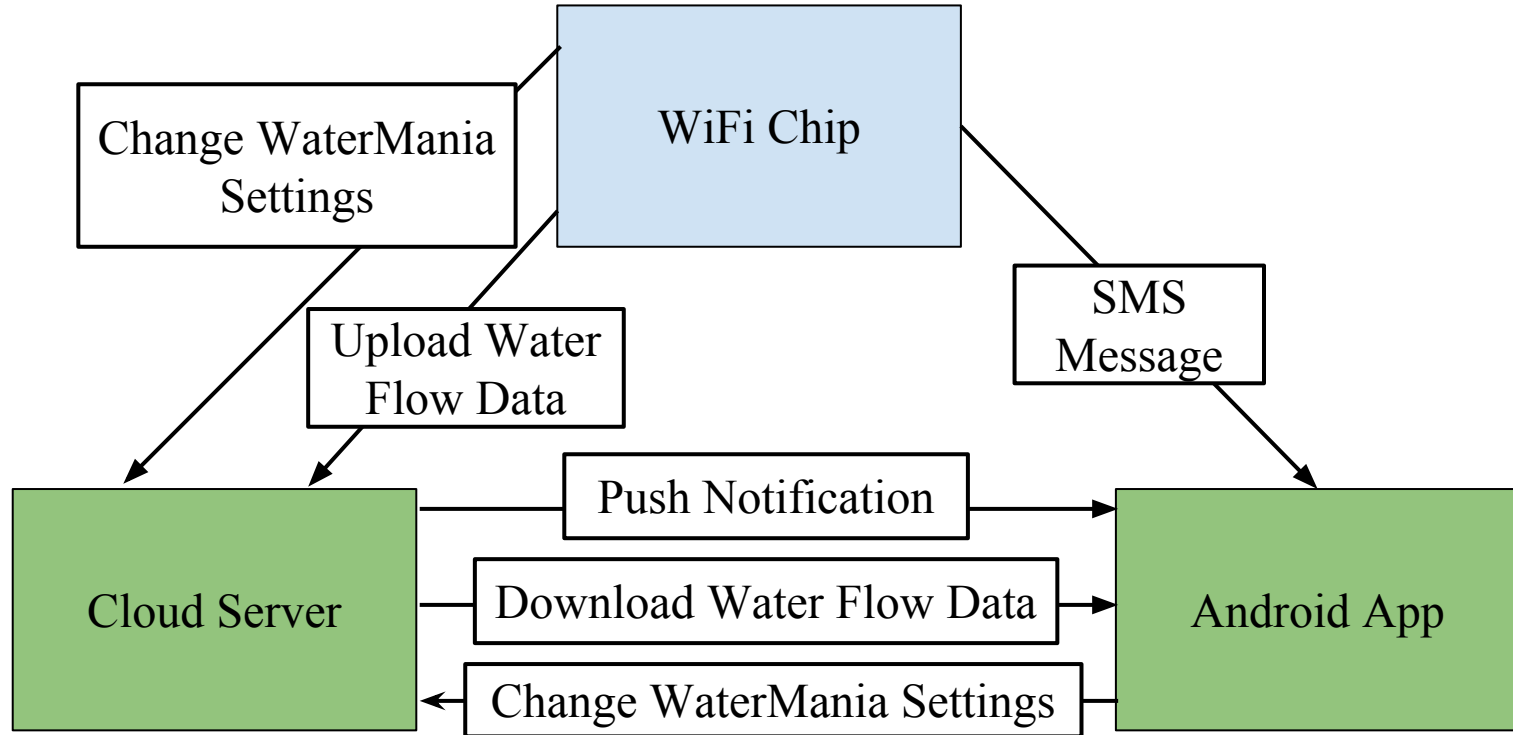
Voltage Difference While Opening/Closing Valve



Software



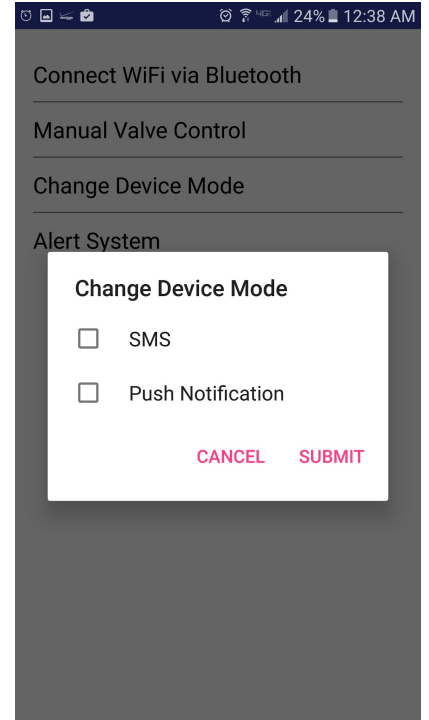
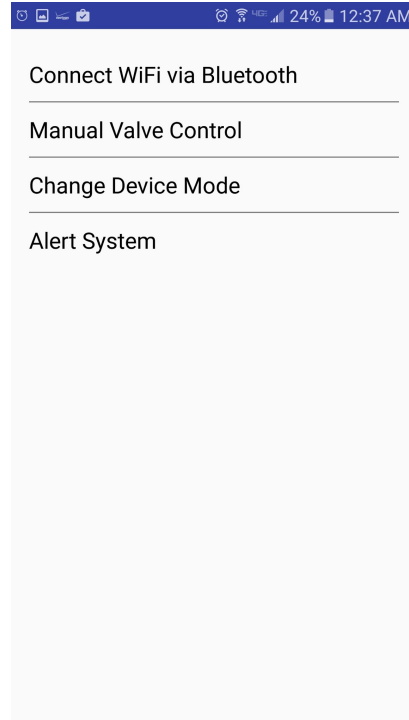
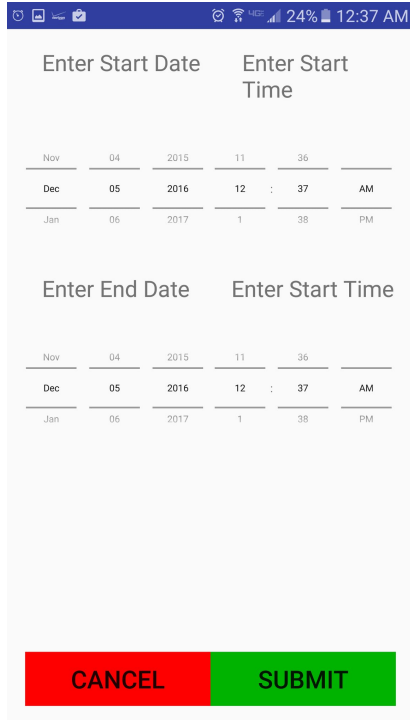
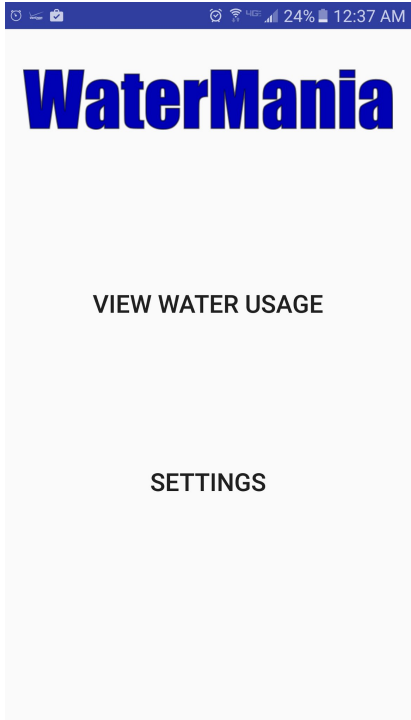
Data Transfer



Alert and Solenoid Demonstration



Android App



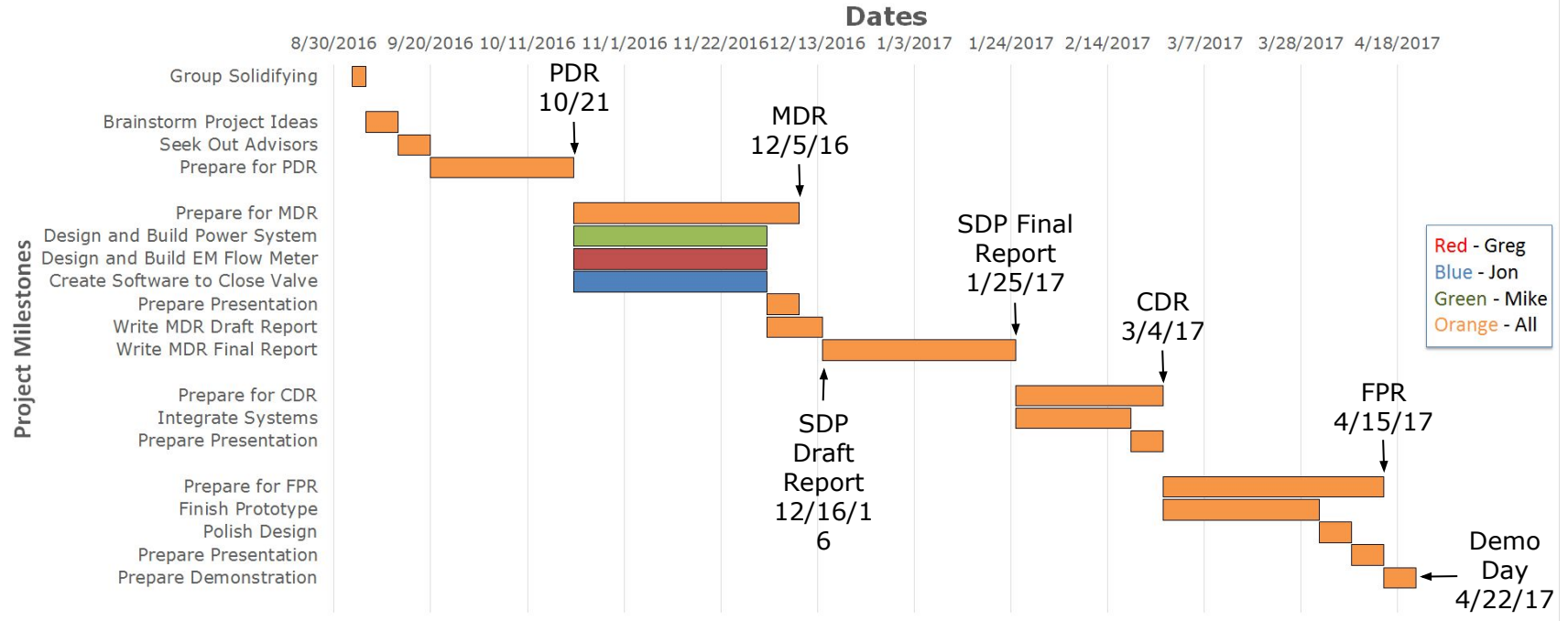
Budget

- Solid State Relay - \$11.28
- MCP3008 ADC - \$19.86
- Raspberry Pi 3 SBC - \$41.99
- GPIO Expansion board - \$9.90
- 110V AC Solenoid Valve - \$26.99
- 24 AWG Magnetic Wire - \$16.40
- Power Cord - \$15.64
- Bridge Rectifier - \$6.75
- 5V Voltage regulators \$6.45
- 12V regulators \$5.61
- Transformer \$16.56

Total: 177.43

Gantt Chart

Gantt Chart

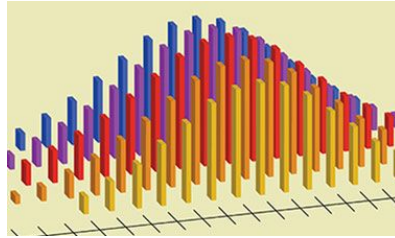


CDR Deliverables

Fully Parametrized
Flow Data



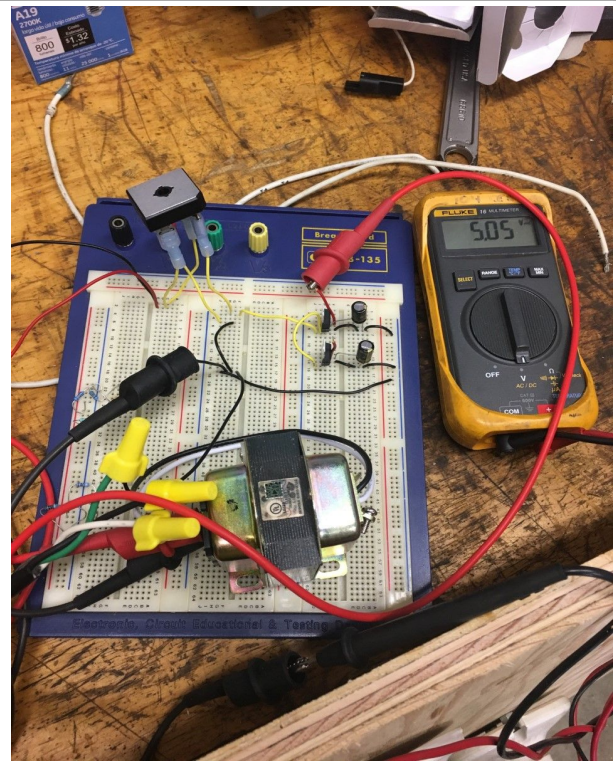
Data Analysis



Integrated and Compacted Design



Bloopers



Thank You

Questions