Berrybell

EECE4638 - Wireless Networking Technologies

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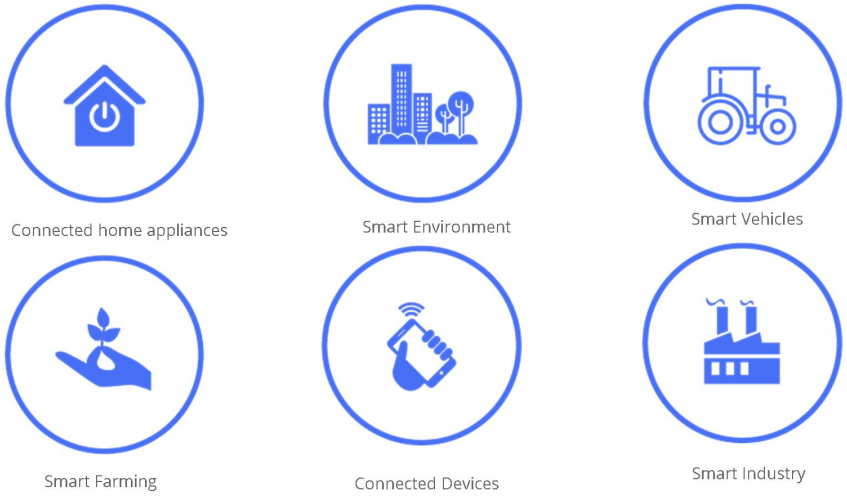
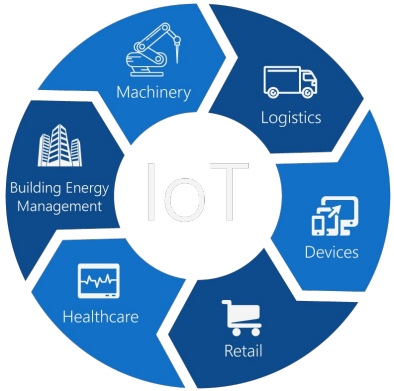
Introduction - Setting the Stage

- Let’s begin... with a joke!
- Why do we love Wi-Fi so much? -> Because we have a connection 😆
- And WOW! The connections are simply endless with the Internet of Things.



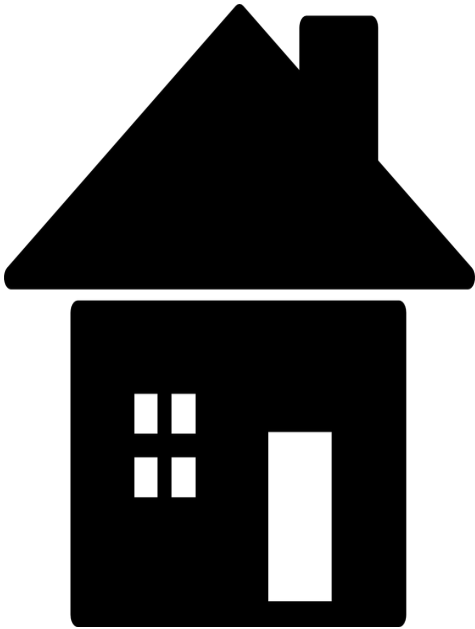
Introduction - Internet of Things (IoT)

- The Internet of Things (IoT) is poised to revolutionize the world around us.
- What is it? -> It’s an emerging technology within Computer Networking.
- Devices and objects can now interact with individuals at a moment's notice.
- Everything, down to that pen you’re using to take notes, can be used to give insight into the world around us.



Introduction - What's Our Problem?

- Homeowners want more connected, efficient homes to stay in-the-know and ease their lives.
- When they're at home, they enjoy using smart home devices such as thermostats, smart TVs, or lighting systems - key words are "at home"
- However, sometimes homeowners aren't actually at home or are able to hear their doorbells.
    - Mail/packages
    - Intruders
    - Visitors



What's Already Been Done?

SkyBell

- HD video, speaker and microphone
- SkyBell app
- $200

August Doorbell Cam

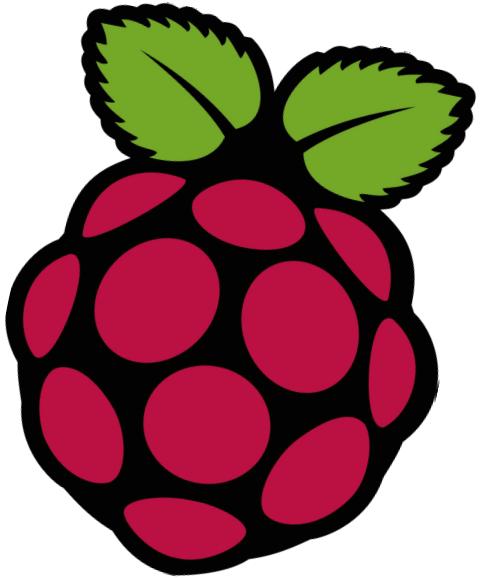
- Video, speaker and microphone
- August application to receive notifications
- $149

What’s the Solution?

- The Berrybell - woot woot!
- A doorbell that sends a text message when someone rings your doorbell, straight to your phone!
- Gone are the days of waiting by the door.
- Say hello to staying in-the-know!

Hardware Background

- RF Transmitter
  - Transmits at 434 MHz
- Arduino Uno + LED + Push Button
  - Microcontroller that powers different devices
- NooElec NESDR Mini 2
  - Receives signals transmitted through air
- Raspberry Pi
  - Microprocessor

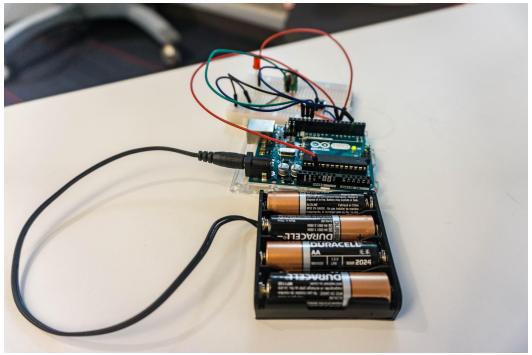


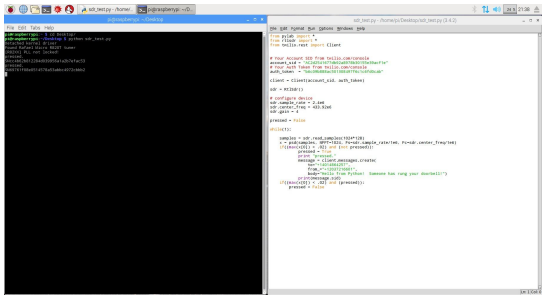
Software Background

- Raspbian
  - Operating System on Raspberry Pi
- Command line coding
  - Terminal on Raspberry Pi
  - Used to download libraries and run code
- Python Coding
  - Python3
- Twilio
  - API (Application Program Interface) used to send SMS messages to a specified telephone number

Experiment Setup

- Built prototype doorbell
  - Push button
  - Red LED indicator
- 434 MHz RF Analog transmitter
- SDR polling for the 434 MHz signal
- Python Code
  - Polls for the signal
  - Sends text message to specified number via Twilio API
- SMS message sent to specified user when button pressed!



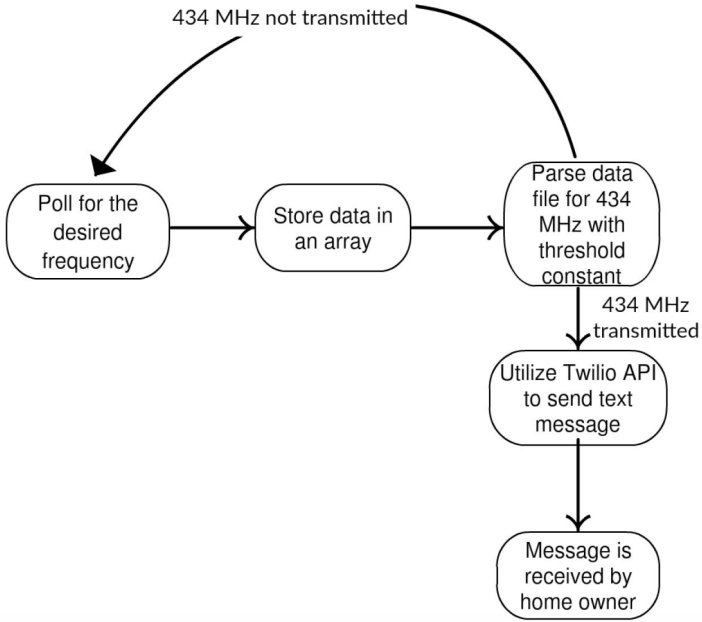


Metrics that We Investigated

- Attenuation of the signal
  - Your loss, my gain
- Time delay from button press to SDR reception
  - Latency? More like wait-and-see

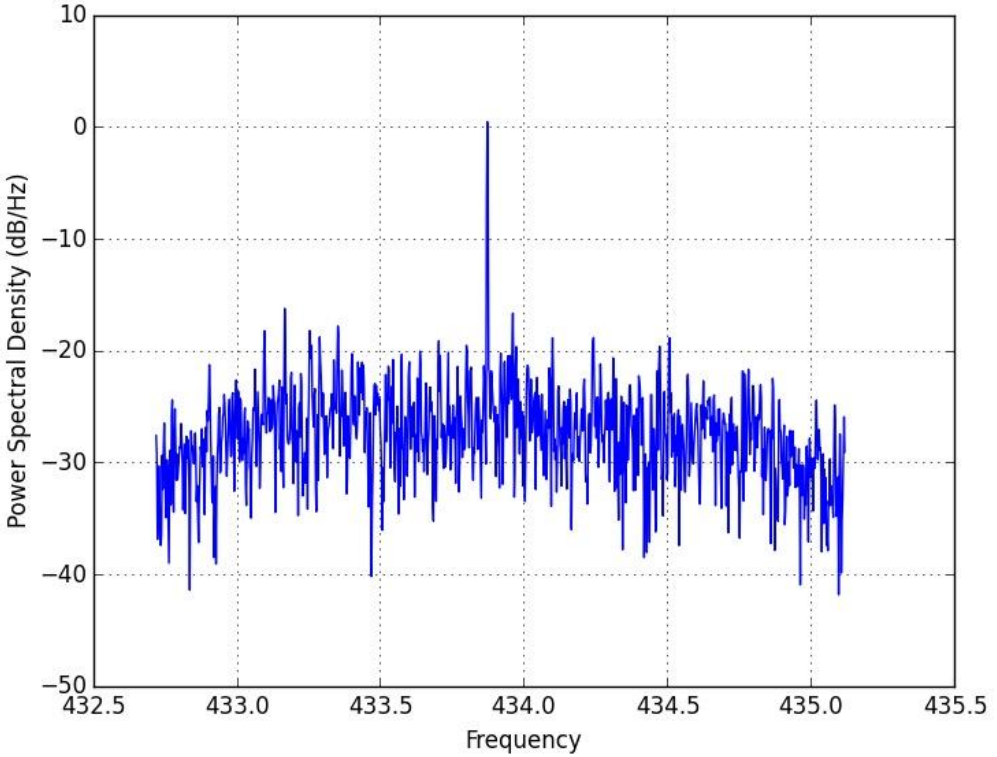
Methods & Algorithms

- **Polling**:
  - Sampling rate: 2.4 MHz
  - Center frequency: 433.92 MHz
  - Gain: 4 dB
  - Collect 1024 * 128 samples per poll
- **Power Spectral Density (dB/MHz):**
  - Frequency-domain analysis using fourier transform to determine the power present in a system across frequencies
  - Measured PSD over distances
  - Threshold value set for doorbell ring



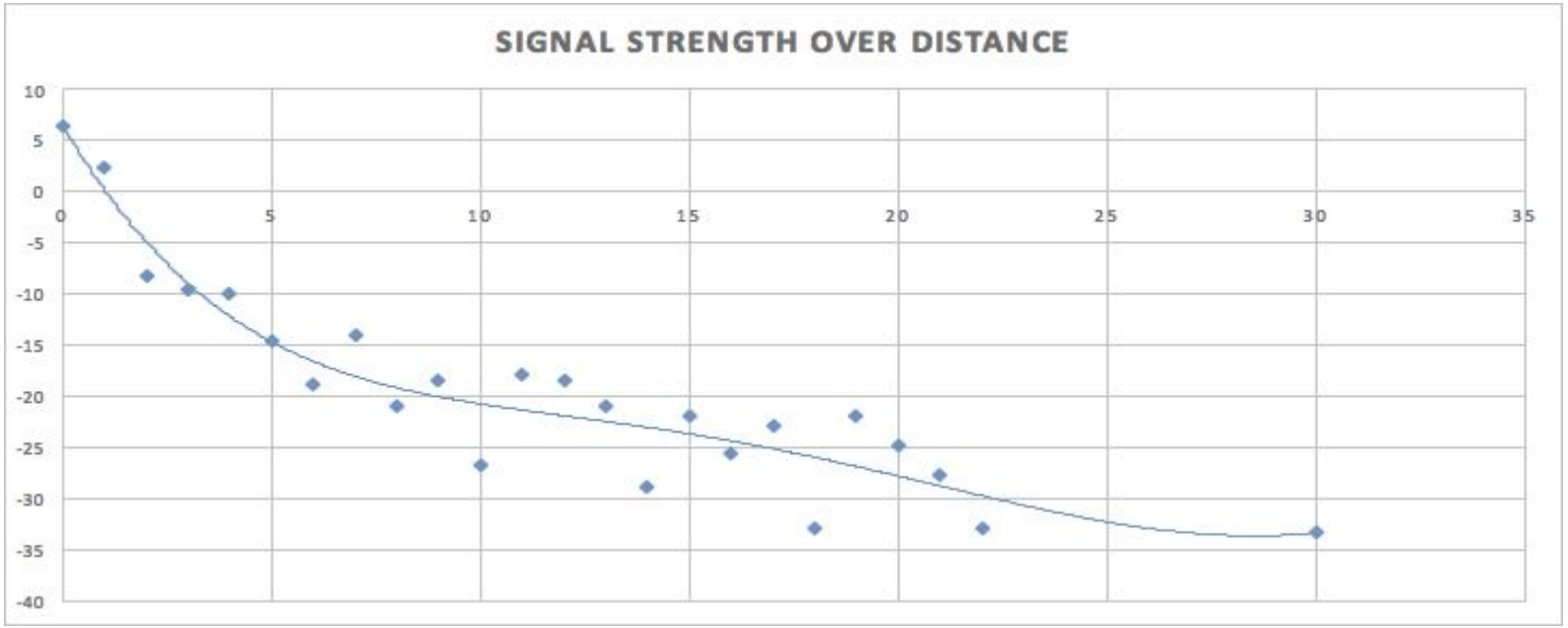
Experimental Results

- Sample plot of our data
- The peak represents the signal strength at our transmitted frequency
- Plotted these peaks over distance to measure the attenuation



Experimental Results

Power Spectrum Density (db/Hz)



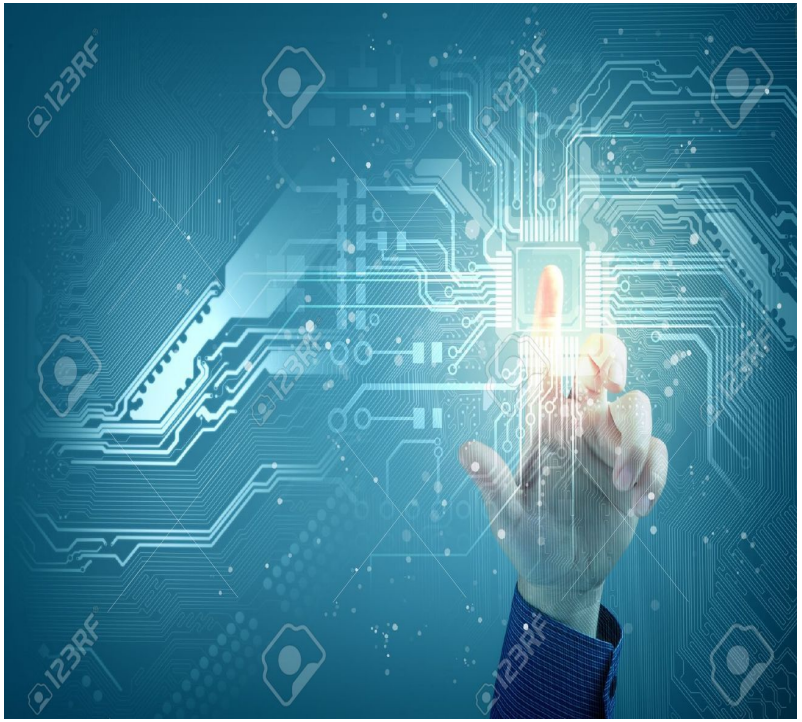
- Time from transmission to receiver ACK < 500 ms
- Time from transmission to text message approx. 2.4 s

Conclusions

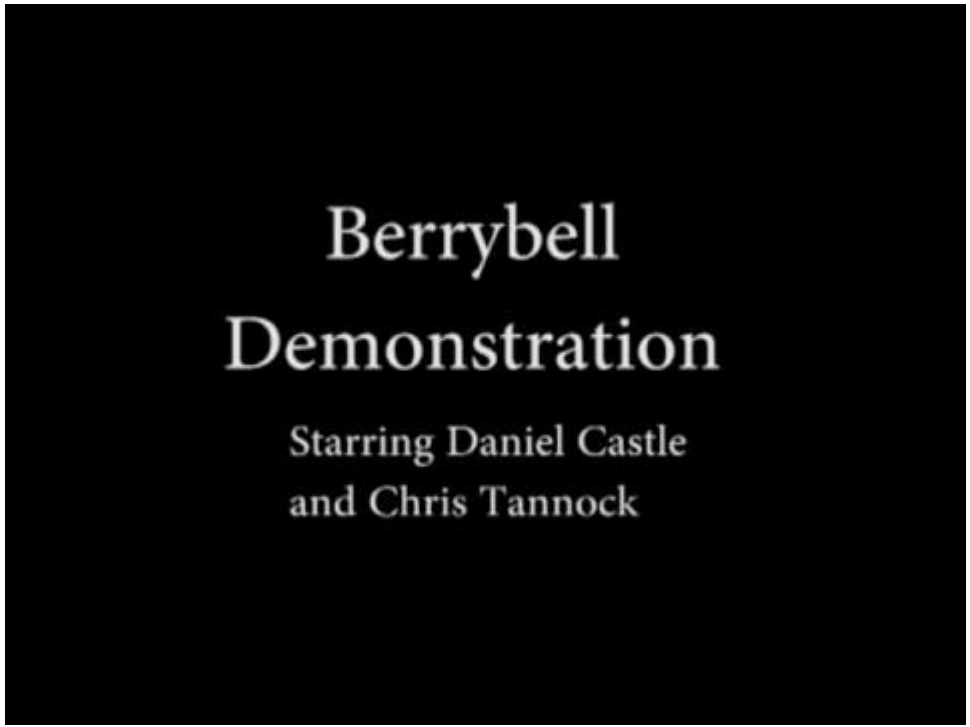
- Signal strength does indeed attenuate over distance
  - Logarithmic in nature
  - Bad samples equals no door bell ring
  - Automatic Gain Control (AGC) could help mitigate signal loss
- Possible to tune threshold to trigger at specific distances
  - Ex. Two 434 MHz devices in your home can be tuned based on distance from receiver to avoid interference
  - Having a high threshold could increase the risk of lost signals, however
  - It’s a balancing act!

Future Work

- Multiple devices
  - Multiple texts to different phones in a household
- Variety of notifications
  - Texts and app notifications/emails
- Different frequencies
  - Don’t want many devices on the same frequency
  - Want to keep narrow in bandwidth
- Longer range of transmission
  - Farther distance
- Shorter transmission time
  - Faster phone-to-text time



Summary


Berrybell
Demonstration
Starring Daniel Castle
and Chris Tannock