TRIWAVE SYSTEMS

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Presentation Overview

1. Background & Motivation

2. Business & Cost Analysis

3. System Overview

4. Risk Assessment

5. Engineering Standards

6. Self Reflection

7. Concluding Remarks

8. Demo

9. Questions

Introduction

Background

- ○ Approx. 500,000 commercial buildings in Canada [1]

- ○ 135 fire related deaths per year from 2010-2014 in Canada [2]

- ○ High Earthquake Potential on Canadian West Coast

- ○ Modernize safety in urban/industrial environments

  - → Complex urban structures

  - → More buildings & people in smaller areas

  - → Navigation in these areas is more difficult in emergencies

Motivation

Optimizing Emergency Response

- Limited information on scene
- Victim location based on witness accounts
- Unreliable and high tendency of human error
- What happens when disaster strikes?

Increase Safety & Efficiency

- More reliable information
- Better path planning
- Limit human error
- Safer for first responders

Indoor Positioning Systems (IPS) Attributes (3)

✓ System accuracy and precision

✓ Coverage and resolution

✓ Latency in making location updates

✓ Building's infrastructure impact

✓ Effect of error/interference on the system

Akriveia Beacon System

- ○ Indoor Positioning System (IPS)

- ○ Designed for Disaster Search & Rescue Operations

- ○ System of Anchor Beacons and Wearable ID Tags

- ○ Integrated with Advance Ultra-Wideband (UWB) Technology

- ○ Trilateration Methods for Tracking

- ○ Near Real-Time Indoor Tracking

Business & Cost Analysis

Global Market & Competitors

- Search and Rescue (SAR) Equipment Market
  - In 2017: **$113.62 billion** (4)
  - Projected in 2022: **$125.66 billion**
- Global Indoor Location (GIL) Market
  - In 2015: **$3.43 billion** (5)
  - Projected in 2022: **$29.4 billion**
- No Direct Competitors
  - Pozyx, Infsoft, KAUST Innovation

Target Customer

Ideal Customers

- ○ Commercial Building owners

- ○ Property management companies

- ○ Need for GIL for occupants in emergencies

Government Incentives

- ○ System increases occupant safety in emergency situations

- ○ Easily integrated into Building Code - Fire Safety

- ○ Reduces risk to emergency personnel

Business Plan

Start Up
- OEM - One time sales model with SW subscription
- Sell Directly, No distributor, higher margin
- Build Distributor channel to bring product to market

Growth And Expansion
- Acquisition of platforms & tech
- Consideration of other application
- Hospital, Military, Logistics applications

Possible Exit
- Initial Public Offering (IPO)
- MBO, MBI
- Acquisition

Business Considerations

Strength / **Weaknesses**

- ○ Unique technology & application
- ○ Adoption in new cellular devices
- ○ Expensive development cost

Opportunities

- ○ Large market in high risk earthquake areas
- ○ No direct competitors or similar application in the market
- ○ High market share

Risks

- ○ Must meet various regulations and standards
- ○ Heavily government regulated
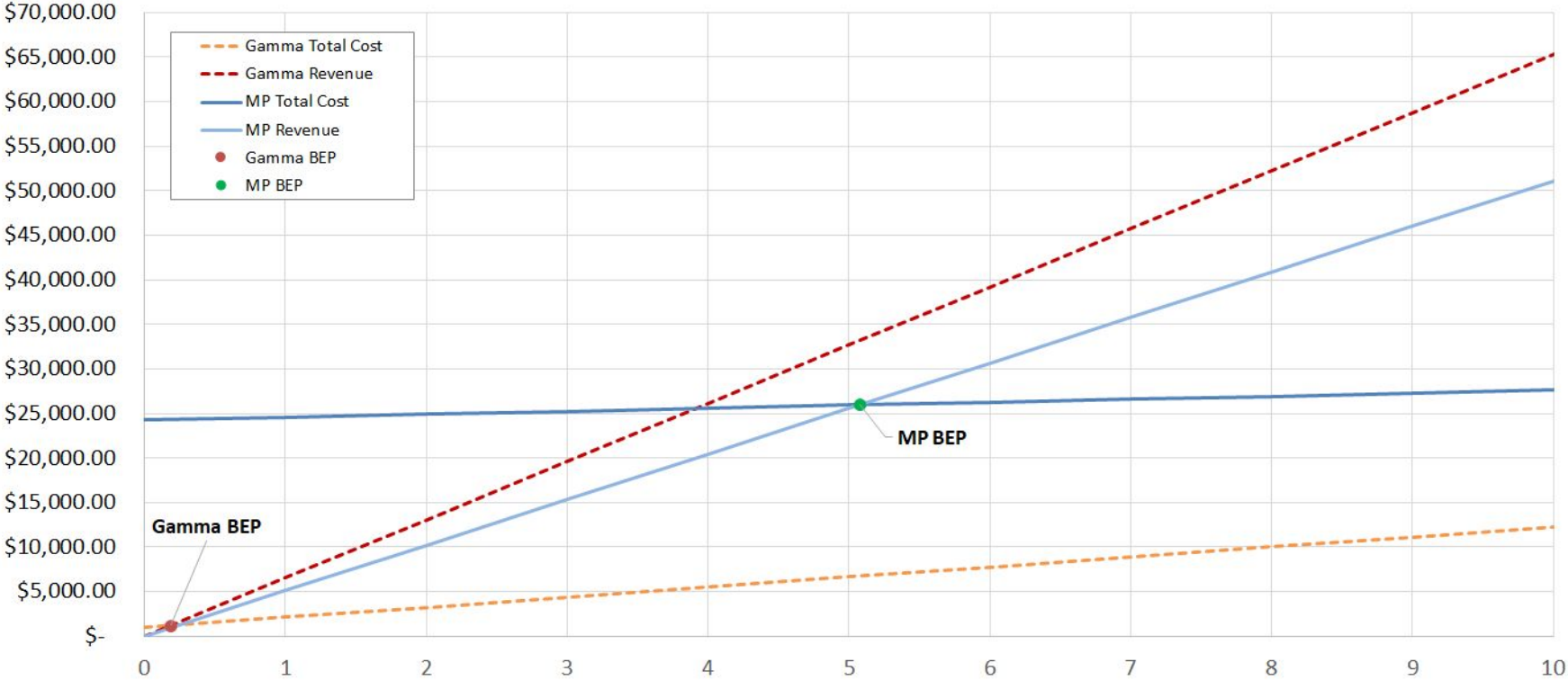- ○ Requires new regulations to be put in place

Production Costs

	Gamma Prototype	Mass Production
Fixed Cost	$1,000.00	$24,237.96
Variable Cost Beacon	$127.55	$36.70
Variable Cost Tag	$74.56	$22.78
Variable Cost Software	$2,500.00	$2,500.00
Require Sale Price (80% Return)	$6,530.85	$5,108.22
Break-Even Point	**1 Units**	**6 Unit**

Break-Even Point Calculation

Introduction | **Market Analysis** | Technical Overview | Risk Assessment | Standards | Reflection | Summary

System Overview

System Layout

ID Tag

Beacon A

Beacon B

Beacon C

DPU

GUI

→ Via RF Communications
→ Via Wi-Fi Communications
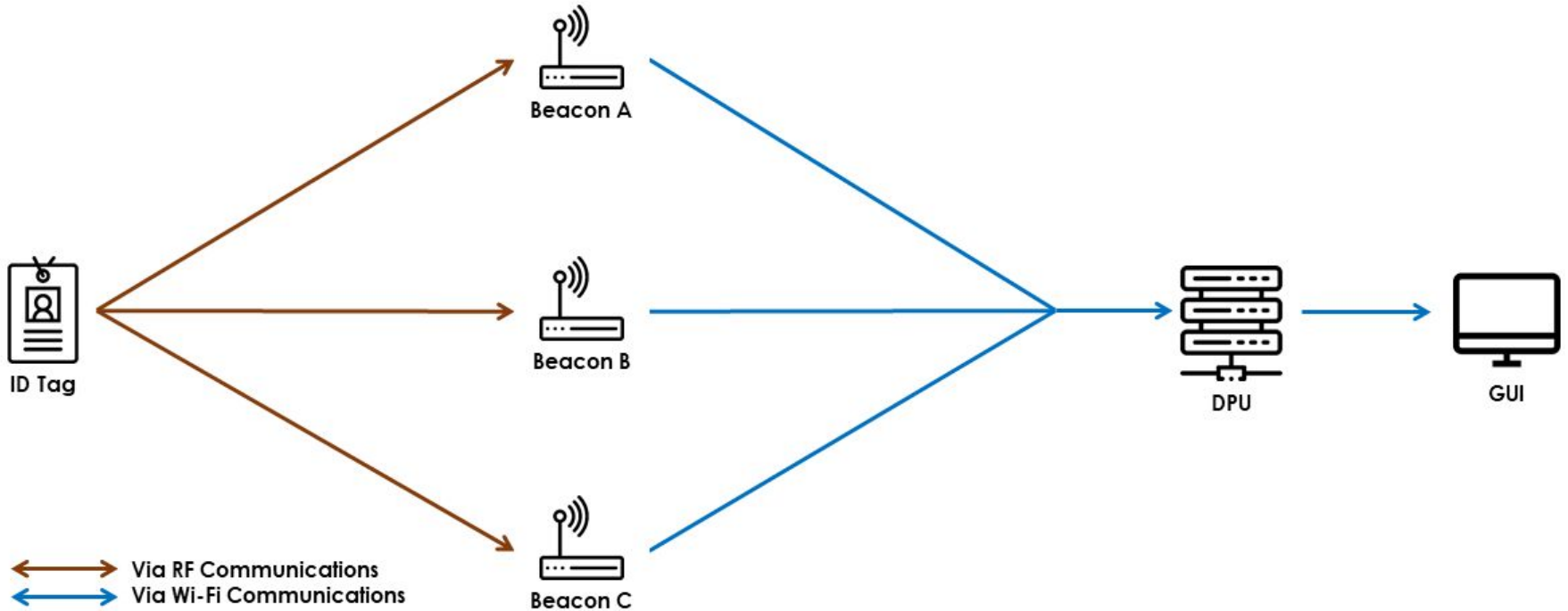
System Components

Beacons

- Stationary UWB Locator Devices
- Use DWM1000 UWB module for ToF Ranging
- Minimum 3 Beacons is Required
- Communicate with Server using UDP via Private Network

Tags

- Small, Light, durable, and wearable electronic tagging devices
- Integrated with DWM1000 UWB Transceivers
- Integrate with access cards or key fobs for every day carry
- During emergency can be toggled on to broadcast location

Core System Features

- Track position in near real-time

- High accuracy upto 0.25cm

- Ranging distance upto 30m

- Multi-Tag tracking support

- Multi-Floor Support

- Wireless Beacon-to-Server communication

- Beacon failure prevention & recovery mechanisms

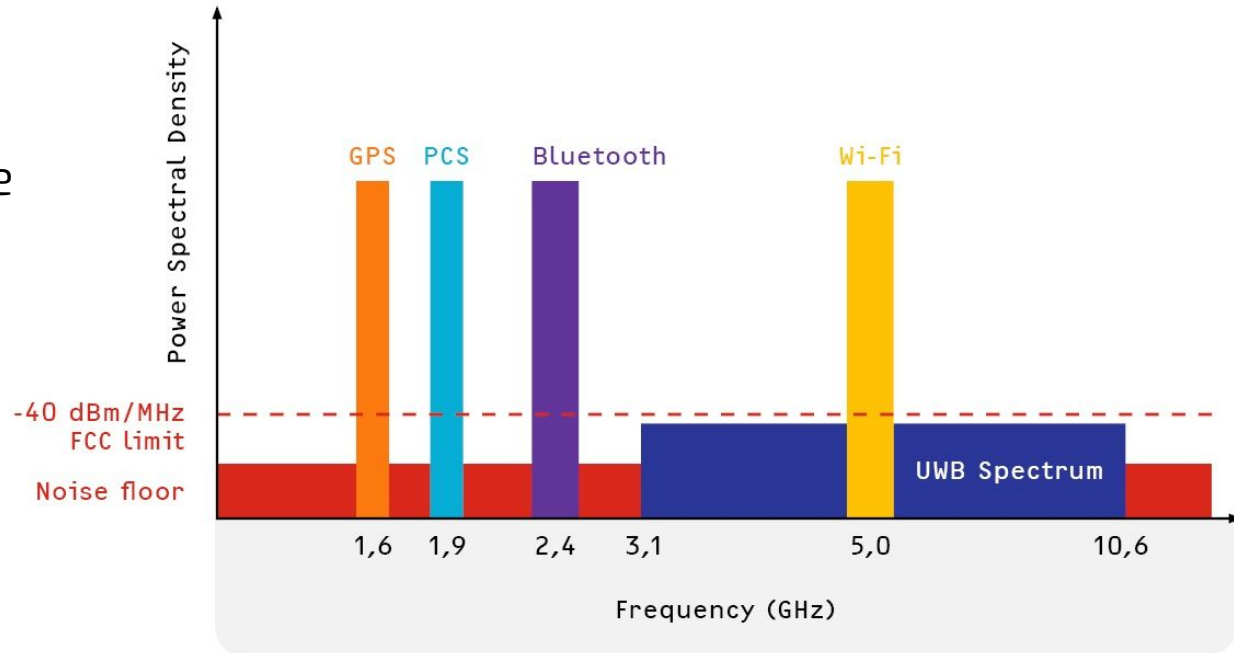- Intuitive user interface for adding/editing users, beacons, and maps

RF Ranging & Trilateration

Ultra-Wideband RF Ranging

- ○ Time-of-Flight based approach

- ○ Minimal interference

- ○ Effective against noise

- ○ Short duration pulses

- ○ Low transmit power

- ○ High data rate

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Trilateration Method

Standard Form of a Circle:

$$(x - x_0)^2 + (y - y_0)^2 = r^2$$
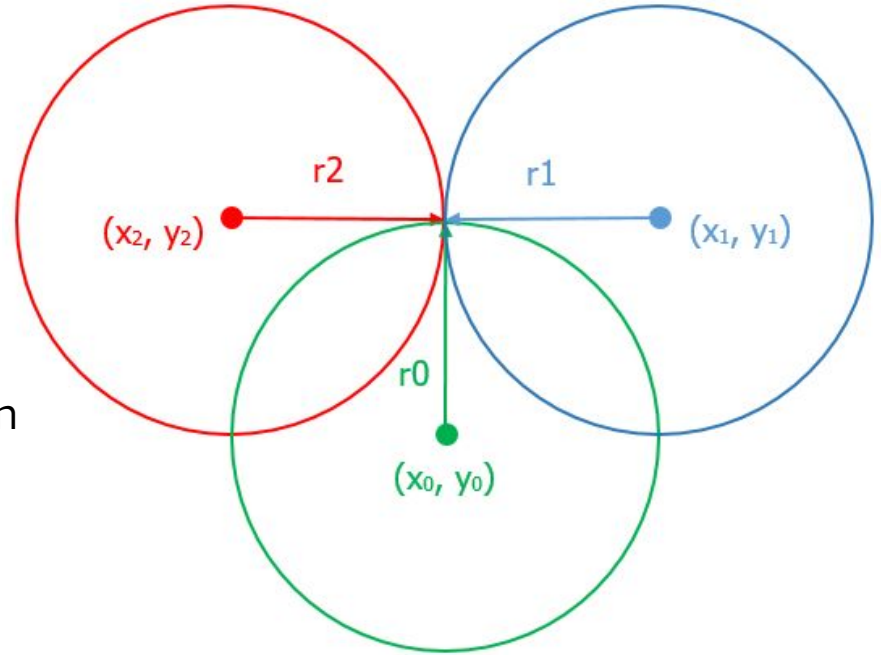
r = distance derived from RF ranging

(x_0, y_0) = cartesian coordinates of beacon

Two Dimensional Trilateration:

$$(x - x_0)^2 + (y - y_0)^2 = r_0^2$$

$$(x - x_1)^2 + (y - y_1)^2 = r_1^2$$

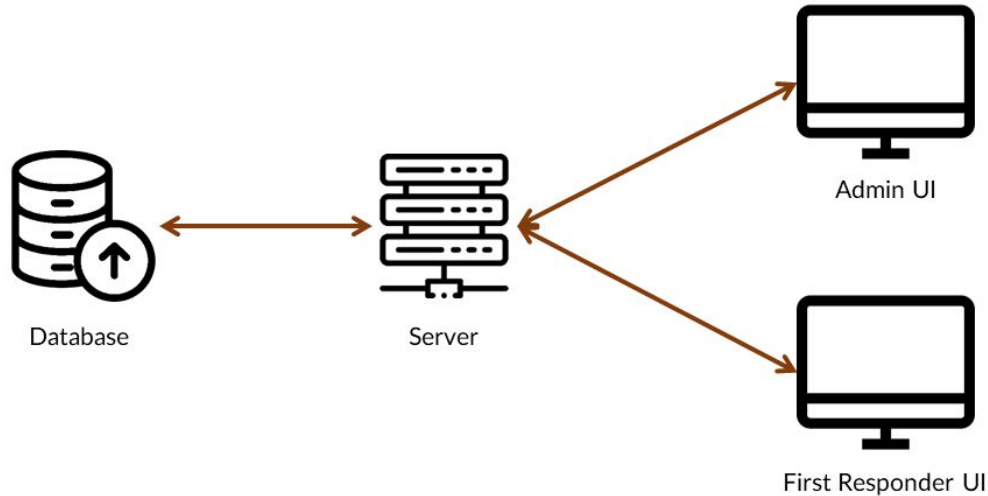$$(x - x_2)^2 + (y - y_2)^2 = r_2^2$$

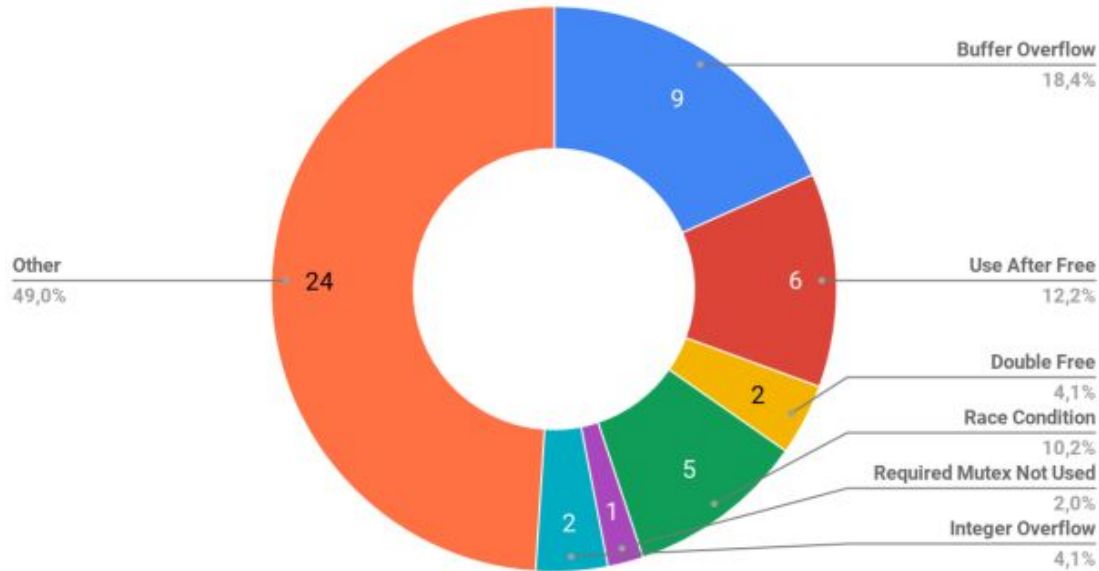Introduction | Market Analysis | **Technical Overview** | Risk Assessment | Standards | Reflection | Summary

Software

Software Overview

○ HTTP Web Server

○ Multi-threaded frontend apps & WebAssembly

○ Implemented in **Rust**

Database

Server

Admin UI

First Responder UI

Rust & Software Security

- Standard library
  - → Security over performance
- Properties of Rust
  - → No Garbage Collector
  - → No Race Conditions
  - → No Buffer Overflow
  - → No Integer Overflow
  - → No Double Free
  - → No Use After Free

Linux CVEs in 2018 (Jan – Apr)

Buffer Overflow 18,4%

Use After Free 12,2%

Double Free 4,1%

Race Condition 10,2%

Required Mutex Not Used 2,0%

Integer Overflow 4,1%

Other 49,0%

9

24

6

2

5

1

2

Linux Security Vulnerabilities Grouped by Cause [7]

Risks

Tag Activation

Issue: User unable to turn on tags

Solutions: Automatic Tag Activation

- ○ Periodic On/Off
- ○ Fall Detection
- ○ Heart beat sensor
- ○ Oxygen sensor
- ○ Remote Trigger

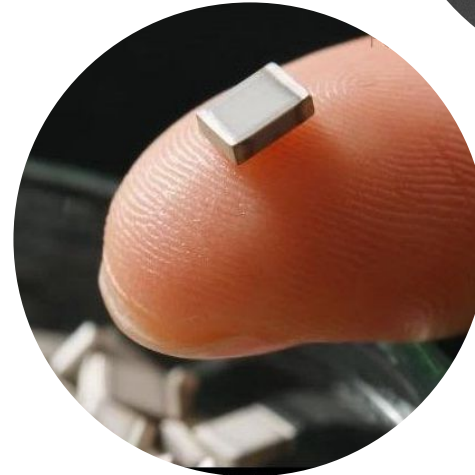**Privacy issue:** Have Tag Broadcast Sound

Tag Battery Life & Maintenance

Issue: Low Tag Battery Life & Deterioration

Solutions:

- ○ Routine maintenance

- ○ Solid State Battery (© 2019 Solid Power)

- ○ Wireless charging

- ○ RF harvester

- ○ Batteryless

External Hazard

Issue: Fires, Flood, Gas, Earthquake, Tampering, Hackers

Solutions:

- Ingression Protection casing
- Fire Resistant Material
  → Fire safe polymer, fire retardant coating
  → Carbon foam insulation
- Locking mechanism, tamper detection
- Improved Network Security
  → PEAP, EAP-TLS

Interference Issue

Issue: Multiple UWB devices increases chance of interference on existing systems operating on the UWB spectrum [6]

Solution: Interference Mitigation:

- Modify signal parameters

- Pulse Shape

- Number of pulses

- Off when not used

Engineering Standards

Adherence to Standards

Factors to consider:

1. UWB in commercial environments

2. Wearable RF Technologies

3. Software Security & Design

4. Emergency Equipment Standards

Requirements & Regulations

- ○ Relies on government regulation to deploy

- ○ Need mix of existing and specific standards

- ○ OSHA Placement & Signage requirements

- ○ ASTTBC certification

- ○ FTP, FSS Code & Material Standards

- ○ FCC Wireless Equipment Requirements (US)

FIRE PROTECTION
ASTTBC
REGISTERED | TECHNICIAN
John Doe
FP0000
AL CO EM EX GS SM SP WA

OSHA®
Occupational Safety
and Health Administration

Self Reflection

Insights

○ Success from the project depends on the Team

○ Clear communication is critical

○ Execution is vital to success

○ Good use of online collaboration - GitLab

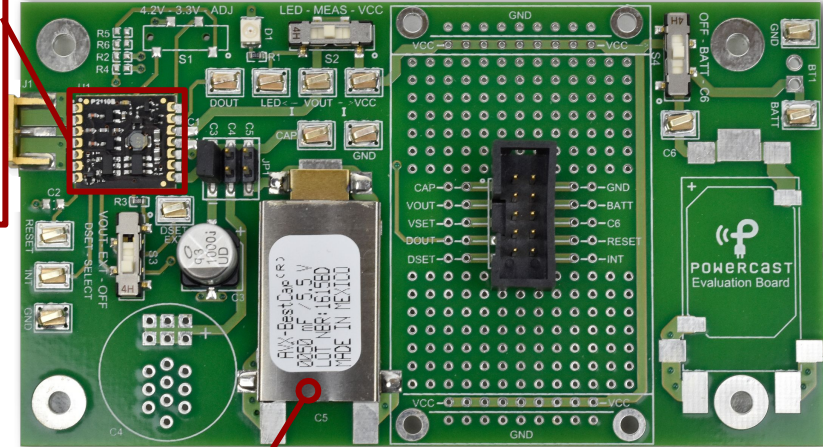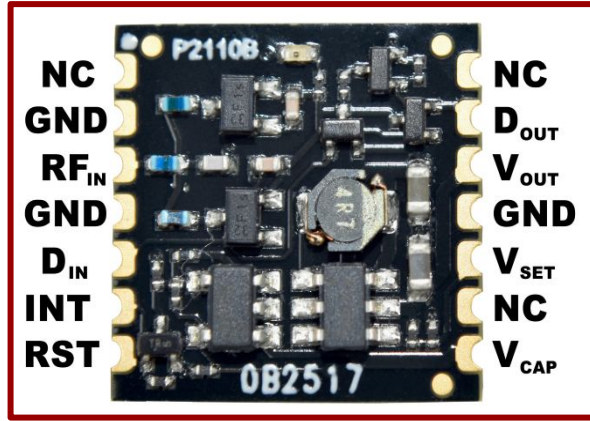○ Overall our team's skills and attitudes complement each other

Concluding Remarks

Future Development

Integrated PCB

RF Harvester & Powercaster
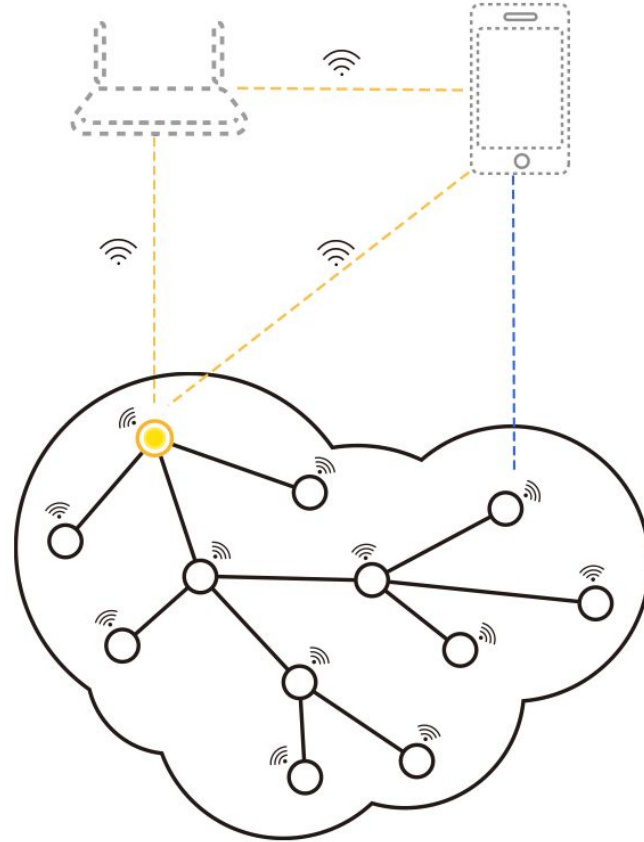

3W 915MHz Transmitter

P2110B

NC	NC
GND	D_{OUT}
RF_{IN}	V_{OUT}
GND	GND
D_{IN}	V_{SET}
INT	NC
RST	V_{CAP}

OB2517

Capacitor

P2110B EVA Board

Powercast Evaluation Board

Wi-Fi Mesh

- **Decentralized Network**

- **Reliable Data Transfer**

- **Wider Coverage**

- **Lower Risk of Failure**

- **Require Better Hardware**

- **Implementation Complexity**

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Cloud Management System

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Acknowledgements

Quick Thank you to:

- ○ Scott's Dad (Retired Firefighter/Fire Prevention)

- ○ Ryne's Girlfriend's Dad (Fire Chief)

- ○ Raymond Messier (North Shore SAR)

- ○ Royce Ng (Amazon Warehouse Safety/SAR)

Demo

Questions?

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