

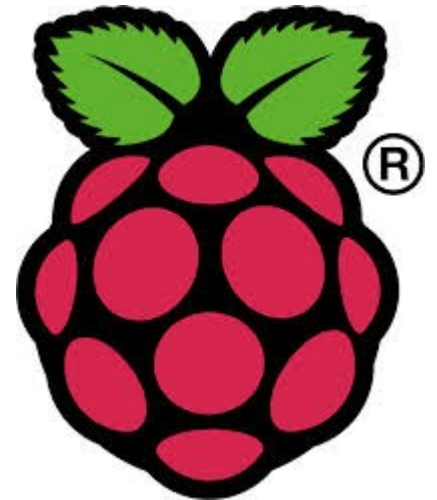
# Raspberry Pi Projects

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# Topics

- Introduction to Raspberry Pi
- Comparison to Other Dev Environments
- Projects
  - Screen Marquee
  - GPS Powered NTP Server
  - Garage Door Opener

# My Qualifications

I am not an expert on GPS Timing accuracy and technology.  
I do have a slight time fetish from working in calibration field.

I am not an expert on NTP.

I am not an electrical engineer, but I did go to an electronics trade school courtesy of the US Marines.

Anyone here could write the application in <insert your language here> using only 6 lines of code and it would include a coffee maker and beer dispenser.

# Raspberry Pi

Low Cost (\$40) Single Board Computer

Runs Linux

Rich Integrated Peripherals

- HDMI Display
- 512MB RAM
- 500MHz ARM Processor
- 10/100 Ethernet
- USB
- Composite Video
- Audio
- Programmable GPIO Pins (20) or so
- I2C Support (2 Buses)
- UART Support
- SPI Support
- Boots from SD Memory Card



# GPIO Pins

- General Purpose Input/Output
- Allow you to sense switch open/close
- Allow you to activate/deactivate other devices by setting a GPIO pin high or low

# I2C and SPI Buses

- Communications Bus
- Allows you to integrate complex sensors and I/O boards.
- E.G. A/D Converters, Thermometers, Barometers, LCD displays, LED Displays, Oxygen Sensors, Humidity, Luminosity...

# PI Strengths

- Cheap
- Runs Linux
- Huge Community
- Open Development Environment
  - Python, Perl, C, Java, LAMP
- Capable Dev Platform with I2C, SPI, UART, GPIO



# PI Weaknesses

- Limited Power Output
  - 3 ma Source Current
  - 16 ma Sink Current
  - 50 ma 3.3V Regulator Supply
- IO Pins not 5V Safe
- No A/D or D/A
- No Decent Industrial/Project Cases





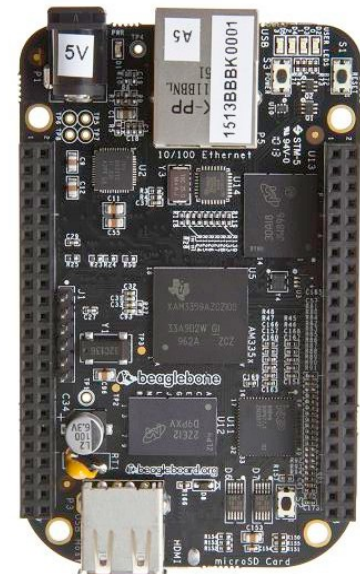
# Other Dev Environments

## Arduino

- Everything is an add-on or “Shield”.
- Runs programs written in C (or C# for Netduino)
- No “Operating System”

## Beagle Bone Black

- Runs Linux
- Faster Processor
- Supports Arduino Add-Ons
- More Capable IO – A/D Converters, 8PWMs, 4 UARTs, 65 GPIO Pins
- Smaller Community



# Marquee Project

- Non-Technical Staff
- Large Facility w/ 6-10 events per day using 10-15 rooms.
- Already had a web calendar for room management.
- Manually created slide show each day.

# Marquee Project Solution

- Raspberry Pi in Kiosk Mode Drives HDTV
- Connects using WiFi
- Browser Displays HTML Page
- Extract Data from Calendar using jQuery/JSON

# Marquee Demo

**7:00 PM**

**Worship Choir Rehearsal - Choir Room**

**8:00 PM**

**Praise Team Rehearsal - Choir Room**

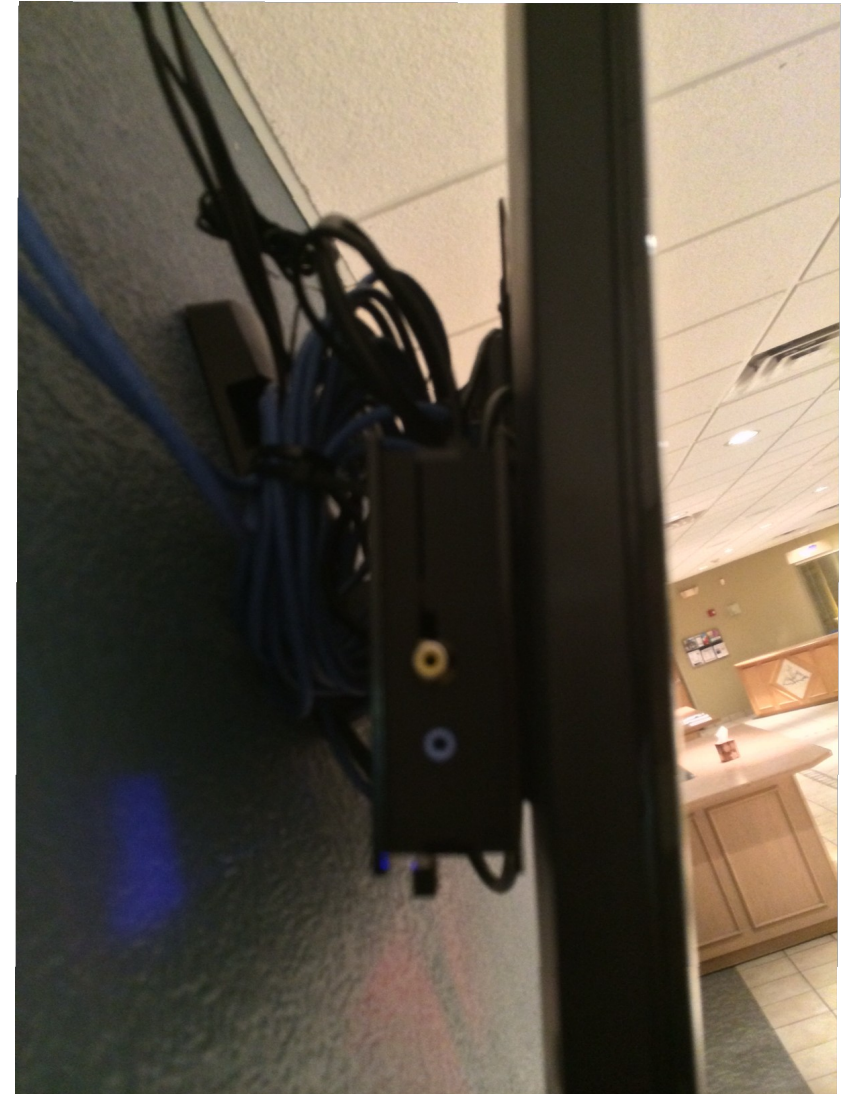
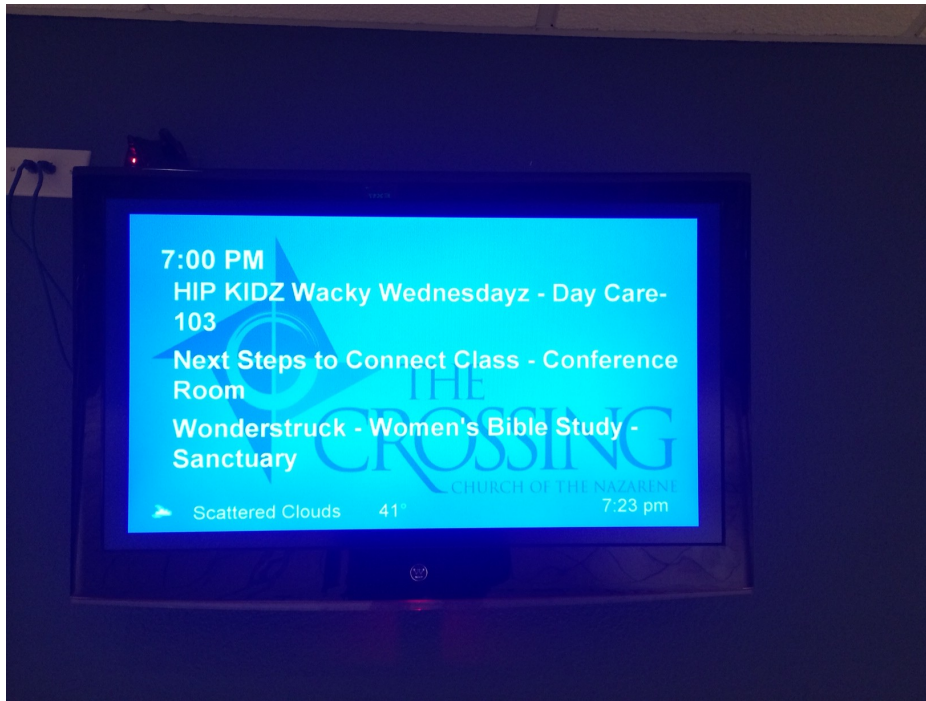


Overcast

39.9°

11:38 am

# Pi Marquee in Production



# Marquee Resources

## Running a Pi in Kiosk Mode

<http://blogs.wcode.org/2013/09/howto-boot-your-raspberry-pi-into-a-fullscreen-browser-kiosk/>

## Screenly Digital Signage for Raspberry Pi

<http://www.screenlyapp.com/>

## Connect Daily Web Calendar – MH Software, Inc.

<http://www.mhsoftware.com>



# GPS Enabled NTP Time Server

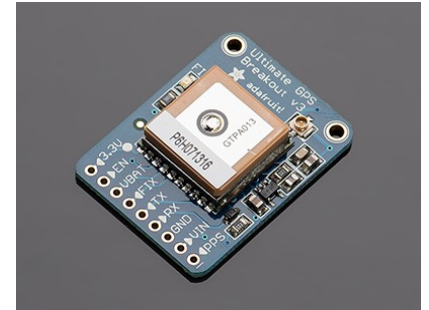
- Serve accurate time to computers on your network.
- Because it's really cool.
- It's as cheap as it gets.



# The Hardware

- Raspberry Pi Model B - \$40
- Adafruit Ultimate GPS Board - \$40  
(alt. SparkFun Part)
- GPS Antenna - \$16
- Nwazet.com Case - \$20

Total Cost ~ \$130





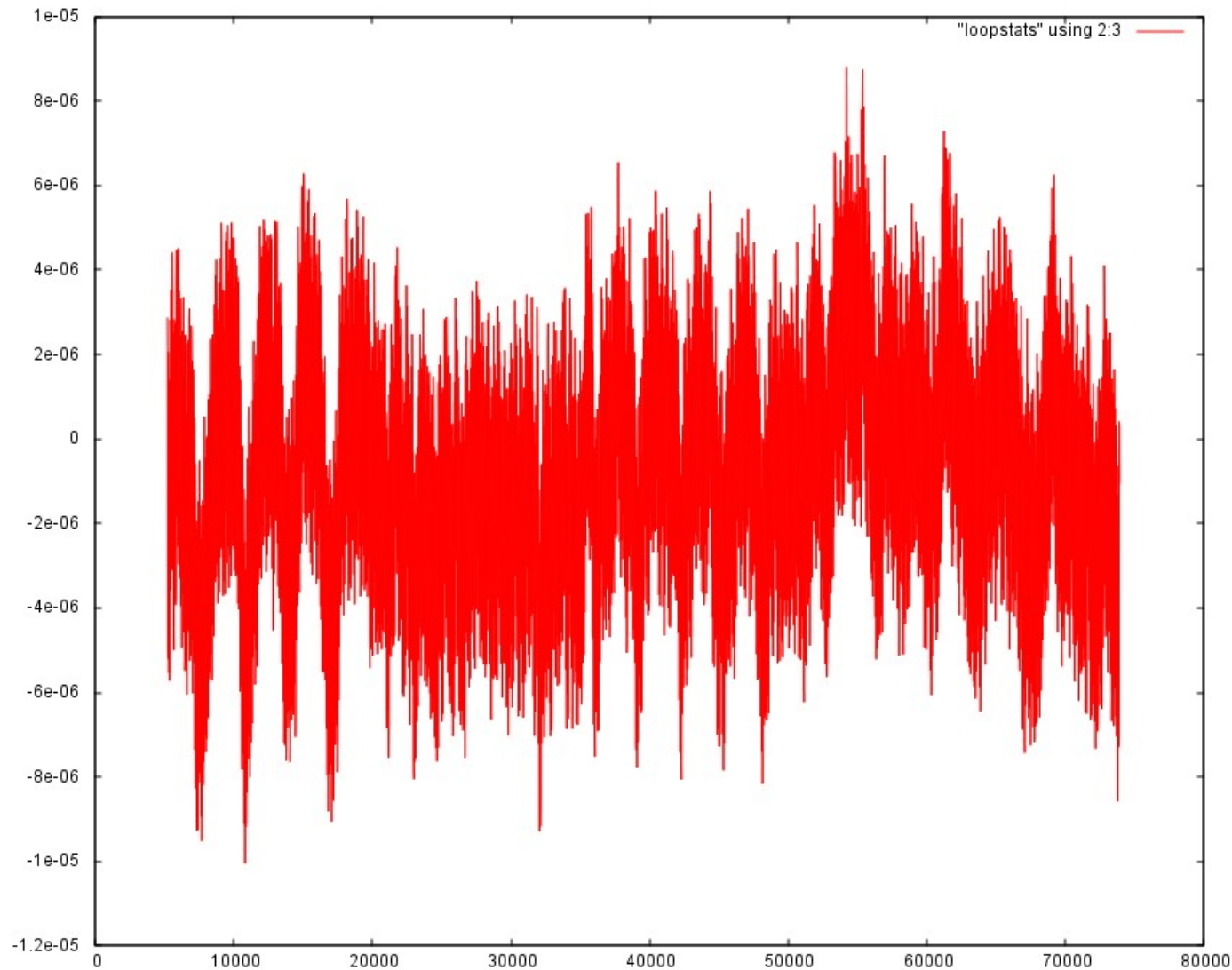
# Software

- Standard Raspbian Distro
- NTP PPS Optimized Distro
- Custom Tweaks for Monitoring
  - Chart Accuracy
  - Monitor NTP Receiver

# Accuracy Factors

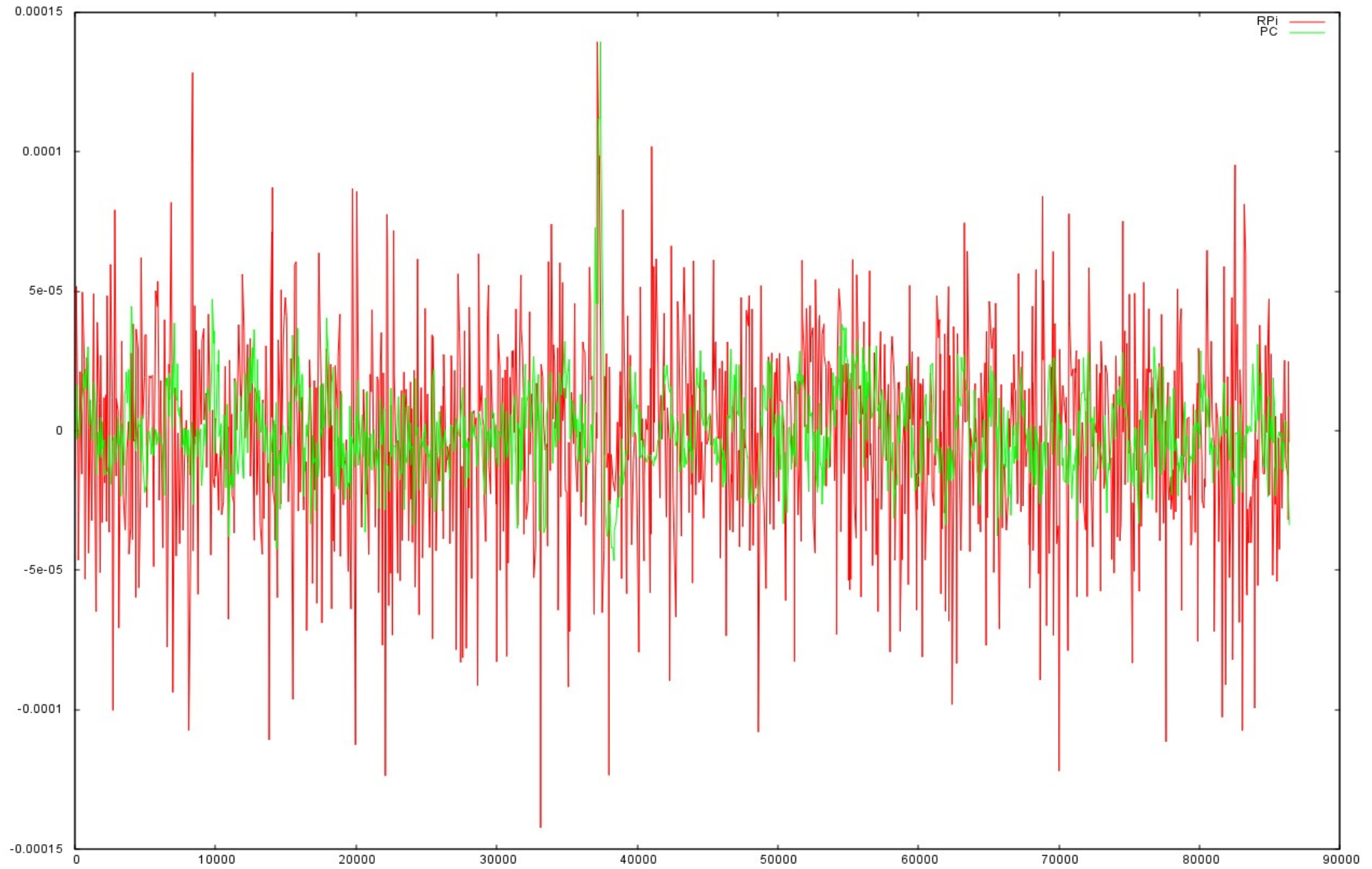
- Pi Network Interface Latency
- GPS Accuracy
- Normal Network Latency
- Relative Accuracy Compared to public NTP Servers
- The Short Answer
  - +/- 15  $\mu$ S on Pi
  - +/- .3ms to Clients – Still 10x Better than public servers.

# Pi NTP Server Loopstats



Std Dev: 3.6uS

# Client Loopstats



# Building the NTP Server

- Solder the header on the GPS board.
- Connect 5 Wires to GPIO connector:  
+5V, Gnd, RX, TX, PPS.
- Burn NTP Distribution on SD Card.
- Turn it On



# Finished NTP Server



# Cool Ideas

- Integrate a thermometer and modify NTP to include it in drift rate mechanism.
- Control cheap rubidium frequency source for really stable PPS reference.
- NIST giving me their old atomic clock when they invent a new one.

# NTP/Pi Resources

AdaFruit Ultimate GPS Breakout Board

<http://www.adafruit.com/products/746>

Raspberry Pi NTP Server In-Depth

<http://www.satsignal.eu/ntp/Raspberry-Pi-NTP.html>

NTP PPS Optimized Raspbian Distribution

[http://ntpi.openchaos.org/pps\\_pi/](http://ntpi.openchaos.org/pps_pi/)

Nwazet.com Pi Tuxedo Case

<http://nwazet.com/nwazet-pi-tuxedo-case>



# Pi Garage Door Opener



- Because I forget to close my door.
- Because I have to turn around and go home to see if I shut the door.
- Others doing it to work around RF Interference
- Cool Technology Demo

# What it Does

- Web Interface to Opener
- Auto-Close Door – Fixed delay with Override Switch
- Email/SMS Alerts on Door Activation
- Temperature Monitor
- Web-Cam for Security
- Logs Events, including video on door open.

# Tour de Force of Techniques

- Sensors on I2C Bus
- Digital I/O
  - Sense Door Open/Close State
  - Use relays to open/close door and turn on lights.
- Web Cam
- Notifications including SMS/EMail
- Mobile Web Interface

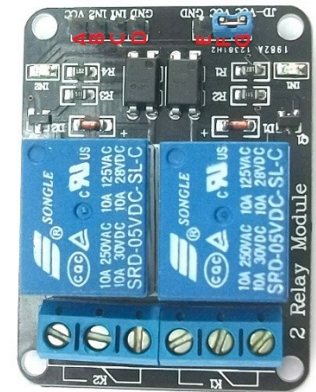
# Software Used

- Pi4J Java library for Pi GPIO
- Apache Tomcat for Server
- GNU Plot
- JQuery Mobile UI
- Custom Application to pull it all together.



# Hardware Used

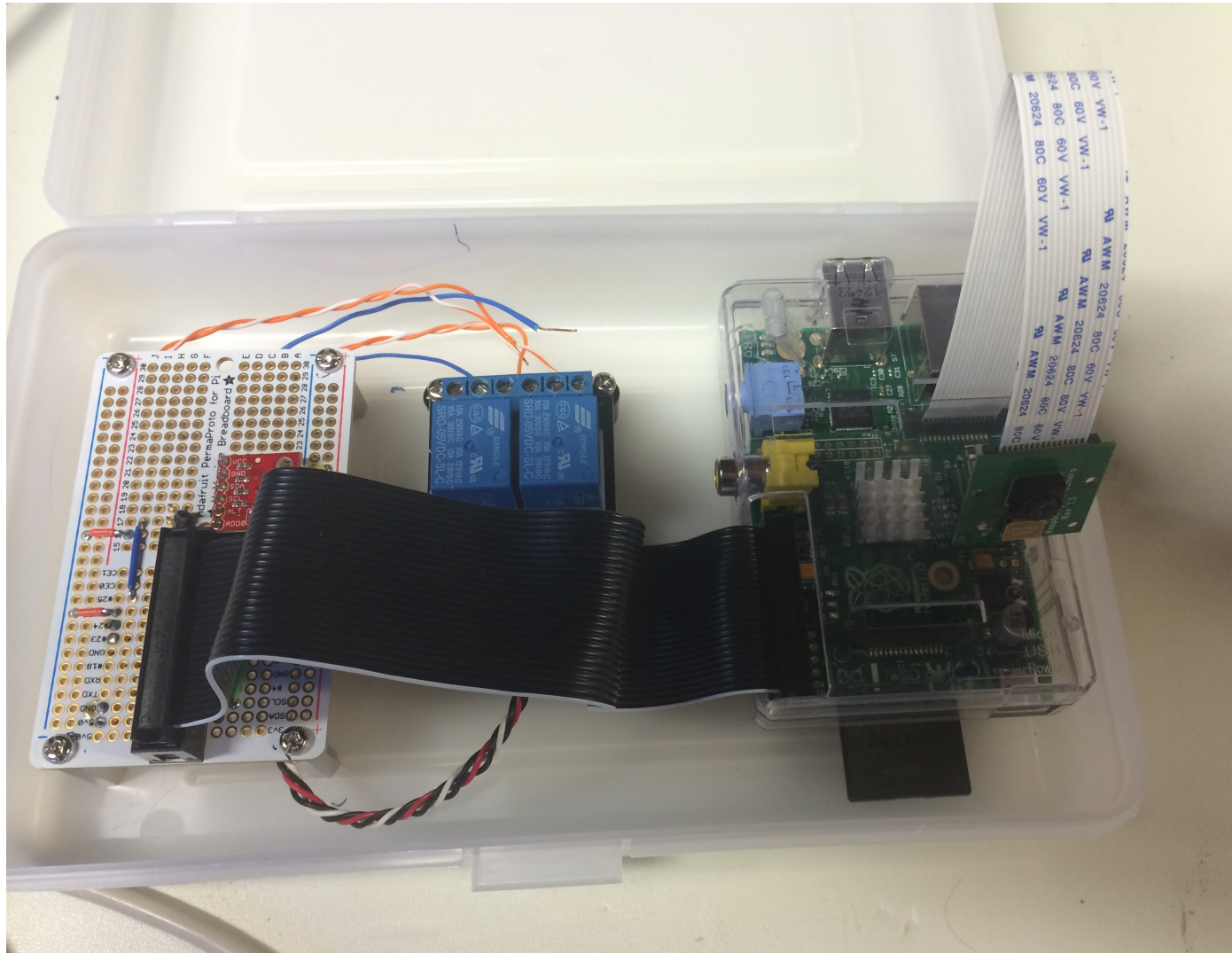
- Raspberry Pi Model B
- Wifi Adapter
- SainSmart 2 Channel Relay Board
- SparkFun TMP102 Temperature Sensor
- Magnetic Reed Switch
- Pi Camera



# Lessons Learned

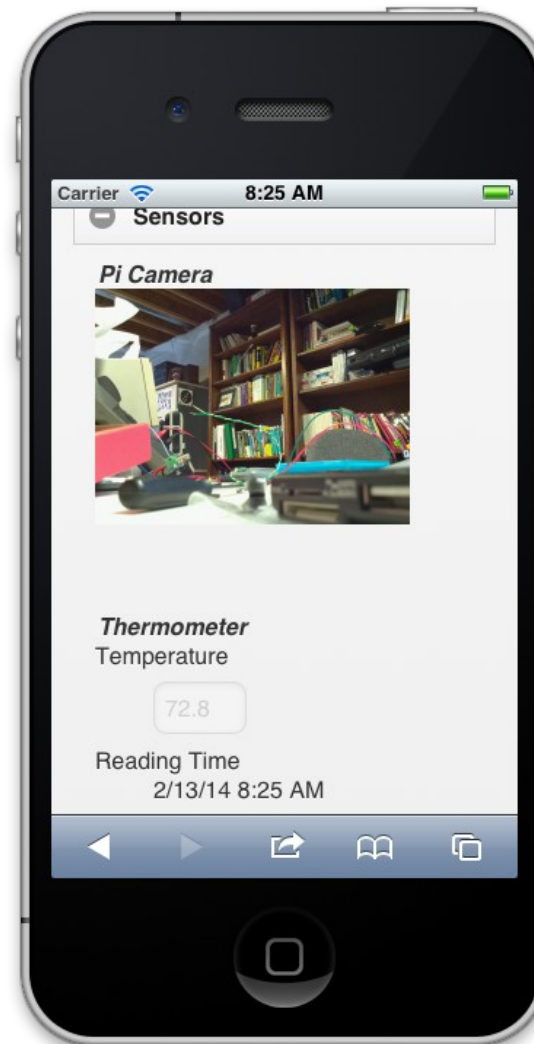
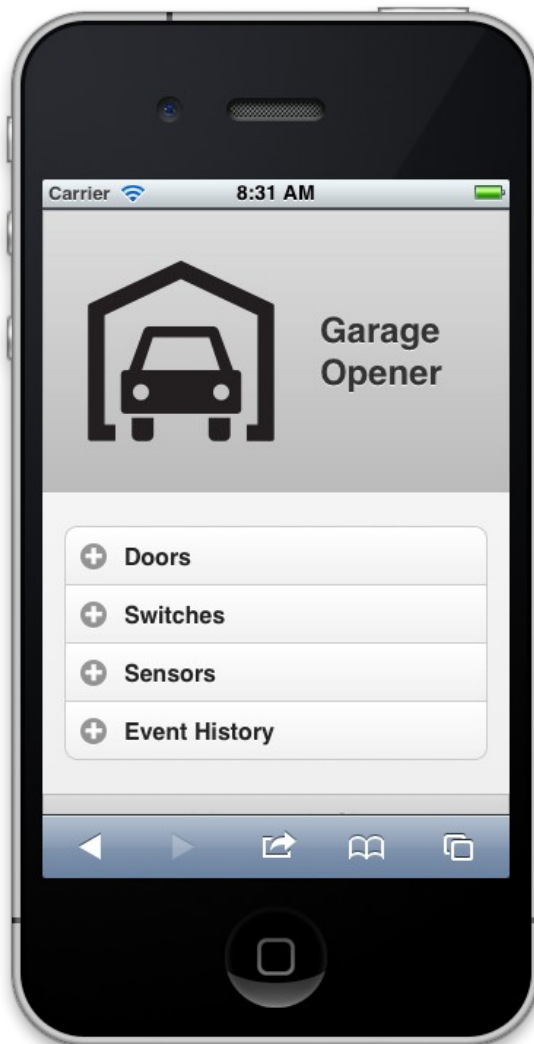
- It's surprisingly complicated to do.
  - Multiple Doors
  - Notifications, listeners, sensors for polling.
  - Concurrency – For example, access to camera when video being viewed.
- Security
- Reliability – Shouldn't randomly activate.

# The Mostly-Finished Project



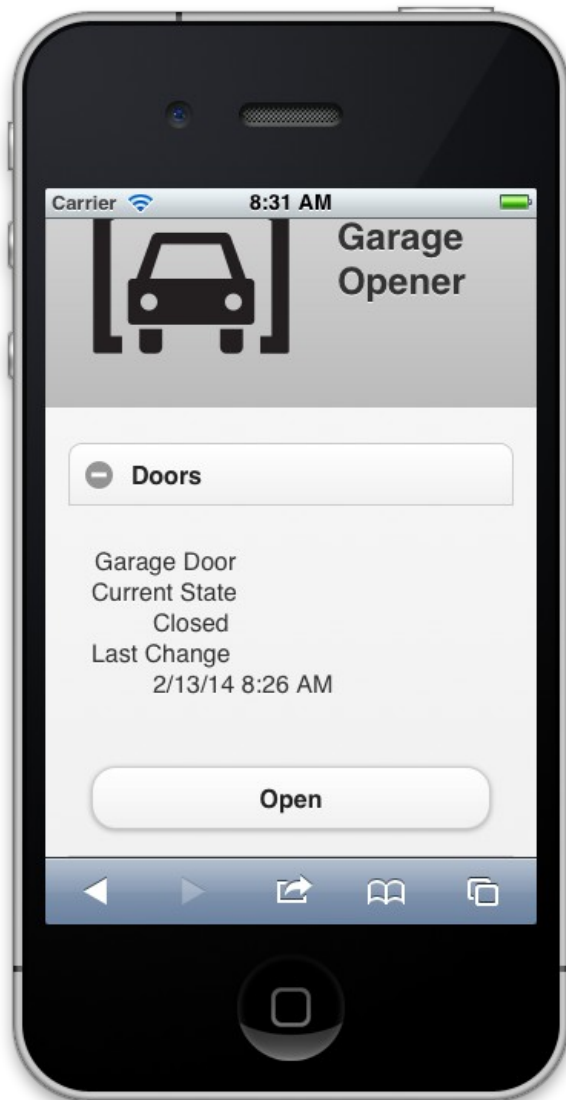


# Screen Shots





# Screen Shots



Edit		Messages (4)	
Search			
●	777612798850	08:43	>
Garage Door - CLOSED			
	777557274075	08:42	>
Garage Door - OPEN			
	777612783254	08:27	>
Garage Door - CLOSED			
●	777557268771	08:26	>
Garage Door - OPEN			

# Demo Web Interface

# Other Cool Projects

- Pi Controlled Greenhouse Enclosure
- Arduino Controlled Charcoal Grill
- GPS Data Logger
- Pi Controlled Brewing System

# Pi/Linux Questions?

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