# Midway Design Review (MDR)

# Neptune

Team 16
December 2, 2015

# Team 16 Introduction

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Faculty Advisor

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EE ’16

**Hang Do**
EE ’16

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EE ’16

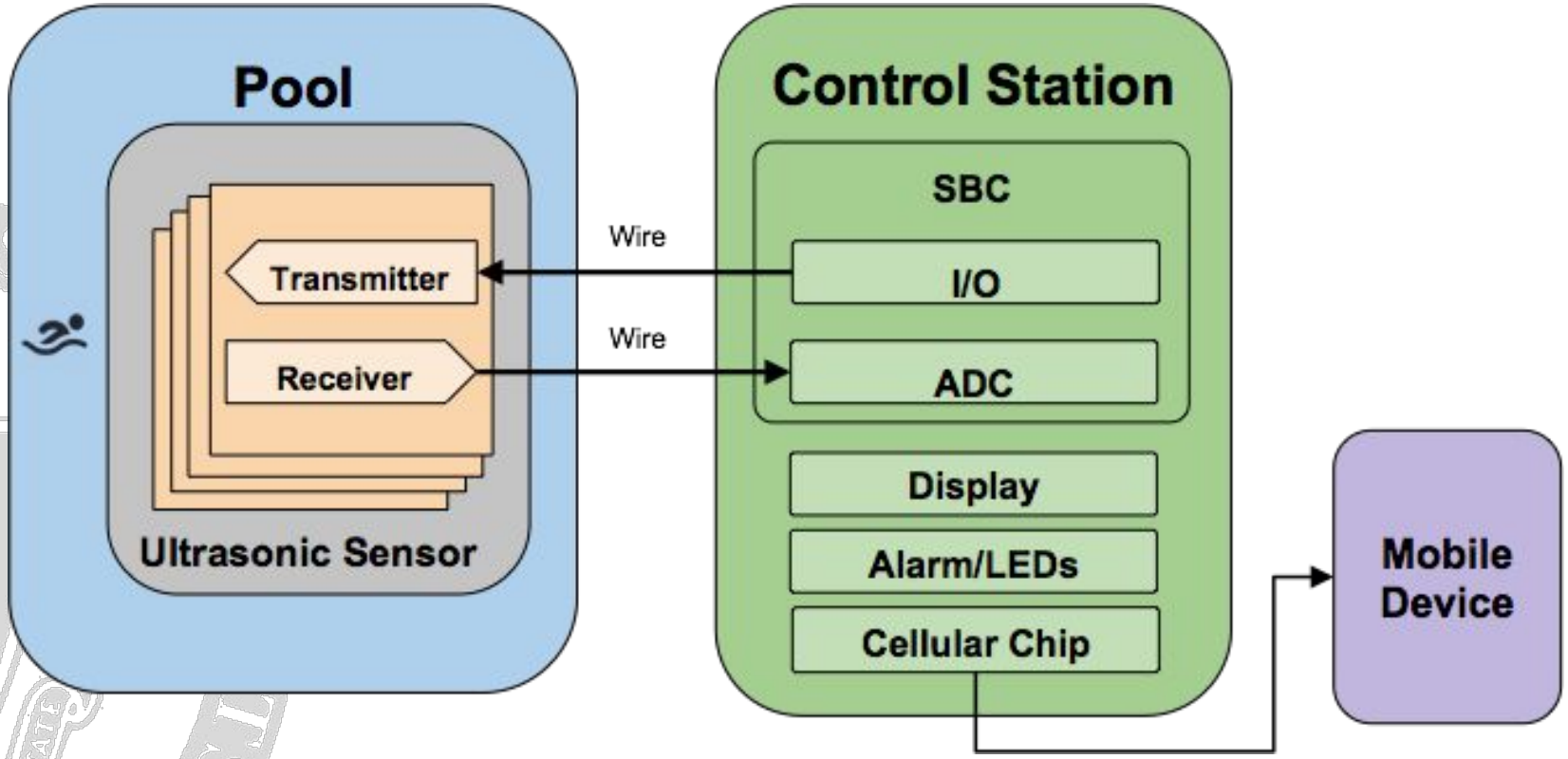
# Problem

Scott

- Unauthorized entry (i.e, "Pool-Hopping") into residential pools
- Can result in:
  - Drowning deaths
  - Safety issues and property damage
  - Liability concerns regarding injuries to children
- Attractive Nuisance Doctrine- landowner may be held liable for injuries to children trespassing on land if they are hurt on an object which is likely to attract children

# Neptune - Previous Block Diagram

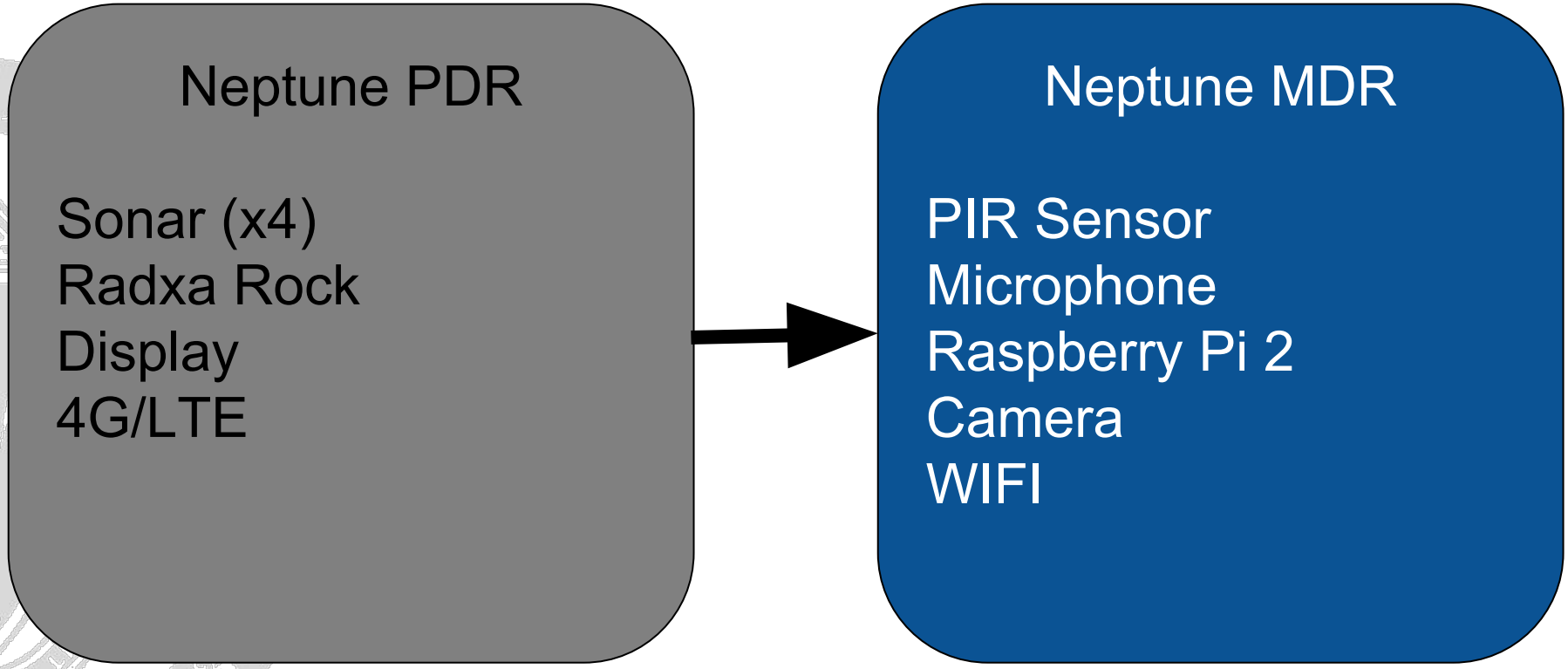
Frankie



# What Has Changed?

Frankie

**Newly Defined Application:** Focus on detecting and reporting unmonitored entry into swimming pools



# Our Solution

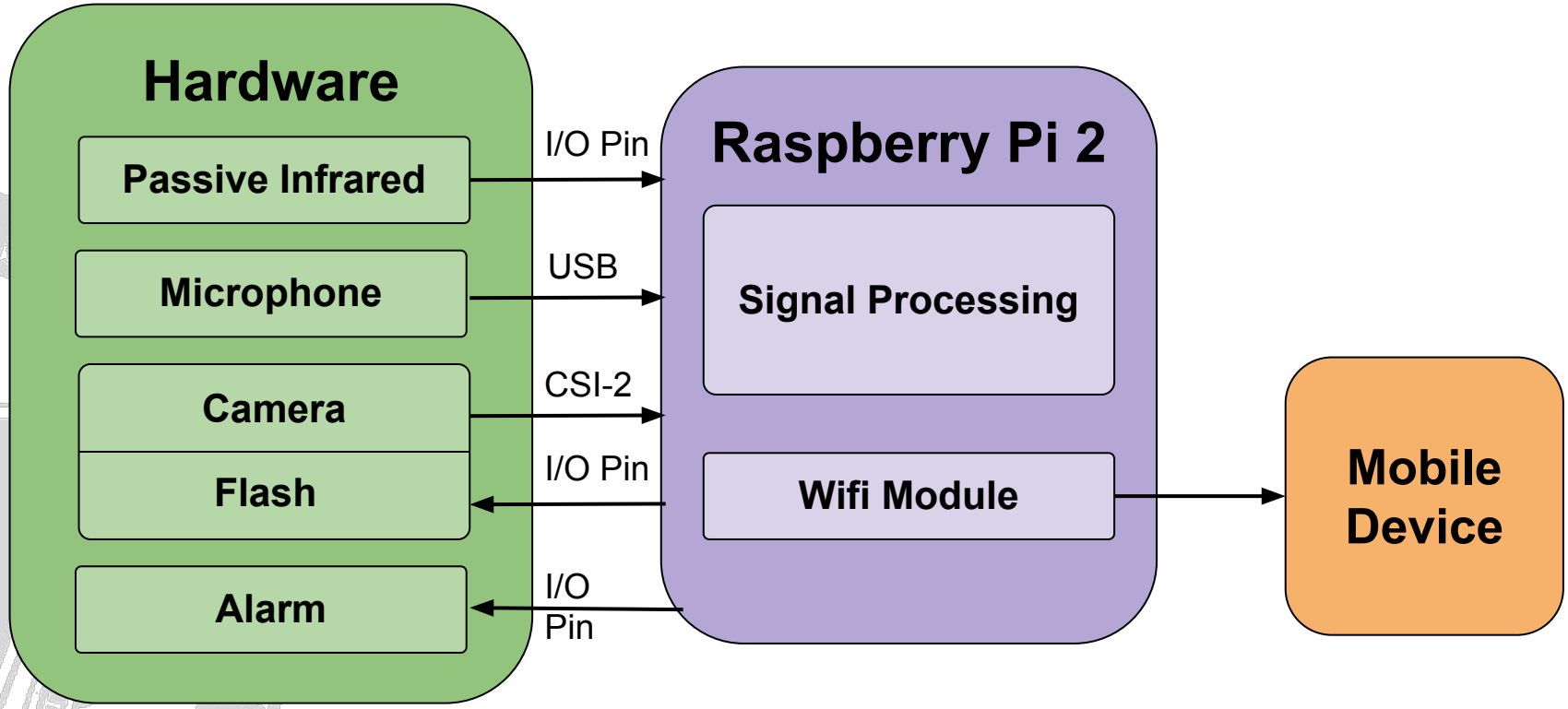
Greg

## Neptune

- Drowning Prevention and Pool Security System
- Uses a PIR sensor to detect movement in combination with audio analysis to detect splashes
- Alerts those nearby with audible alarm located poolside
- Contacts the person in charge by messaging MMS picture

# Neptune - Revised Block Diagram

Greg



# System Requirements

Frankie

- Easy to install
  - Must be accessible for a majority of pool owners
- Small footprint and weatherproof for outdoor use
- Able to detect unexpected entry into a typical pool 24/7
- Needs to send an MMS text message with recognizable photo attachment to registered phones within 10 seconds
- Have the ability to turn off the system for a limited time while using the pool
- Must minimize the likelihood of false alarms

Subsystem #1:

# PIR Sensor

# Passive Infrared (PIR) Sensor

Hang

- Detects movement of people and animals
- Provides the earliest detection upon entering the pool area
- Reduces the false positives between humans and objects

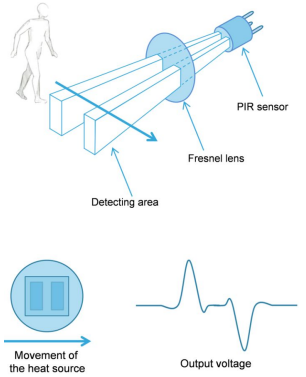
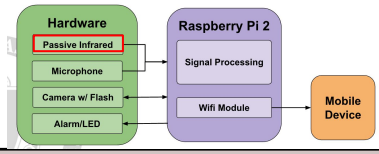



**Figure 1: Principle of PIR Sensor[1]**

**Figure 2: PIR used for Neptune**

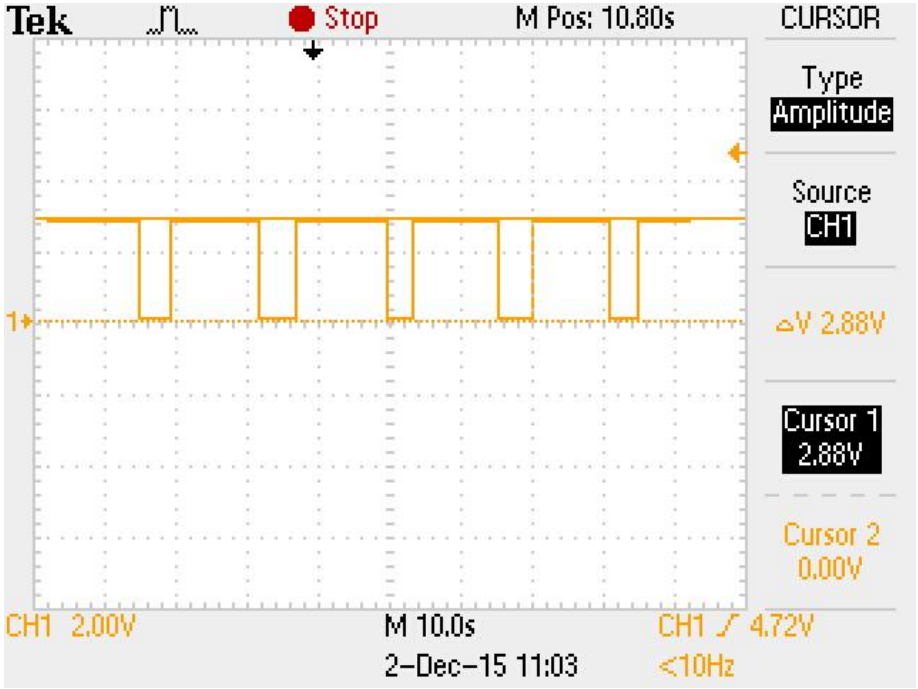



[1]Colliard-Piraud, Sylvain. "Signal conditioning for pyroelectric passive infrared (PIR) sensors". 2013. STMicroelectronics. http://www.st.com/web/en/resource/technical/document/application_note/DM00096551.pdf. Web. 2 Dec. 2015.

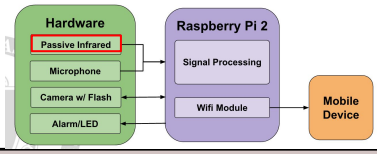
# PIR Specifications

Hang

- Price: $9.95
- Range: 6.92 meters
- Power supply: 0.5 mW
- Reset time: ~ 5s
- Output:
  - Motion detected:
    - LED:ON
    - Digital pulse: 2.88V
  - No motion detected:
    - LED:OFF
    - Digital pulse:0V

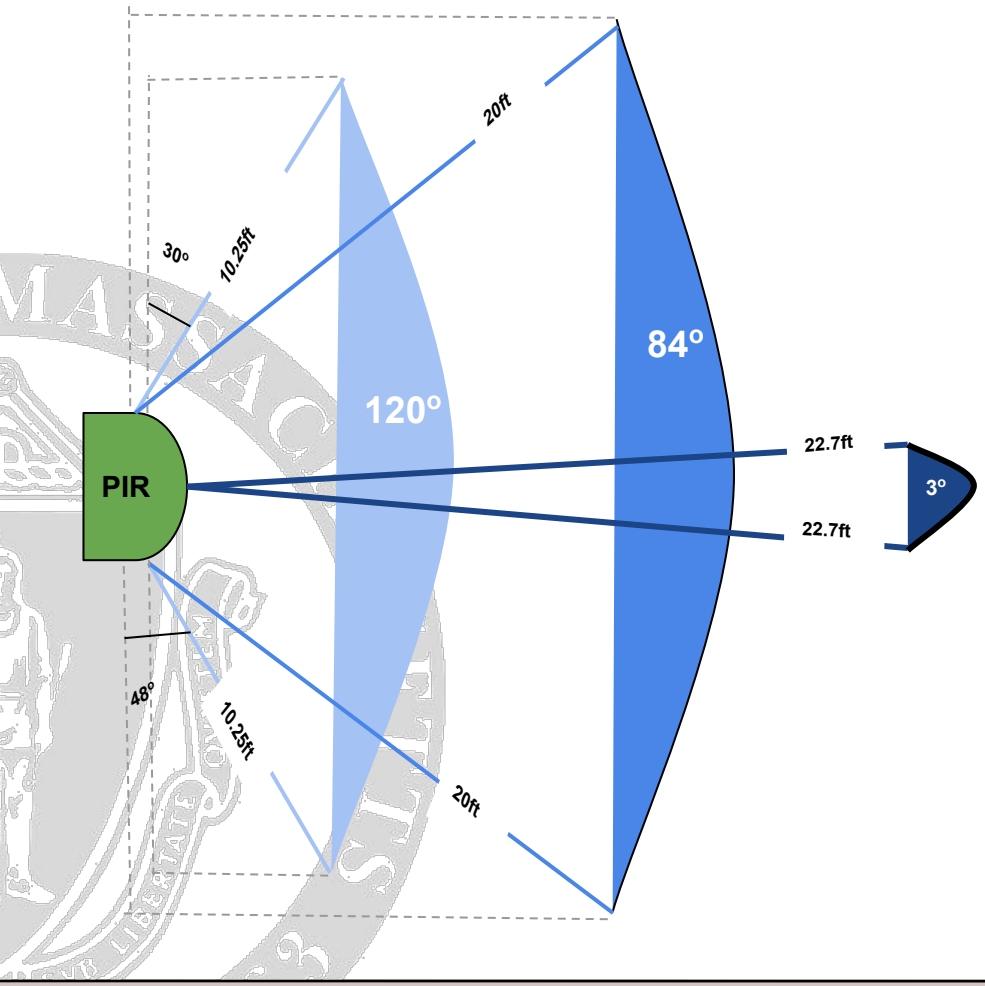



**Output of PIR displayed on Oscilloscope**

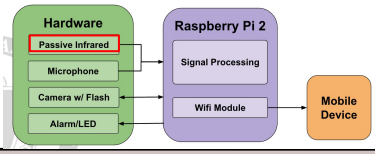


# PIR Sensitivity

Scott




- This is a diagram showing the results of an experiment testing the effective range of the PIR sensor
- The experiment proved that the PIR has a 120° field of view.
- However, the range on the outskirts of the field is only about 10 ft
- As we moved nearer to a straight line in front of the sensor, an 84° vision cone with a range of around 20 ft was measured
- Maximum range of PIR proved to be 22.7 ft (6.9 m) but only for a very narrow portion of the field of view (3°)
- In conclusion, PIR will detect any object within 20 ft for an 84°scope (70% of field) and any object within 10 ft for the entire 120° field of view

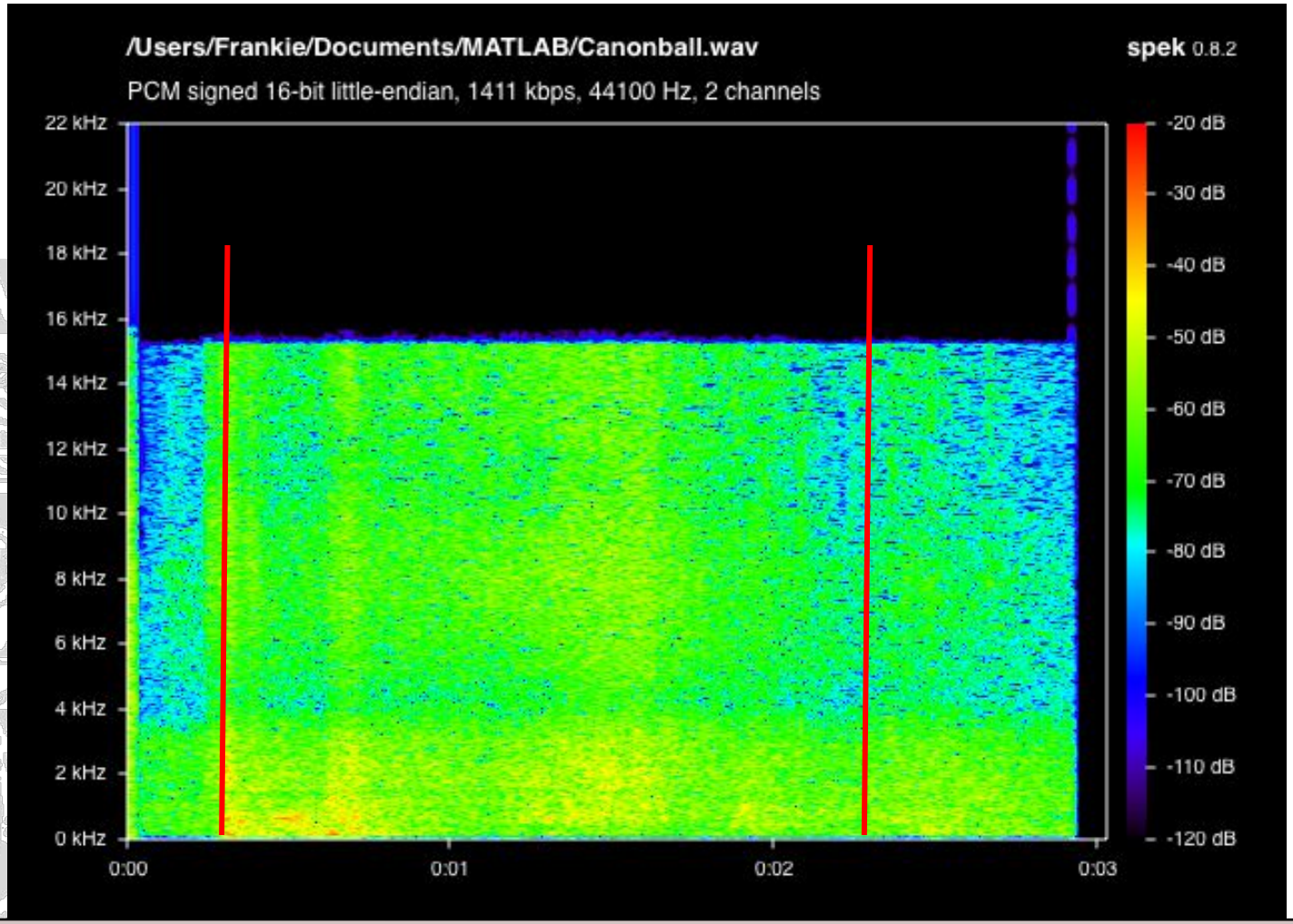


Subsystem #2:

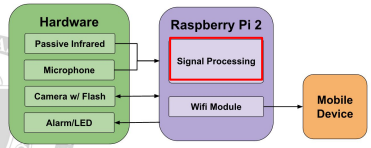
# Audio Analysis

# Audio Example - Cannonball

Frankie

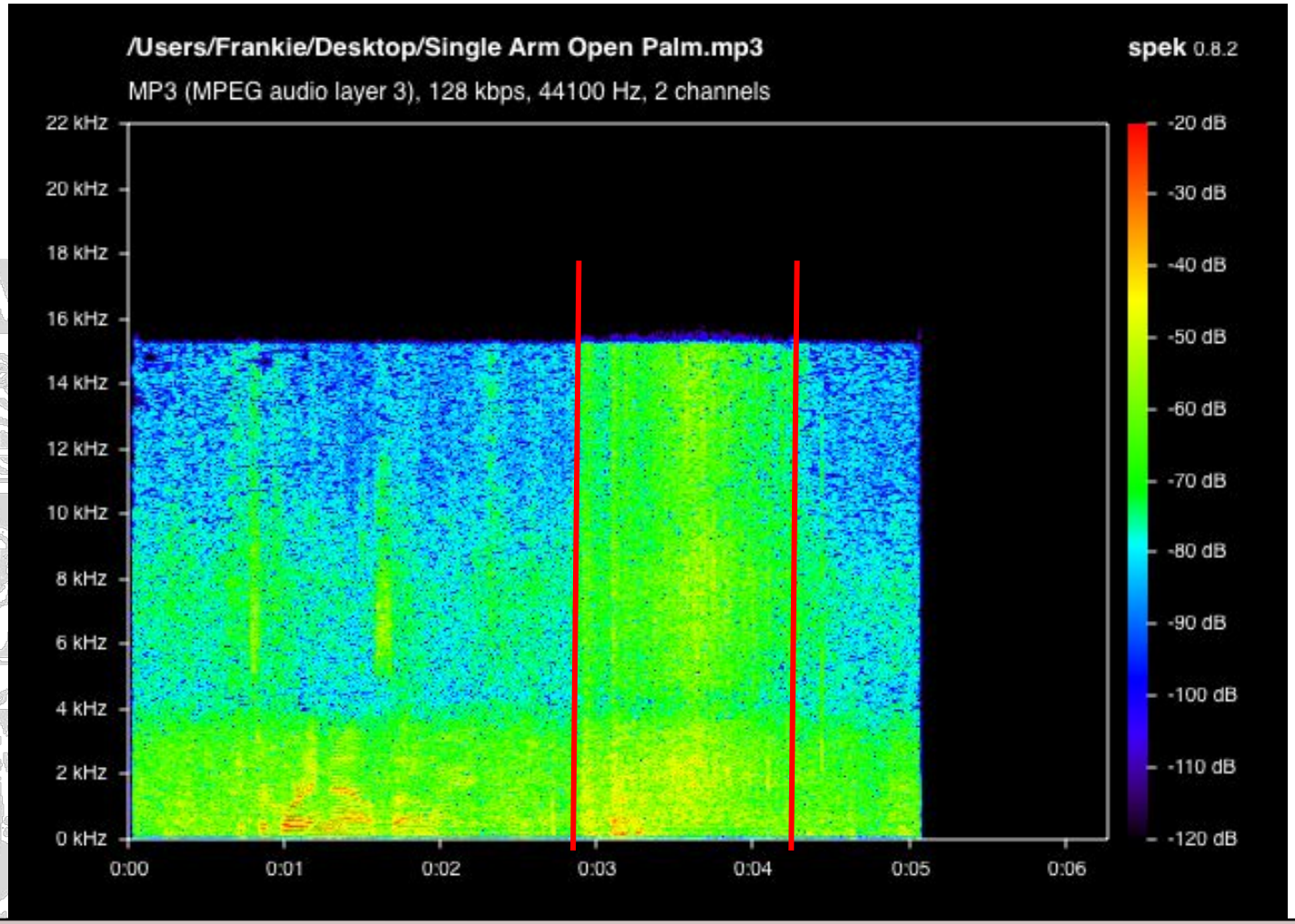



The spectrogram on the left represents the below audio sample, which is a Cannonball type splash in a pool.

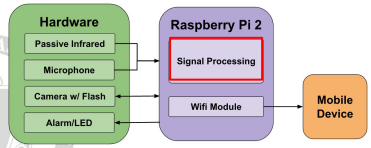


# Audio Example - Speech & Splash

Frankie




This spectrogram shows the distinction between spoken words and the higher frequency sound of a typical splash



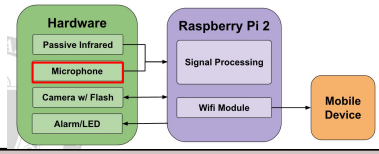
# Microphone Selection

Frankie

## CAD U1 Dynamic Recording Microphone

- USB to interface with Raspberry Pi 2
- Inexpensive, costs just $20
- Cardioid pickup pattern

Based on the audio analysis of different splashes, most microphones would work for our system.



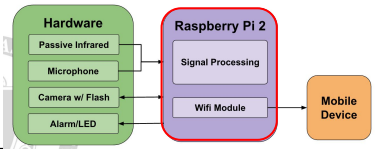
Subsystem #3:

# Raspberry Pi & Cell Phone Communication

# Raspberry Pi 2

Greg

- Specifications:
  - Power consumption: 9 Watts
  - 40 Pin GPIO (17 I/O ports)
  - Quad-core 900 MHz ARM Cortex A7 CPU
  -
- Software:
  - MatLab for audio processing
  - MMS messaging using Gmail and Wifi connection

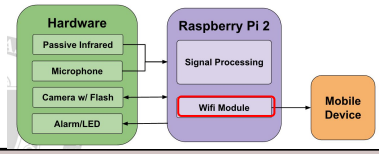


# Wifi

Scott

- Raspberry Pi will utilize a USB WiFi Adapter in order to access local networks (150 Mbps)
- Since we are using GMail to send MMS messages, internet access is essential

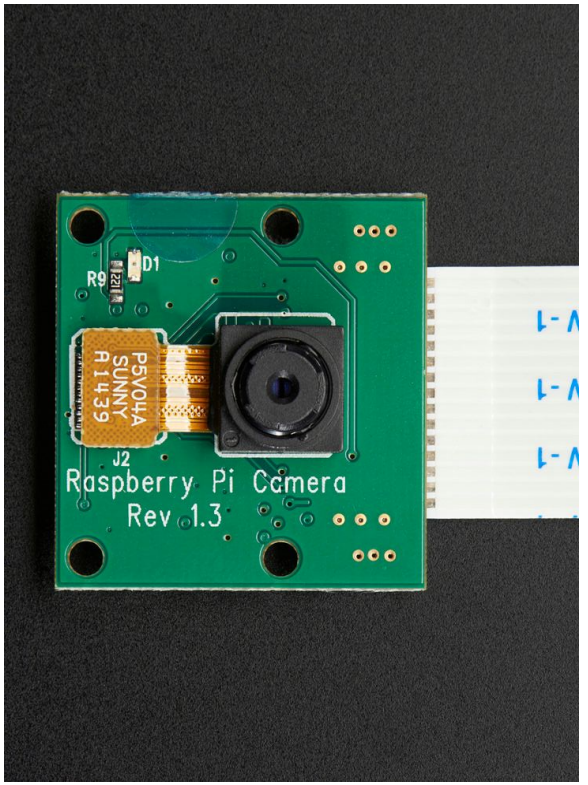

- We decided to use Wifi as opposed to 4G/LTE because of cost considerations and complexities involved with using cellular chip

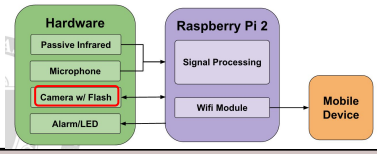


# Camera with Flash

Scott

- Raspberry Pi Camera to take pictures of pool environment
- RPi Camera provides seamless integration with the Pi itself
- In order to take pictures at night, a LED will be utilized to provide a flash



# GUI

Greg

NEPTUNE

Phone Number

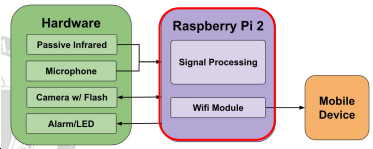
xxx-xxx-xxxx

Provider

Verizon

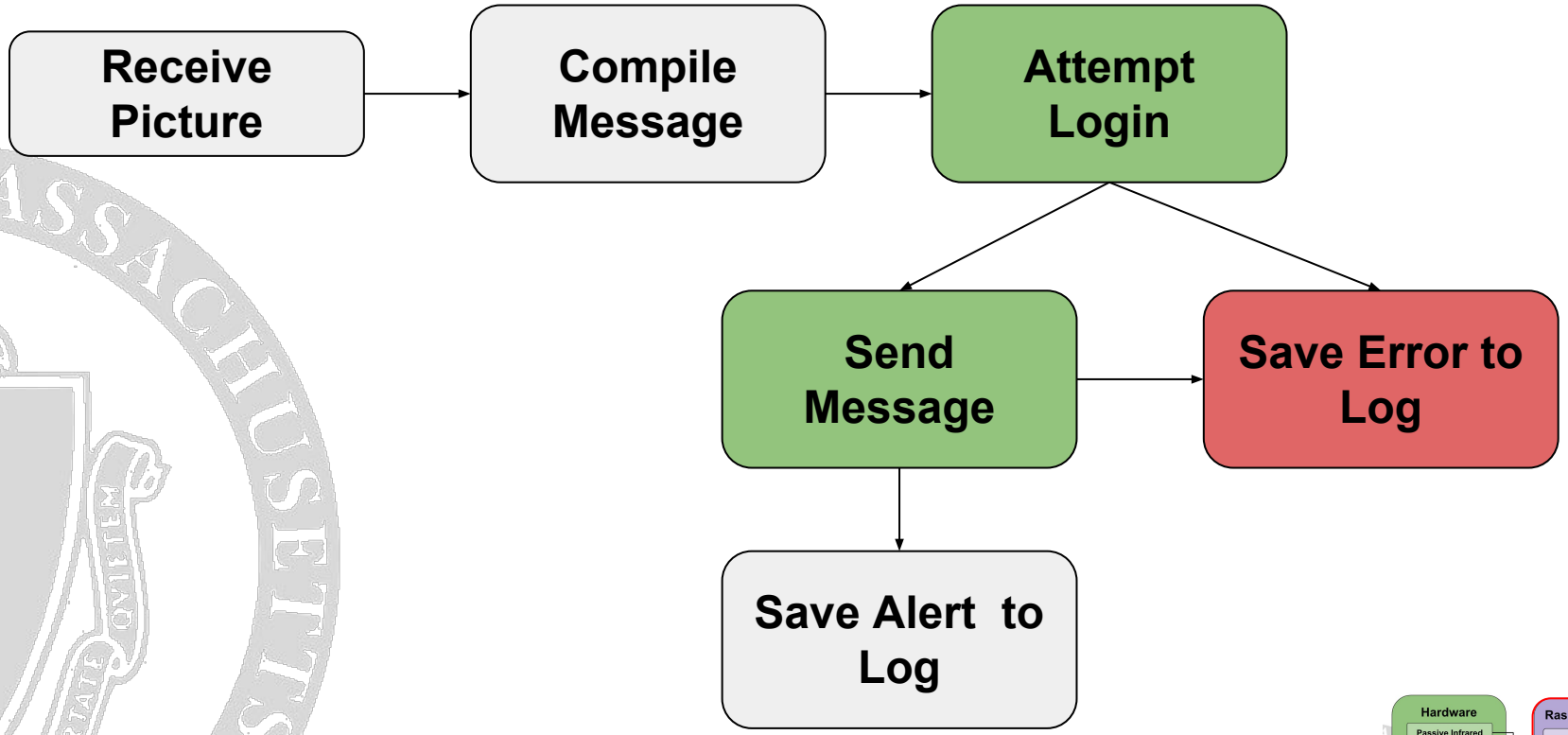
Update

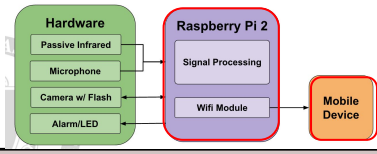
Log



# Cell Phone Communication

Greg



# DEMO Message System

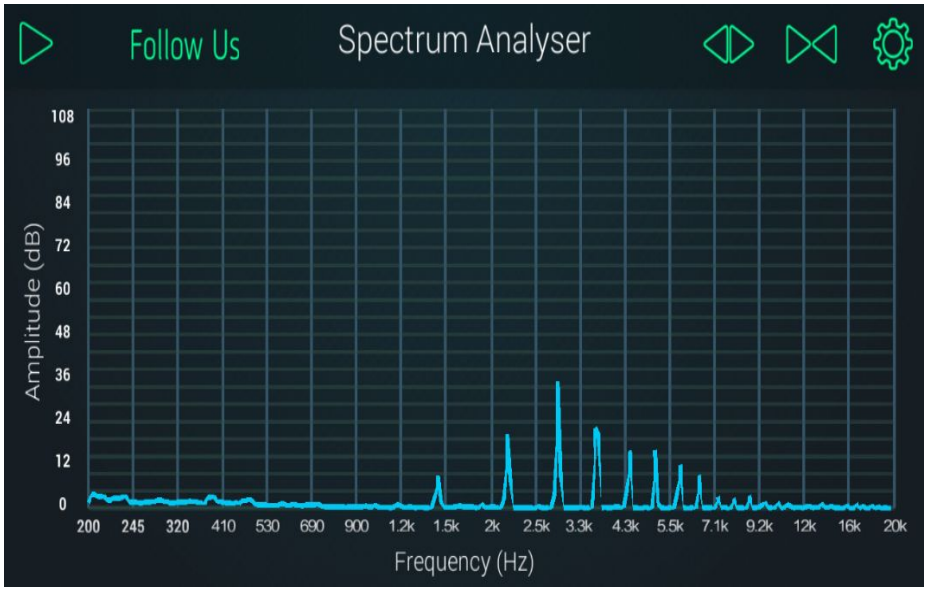
Subsystem #4:

# Alarm System

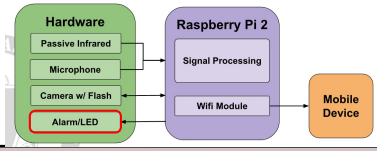
# Poolside Alarm

Hang

- Once the motion and splash are detected, the control station will trigger the switch to activate the alarm system.
- Power supply: 12V
- Alarm:
  - Uses 90 Ω speaker
  - Ranges from 8-32 dB sound
- LED:
  - Uses diffused white 10mm LED



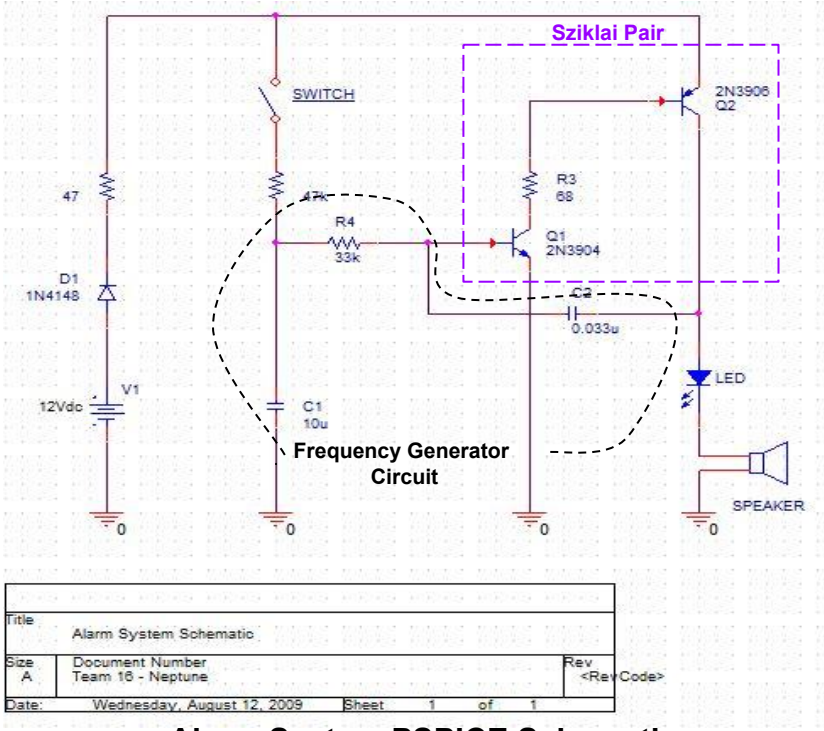

**Alarm System Frequency vs. Amplitude Plot**



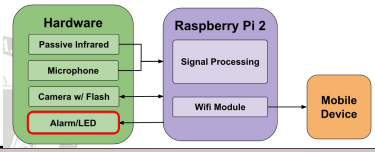
# Poolside Alarm System Design

Hang

- The combination of C1, R4, and C2 in series results in frequency generator circuit
  - C1: controls response time of the switch
  - C2: controls sound wave of the speaker
- Sziklai Pair (Complementary Feedback Pair) along with C2 is designed to drive the LED and Speaker




Alarm System PSPICE Schematic



# DEMO Alarm/ PIR

# Expected Expenses

Hang

- Total expense is $115.2

| Items | Quantity | Total Cost |
|---|---|---|
| Raspberry Pi 2 | 1 | $35 |
| PIR Sensors | 2 | $20 |
| Microphone | 1 | $20 |
| Wifi Adapter | 1 | $7 |
| Raspberry Pi Camera | 1 | $30 |
| 90Ω Speaker | 1 | $1.25 |
| Diffused 10mm LED | 1 | $1.95 |
| | | |

# Wrap up

Scott

- System will be powered by 120 VAC (wall)
- Using signals received from PIR sensors and microphone, extensive signal processing will be performed on Raspberry Pi. The goal is to derive a sort of "risk threshold" which will be used to determine if the the alert notifications (text and alarm) will be initiated
- Swimming Pools are considered an "attractive nuisance". It is worth it to take all necessary precautions to prevent injury and death

# Deliverables for CDR


Frankie:

- Receive input from microphone and integrate with Raspberry Pi 2
- Analyze input and determine if a splash occurred
- Determine appropriate “risk threshold”

Scott:

- Integrate PIR sensor with Raspberry Pi 2
- Take photo with flash when “risk threshold” is exceeded

Greg:

- Send captured photo over MMS
- Create user interface for initial setup of Neptune system

Hang:

- Increase decibel level of Alarm and integrate with system
- Design a circuit to provide power for the Neptune system

# Responsibilities and Calendar for 2016

Frankie

Thank You! Questions?