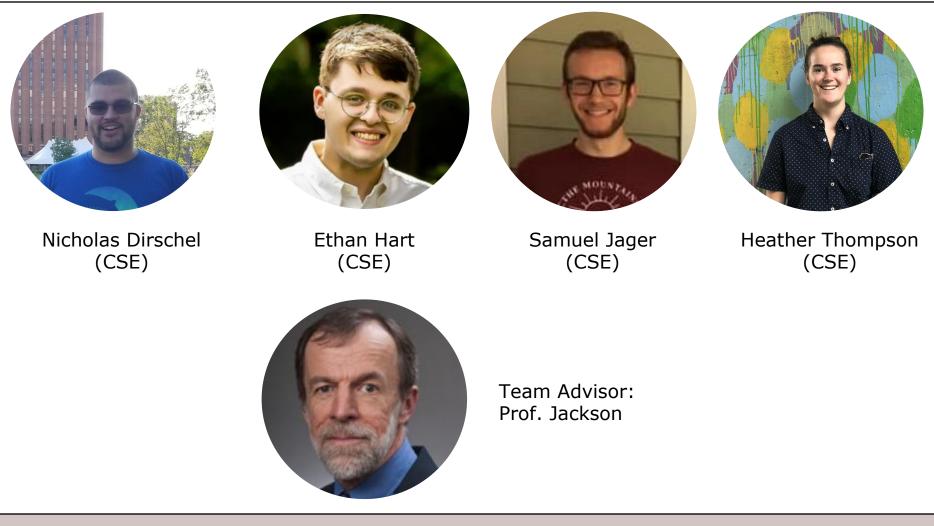
# Midway Design Review

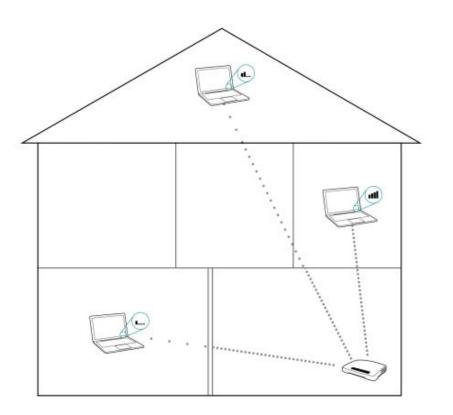
Mappa Signa December 9th, 2019

#### Introduction



#### **Problem Statement**

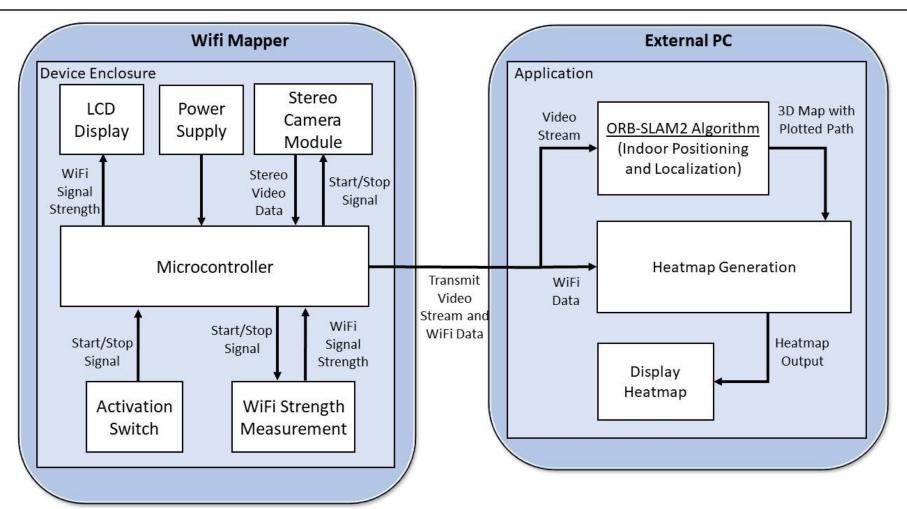
- WiFi signal is inconsistent throughout homes and offices
- Most homes have a single access point
- Houses are filled with walls and furniture that block WiFi signals
- Current solutions require copious manual input of data



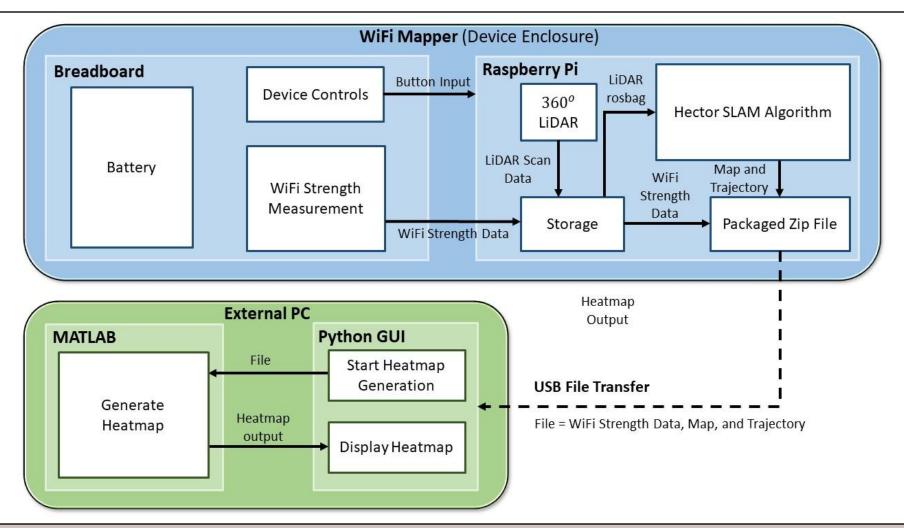
#### System Specifications

- 1. Battery lasts minimum of 3 hours or long enough to map entire building.
- 2. Map creation and trajectory estimation without user input of pre-existing map.
- 3. Suggest optimal signal booster placement based on heatmap results.
- 4. Turn on and go functionality, no user intervention until data analysis.

#### Original Block Diagram (PDR)



#### **Current Block Diagram**



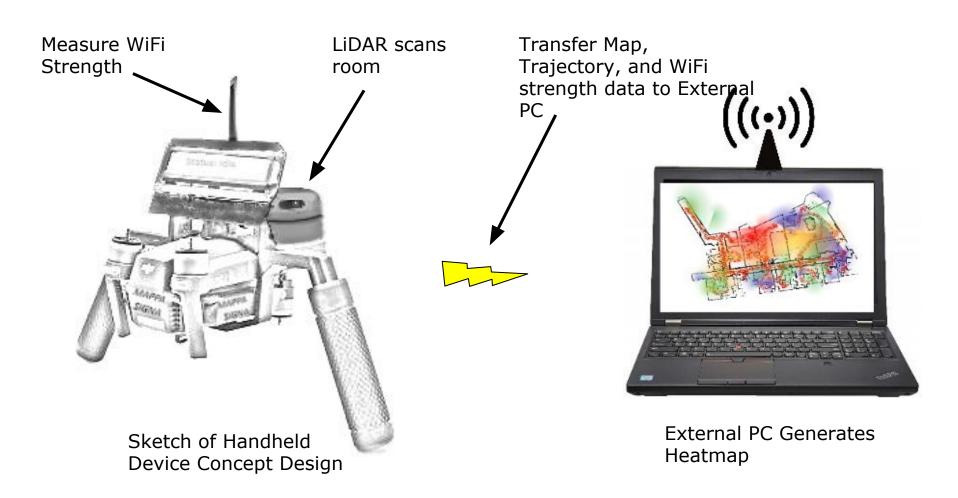
#### Proposed MDR Deliverables

- Create map of environment
- Simultaneously capture WiFi data
- Communicates with external PC via USB to transfer map, trajectory, and wifi measurements
- Combine received data to create heatmap of WiFi signal strength

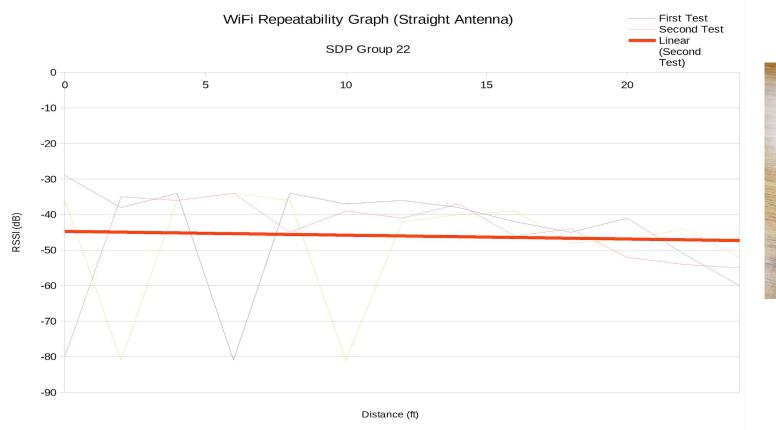
#### MDR Deliverable - Progress

- Create map of environment using LIDAR & Hector SLAM
- Simultaneously capture WiFi data
- Communicates with external PC via USB to
  - transfer map, trajectory, and wifi measurements
- Combine received data to create heatmap of
   WiFi signal strength

#### **Concept Design**

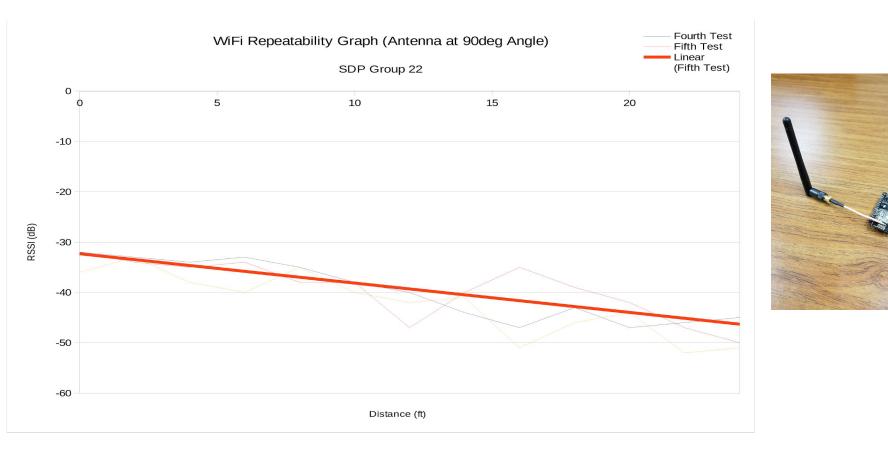


#### Measuring WiFi Signal Strength





#### Measuring WiFi Signal Strength



#### 360° LiDAR: RPLIDAR A2M8

- Specs:
  - Range: 0.15 12m
  - Distance Accuracy: ~1%
- Open Source Package: rplidar\_ros
  - Read raw scan data from LIDAR
  - Record scan data for playback at later time



#### Hector SLAM using LiDAR

- Simultaneous localization and mapping
- Can perform using:
  - real-time LIDAR scans
  - simulated-time LIDAR scan recordings

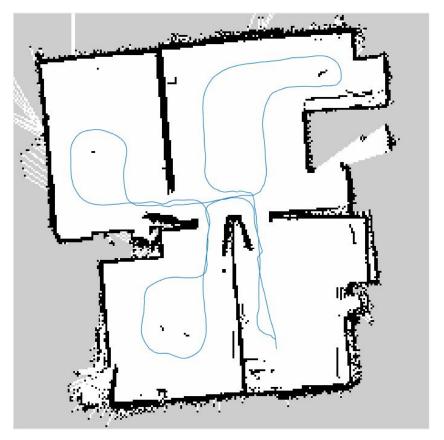


Fig. 5: Hector SLAM Map and Trajectory results from Cliffside apartment.

#### Microcontroller: Raspberry Pi 3

- Purpose:
  - Simultaneously record WiFi strength and LiDAR scan data
  - Perform Hector SLAM
  - Transfer map, trajectory, and wifi strength data to PC.



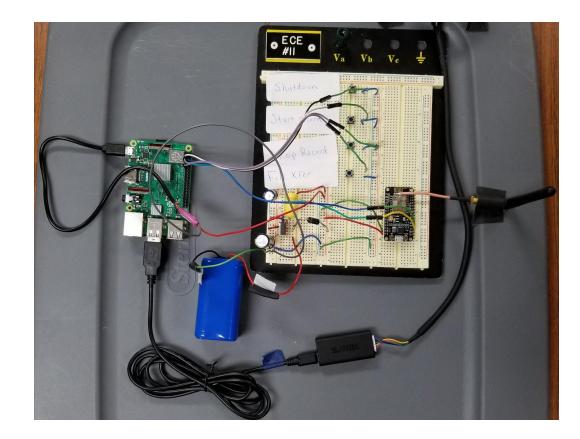
#### Power

- 7.2V 6500mAh Lithium-Ion battery powers:
  - Raspberry Pi 3
  - LiDAR Scanner
  - NodeMCU Amica WiFi
- Total system power usage between 1200-1900 mA
  - 3-4 hours of battery life
- Buck regulator used to step down voltage from 7.2V to 5V



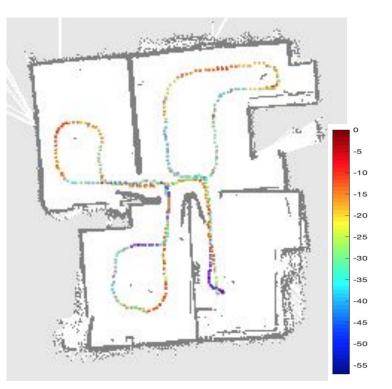
#### Significant Hardware Component

- Data transfer from WiFi device to Raspberry Pi
- Regulate power for each component
- Display current signal strength



#### Computer Application on External PC

- Generate Heatmap
  - Combine SLAM trajectory with WiFi signal strength data
- Signal Booster Suggestion
  - suggest signal booster placement based on weak points of heatmap



#### Parts Used

- Raspberry Pi Compute Module 3 ~\$40
- RPLiDAR A2M8 \$319
- WiFi Breakout Board \$25
- Activation Switch \$1
- Lithium ion battery \$60
- Step-down regulator \$6
- External PC \$0

#### Team Roles + Responsibilities

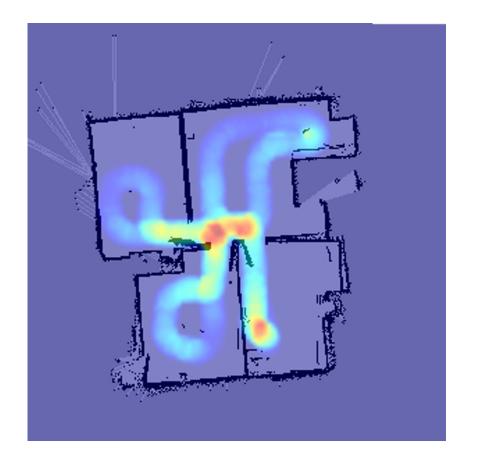
- Nick Dirschel (CSE)
  - WiFi Data Processing
  - GPIO Pin Configuration
- Ethan Hart (CSE)
  - PCB Development
  - Power Management
- Samuel Jager (CSE)
  - LIDAR Data Processing + SLAM Implementation
  - Process automation
- Heather Thompson (CSE)
  - Heatmap Generation (Matlab)
  - Application Development: Signal Booster Placement

#### Gantt Chart

Mappa Signa Sin 2, 2000 Sin 3, 2000																_												_					_				_			
ASSIGNED TO START END M T W T F S M T V T F S N T V T V T <th colspan="4">Mappa Signa</th> <th colspan="5">Jan 20, 2020</th> <th colspan="5">Jan 27, 2020</th> <th colspan="6">Feb 3, 2020</th> <th colspan="5">Feb 10, 2020</th> <th colspan="5">Feb 17, 2020</th> <th colspan="5">Feb 24, 2020</th> <th></th> <th colspan="4">Mar 2, 2020</th>	Mappa Signa				Jan 20, 2020					Jan 27, 2020					Feb 3, 2020						Feb 10, 2020					Feb 17, 2020					Feb 24, 2020						Mar 2, 2020			
IASK       TO       SIAH       END       M       TW       F S S M						1 22	23 24	4 25	26 2	7 28	29 3	30 31	1 1	2	3 4	5	6	78	9	10	11 1	2 13	14	15 1	16 1	7 18	19	20	21 2	2 23	24	25 2	26 2	7 28	29	1	2	3 4	5	6
Configure LCD Display for Device Nick 1/21/2 1/28/20   File transfer over WiFi to PC Nick 1/28/20 2/4/20   Design PCB in Altium Ethan 1/21/2 1/31/20   Submit PCB Design for fabrication Ethan 1/31/20   J1/20 2/10/20 2/11/20   Perce Encasement Design (CAD) Samuel 1/26/20   Samuel 1/21/20 2/11/20   JD Print Device Design Samuel 2/11/20   Samuel 2/11/20 2/15/20   GUI Refinement Heather 1/31/20   J20/20 2/11/20   Samuel 2/11/20   Z11/20 2/11/	TASK		START	END	м	r w	TF	s	S N	ит	w	T F	s	s	мт	w	т	FS	s	м	т	V T	F	s	s N	1 T	w	т	F	s s	м	т١	N	F	s	s	м.	r w	т	F
File transfer over WiFi to PC Nick 1/28/2 2/4/20   Design PCB in Altium Ethan 1/21/2 1/31/20   Submit PCB Design for fabrication Ethan 1/31/2 2/10/20   Povice Encasement Design (CAD) Samuel 1/26/2 2/11/20   Samuel 1/21/2 2/11/20 2/11/20   Potrint Device Design Samuel 2/11/20 2/15/20   Sol Print Device Design Samuel 2/11/20   Samuel 2/11/20 2/15/20   GUI Refinement Heather 1/31/20   Heather 1/31/20 2/3/20	Power LiDAR directly through PCB	Samuel	1/21/20	1/26/20																																				
Design PCB in Altium Ethan 1/21/20 1/31/20   Submit PCB Design for fabrication Ethan 1/31/20 2/10/20   Device Encasement Design (CAD) Samuel 1/26/20 2/11/20   1/26/20 2/11/20 2/15/20 1   Submit PCB Design + Collect Data Group 2/16/20 2/19/20   GUI Refinement Heather 1/31/20 2/32/20	Configure LCD Display for Device	Nick	1/21/20	1/28/20																																				
Submit PCB Design for fabrication       Ethan       1/31/20       2/10/20       Image: Comparison of the co	File transfer over WiFi to PC	Nick	1/28/20	2/4/20						2																														
Device Encasement Design (CAD) Samuel 1/26/20 2/11/20   Heatmap Software Refinement Heather 1/21/20 2/15/20   3D Print Device Design Samuel 2/11/20 2/15/20   Test design + Collect Data Group 2/16/20 2/19/20   GUI Refinement Heather 1/31/20 2/23/20	Design PCB in Altium	Ethan	1/21/20	1/31/20																																				
Heatmap Software Refinement Heather 1/21/20 2/15/20   3D Print Device Design Samuel 2/11/20 2/15/20   Test design + Collect Data Group 2/16/20 2/19/20   GUI Refinement Heather 1/31/20 2/23/20	Submit PCB Design for fabrication	Ethan	1/31/20	2/10/20																																				
3D Print Device Design       Samuel       2/11/20       2/15/20         Test design + Collect Data       Group       2/16/20       2/19/20         GUI Refinement       Heather       1/31/20       2/23/20	Device Encasement Design (CAD)	Samuel	1/26/20	2/11/20																																				
Test design + Collect Data         Group         2/16/20         2/19/20           GUI Refinement         Heather         1/31/20         2/23/20	Heatmap Software Refinement	Heather	1/21/20	2/15/20																																				
GUI Refinement Heather 1/31/20 2/23/20	3D Print Device Design	Samuel	2/11/20	2/15/20																																				
	Test design + Collect Data	Group	2/16/20	2/19/20																																				
Data analysis, Performance statistics Group 2/19/20 2/23/20	GUI Refinement	Heather	1/31/20	2/23/20																				90			940													
	Data analysis, Performance statistics	Group	2/19/20	2/23/20																																				
CDR Group 2/24/20 3/5/20	CDR	Group	2/24/20	3/5/20																																				

#### **Proposed CDR Deliverables**

- Convert power and device controls to PCB
- Create device enclosure for easier use
- Incorporate LCD display to show status of device
- Automate file transfer from device to external PC over WiFi



#### FPR and Demo Day

- Final Product
  - Device encapsulated in comfortable form factor
- Demonstration of Mappa Signa
  - Create 2D map of current room
  - Generates heatmap from newly acquired data
  - Recommends best places on map to place a signal booster based on heatmap and amount of boosters user requests



#### Video Demo



## **Questions?**