



# Keyless Entry for a Secure Smart Lock

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Group 11



# Basic Description

- Multiple ways to unlock the door
- Deadbolt mounted to small door frame to simulated actual door
- Motor mounted to single cylinder deadbolt
- Monitoring the doors state change (when it is unlocked/locked)



# Motivation

- Move home towards smart system
- Increase access to home
- Be able to monitor entry/exit
- Not have to worry about being locked out of home



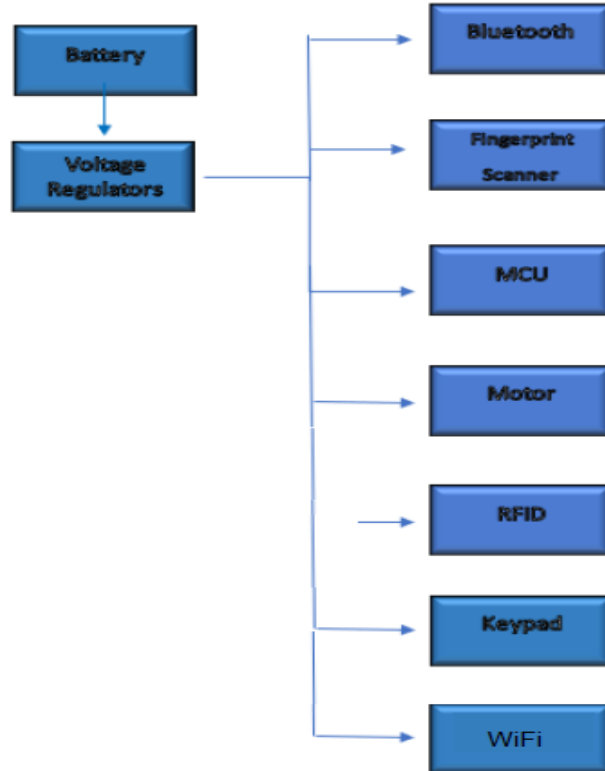
# Goals and Objectives

- Power efficient
- Multiple ways to unlock the door
- Monitor when the door is unlocked/locked through App
- Keep developmental costs low

# Specifications

Classifications	Description	Characteristics
Performance, Functionality, and Operation	Able to update with new operating code	
Economic	Relatively Inexpensive to create	<\$120
Energy	Long Lasting Battery Life	Approximately 1 year
Usability and Maintainability	Simplistic to Use	Keypad, Fingerprint Sensor, RFID Card, WiFi, Bluetooth Application
Usability and Maintainability	Functions when Battery is dead	Manual unlock and lock
Usability and Maintainability	Easy Battery Replacement	1 minute replacement time
Usability and Maintainability	Wifi Accessible	

# Power Diagram





# Motor Comparisons

Types	Servo	Stepper	DC
Voltage	4-12V	2-5V	6-12V
Stall Torque (oz/cm)	402	18.41	285.05
Max Travel (deg)	198	1.8 (increments)	Continuous
Current	300mA	700mA	360mA
Motor Driver Needed	No	Yes	Yes
Price	N/A	\$12.99	\$19.90



# Comparison of Power Supply

Type	Voltage (DC)	mAh	Pros	Cons	Cost
<b>AC Adapter</b>	5V	Lifetime	<ul style="list-style-type: none"><li>-Constant power</li><li>-Less maintenance</li></ul>	<ul style="list-style-type: none"><li>-Requires a power cord to be routed to PCB</li><li>-Bulky</li></ul>	\$28
<b>AA Battery</b>	1.5Vx4=6V	2000-3000	<ul style="list-style-type: none"><li>-Readily available</li><li>-Affordable</li><li>-Compact</li><li>-High Capacity</li></ul>	<ul style="list-style-type: none"><li>-Needs replacement overtime</li><li>-Susceptible to corrosion</li></ul>	\$5 for 4
<b>9V Battery</b>	9V	500	<ul style="list-style-type: none"><li>-Higher voltage</li><li>-Compact</li><li>-Cheap</li></ul>	<ul style="list-style-type: none"><li>-Low Capacity</li><li>-Needs replacement overtime</li><li>-Susceptible to corrosion</li></ul>	\$8 for 2



## Required Power of Essential Devices

Device	Voltage	Current
MCU	5V	50mA
Servo	4-12V	300mA
RFID	5V	55mA
BLE	5V	1.7mA
Fng Print	3.3V	<40mA
WiFi	6V	60mA



# Voltage Regulators

5V Regulators	LD117		KA278R05C	
<b>Input Voltage</b>	7V (max)		35V (max)	
<b>Output Voltage</b>	4.9-5.1V		4.88-5.12V	
<b>Quiescent Current</b>	5-10mA		10ma	
<b>Output Current</b>	800-1300mA		2A (max)	
<b>Dropout Voltage</b>	Io=100mA	1-1.1V	Io=1A	0.5V
	Io=500mA	1.05-1.15V		
	Io=800mA	1.10-1.2V		
<b>Price</b>	\$0.15		\$1.17	

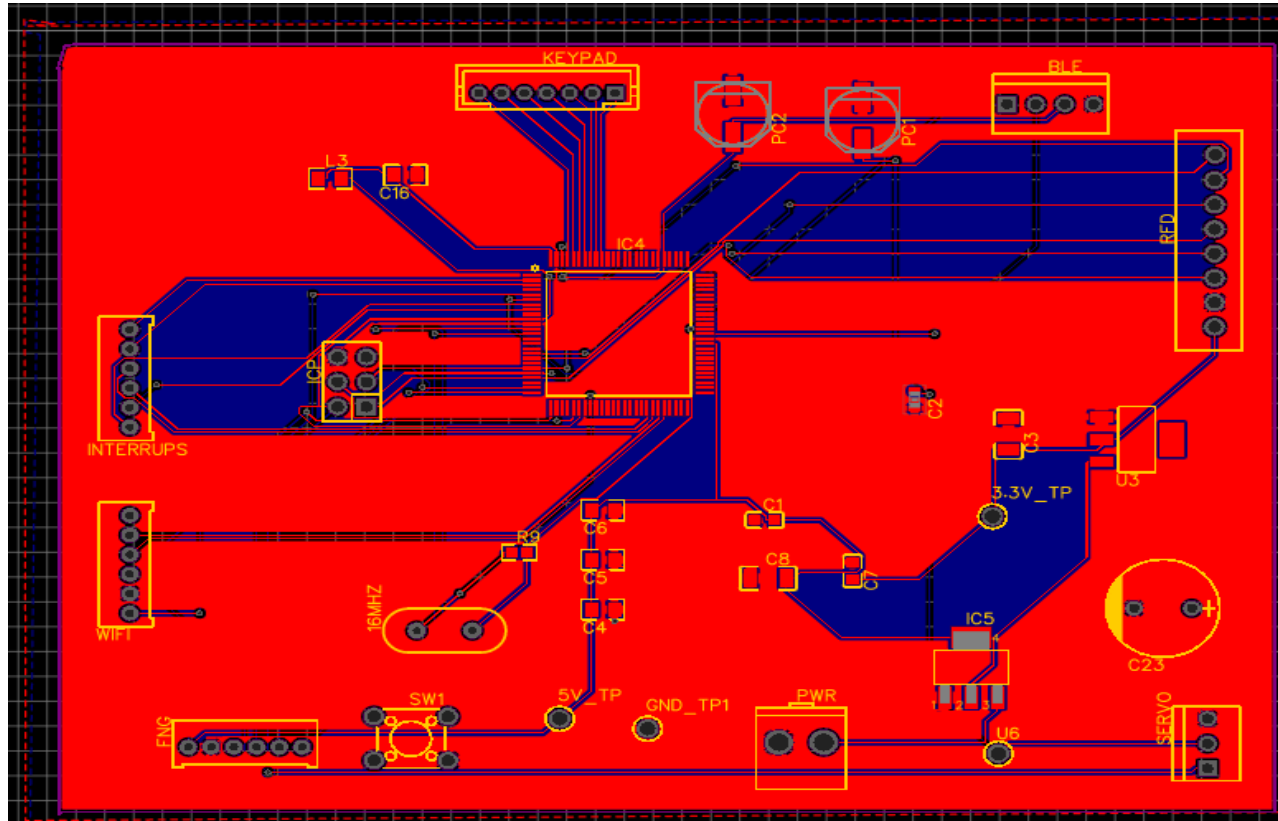
3.3V Regulators	LP2986		MAX1651	
<b>Input Voltage</b>	16V (max)		3-16V	
<b>Output Voltage</b>	3.3V		3.17-3.43V	
<b>Quiescent Current</b>	850µA		100µA (max)	
<b>Output Current</b>	350mA (max)		1A (max)	
<b>Dropout Voltage</b>	Io=1mA	7mV	Io=500mA	300mv
	Io=50mA	225mV		
	Io=150mA	500mV		
<b>Price</b>	\$0.15		\$2.13	



# Software Design

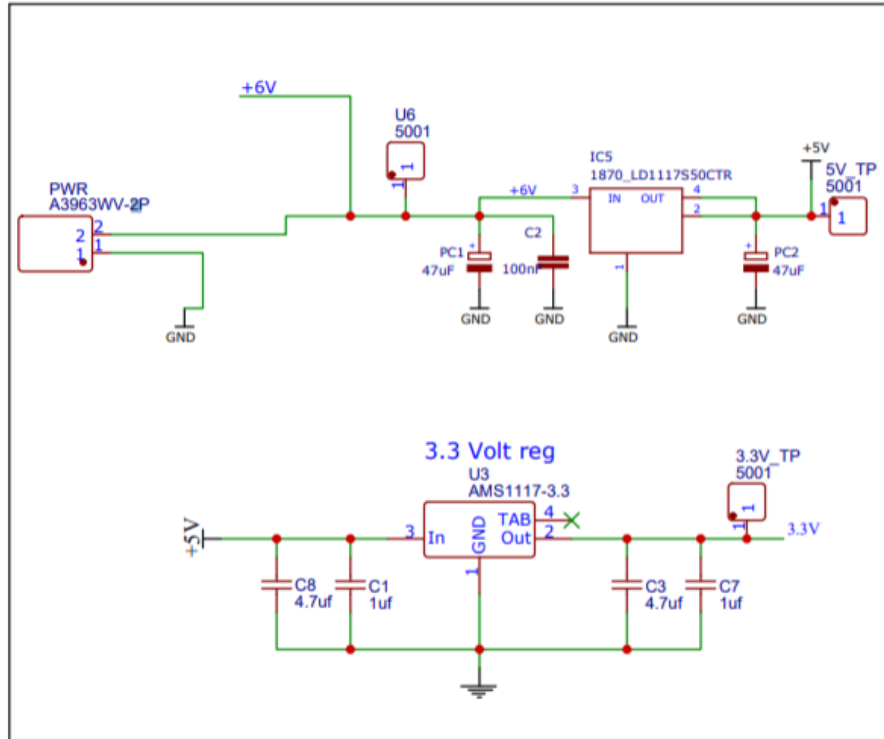
- Hardware Interface
  - Sensor Logic
    - Sensor Input
- Software Interface
  - User Settings
    - Logs

# PCB Design



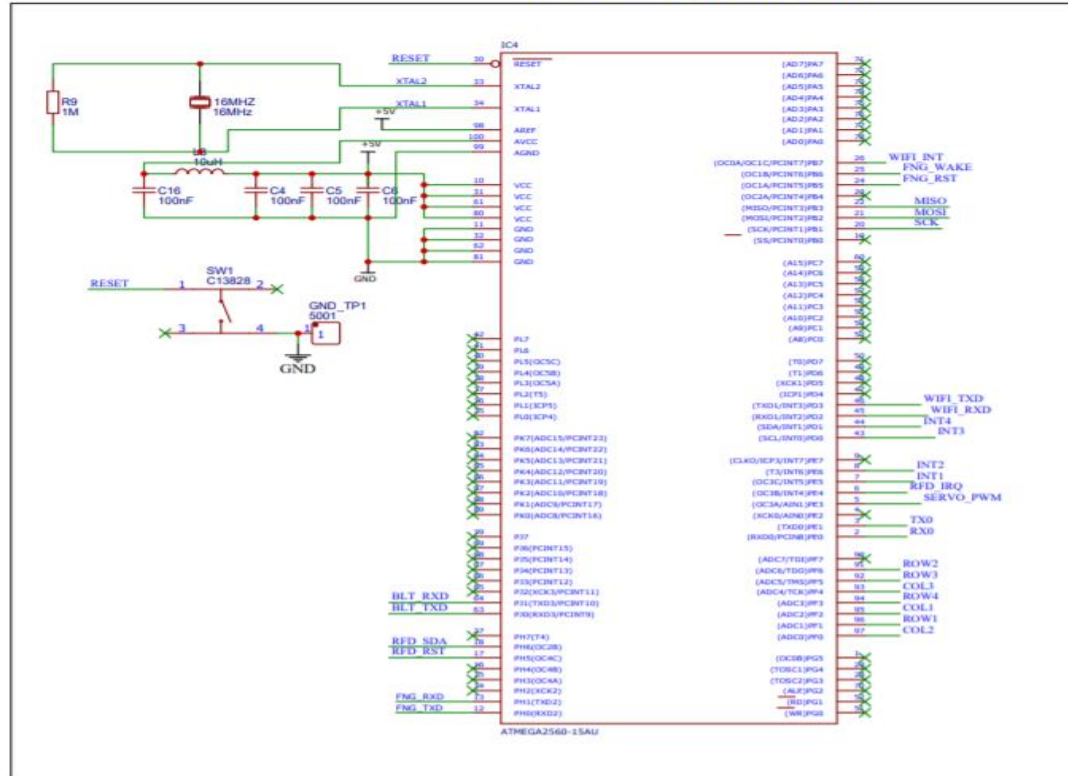
# Schematic Design

## POWER



# Schematic (cont)

## ATMEGA2560



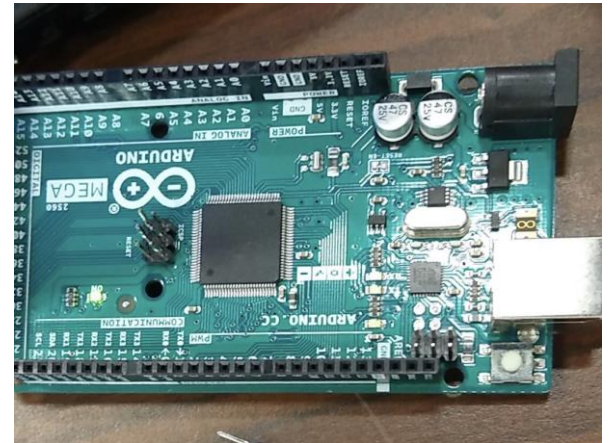


# PCB Design and Acquisition

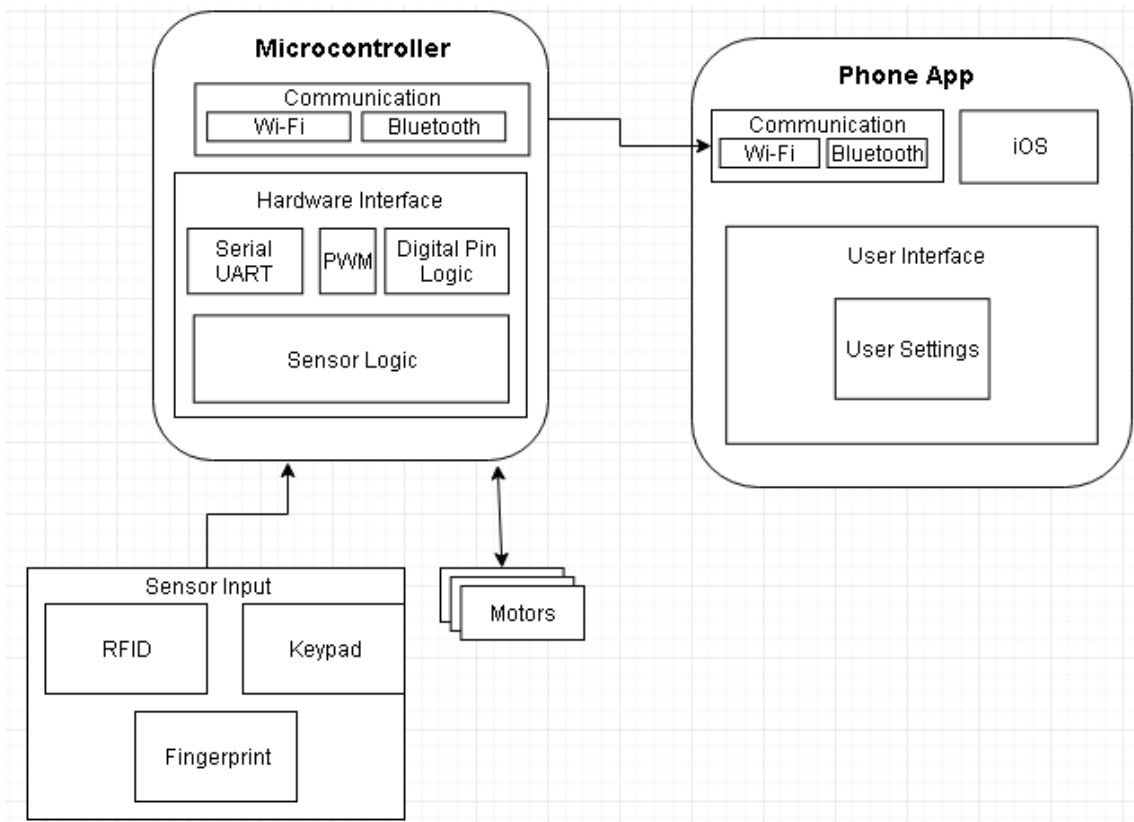
- Developed in EasyEDA
- PCB ordered through JLCPCB
- Components ordered through LCSC Electronics

# Development Environment

- Original: Beaglebone Black Wireless
  - Camera Option
  - Built-in Wifi
  - Readily Available
- Reason for Change
  - Encountered issue with Built-In Wifi
  - Arduino was the next best option
- Replacement: Arduino Mega 2560
  - Experience
  - Plethora of Documentation
  - Simple coding



# Software Design



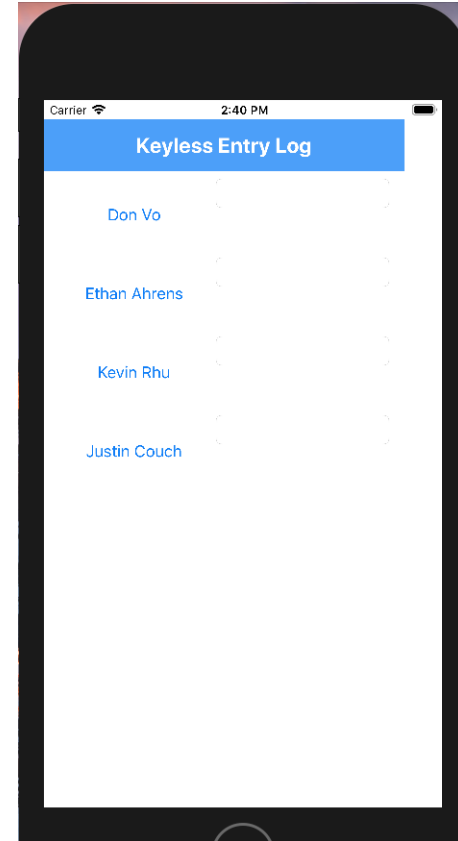



# Application Concept

- Originally, the screens were captured and constructed through the Marvel app.
- The code grew to be increasingly difficult to implement in the programs that we had available to us.
- There was difficult constructing this app on the windows system with our limited knowledge on phone applications.

# Application Layouts

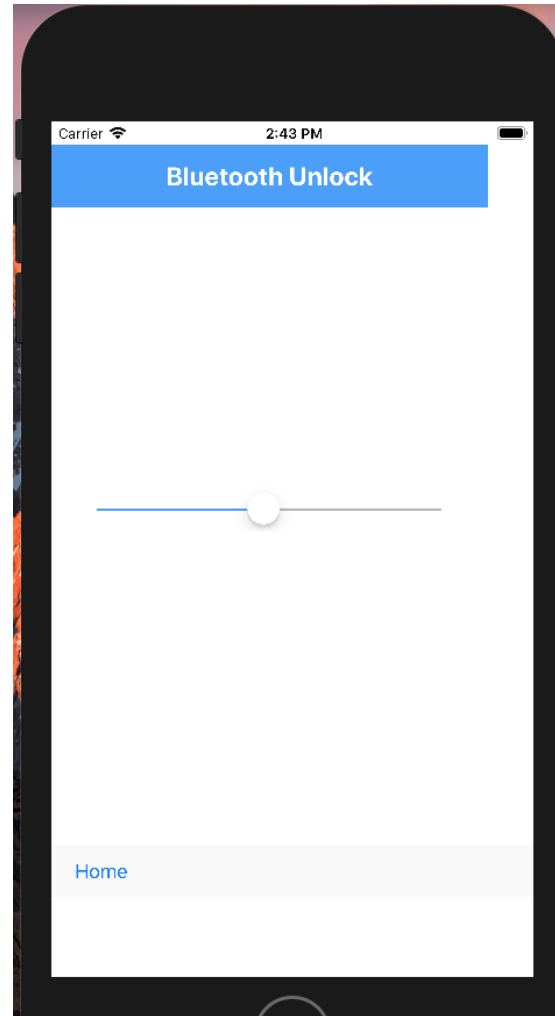
- Developing Through Xcode on Swift Language on Mac
- Testing and simulation was completed through an iPhone 8 prior to simulation.
- Entry Log is the command screen
- Options screen allows us to select what method of entry we want to use





# Application Layout and Features

- App is heavily structured through interrupts, so it offers smooth and easy transitions.
- Communicates to the PCB through bytes, so we had to convert our integer values to bytes.
- App is set to immediately search for the Smartlock for ease of use.



# RFID Sensor (Original)

- Choice: DLP-RFID2
- High Frequency RFID
- Operating Voltage: 3-5V
- USB and TTL interface
- Price Point
- Replaced with MFRC RC522 RFID-RC522 RF IC Card Reader Sensor

**Table 8: RFID Sensor Comparison**

Model	Vendor	Price	Pin Count
DLP-RFID2	Mouser/Digikey	\$34.95	14
RWD-QT-R2-ND	Digikey	\$40.37	24
RI-STU-MRD2	Digikey	\$92.40	30



# RFID Sensor (Replacement)

- Reason for Replacement:
  - Required an expensive custom development board
  - Lack of knowledge available
  - No tags
- Replacement sensor: MFRC RC522  
RFID-RC522 RF IC Card Reader  
Sensor
  - Easy to program
  - RFID tags came with Sensor
  - Wealth of available knowledge
  - Low Cost
  - Susceptible to noise



# WiFi Implementation

- Node MCU
- Receives through digital input
- Transmit serial communication through UART

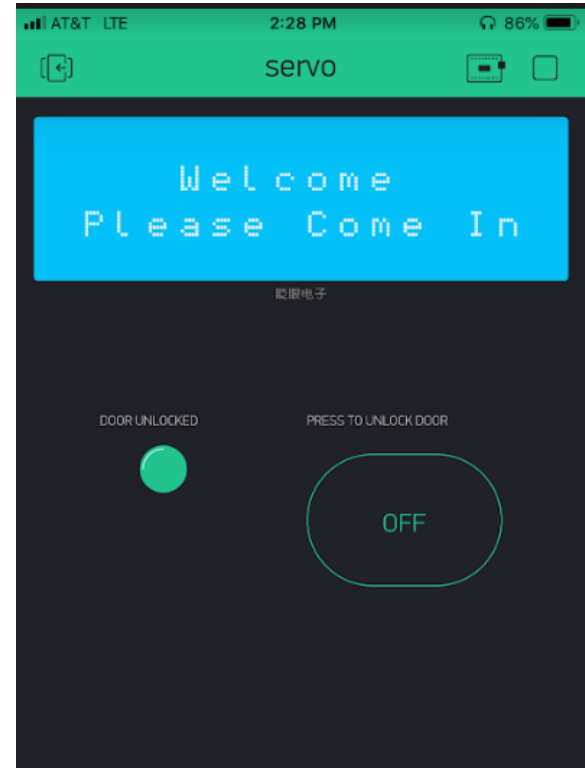
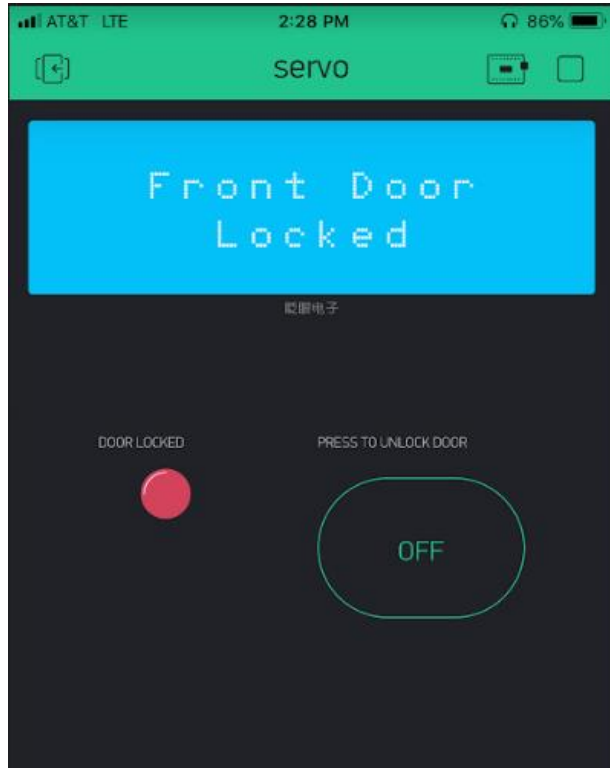




# WiFi App

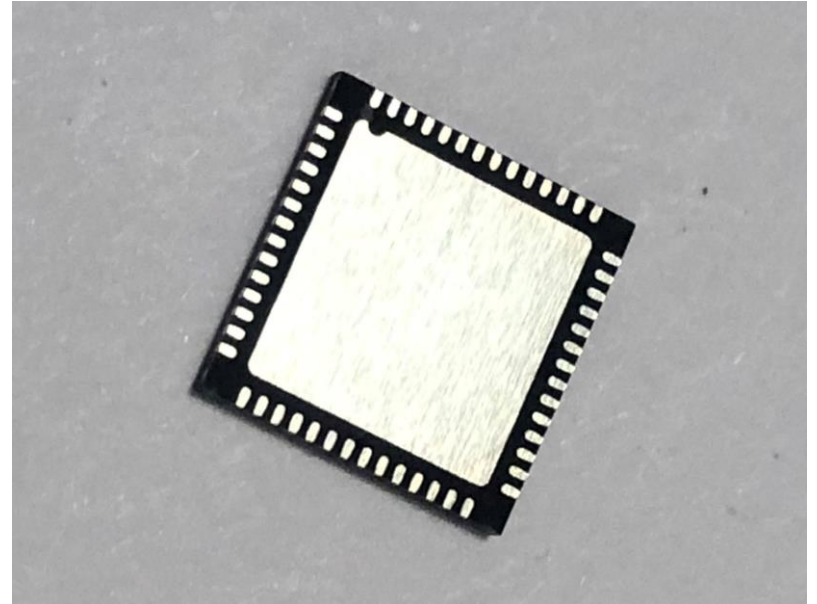
- Uses Blynk Iot Platform
- WiFi module connect to WiFi and sends and receives data to and from Blynk's personal servers
- WiFi app uses custom app authentication code to interface app with hardware

# WiFi App Layout



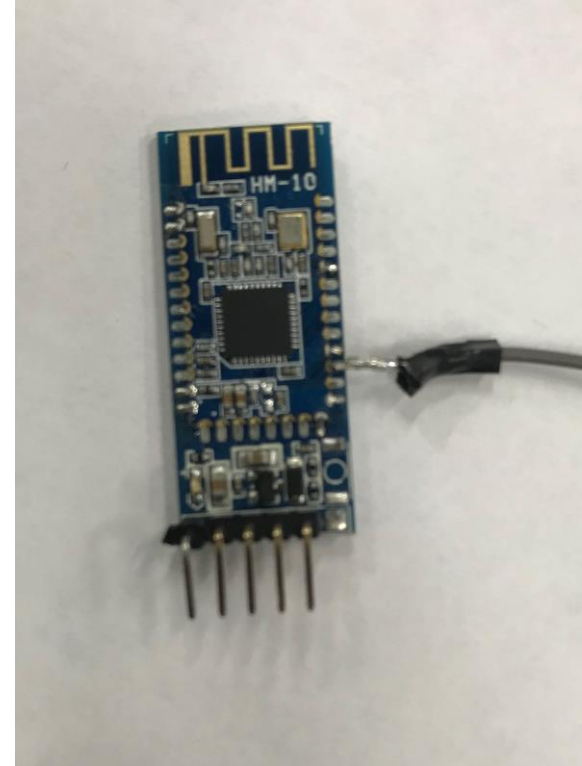
# Bluetooth Choice (Original)

- Cypress PSoC 4100\_BLE
  - 256 KB of Flash Memory
  - Easily Programmable
  - Data rate of about 1 Mbps
  - BLE Device (low energy)
    - Operating Voltage of 1.8 V - 5.5 V
  - Range of 50 meters.
  - Very Small 7 mm x 7 mm x 0.55 mm
- Replaced with the DSD HM-10



# Bluetooth Choice (Replacement)

- Reason for replacement
  - Lack of available knowledge
  - Lack of Interface options with our Development Board
- Replacement: DSD Tech HM-10
  - Wealth of knowledge programming with module with Arduino
  - Easy to interface with through the Arduino
  - Low Cost



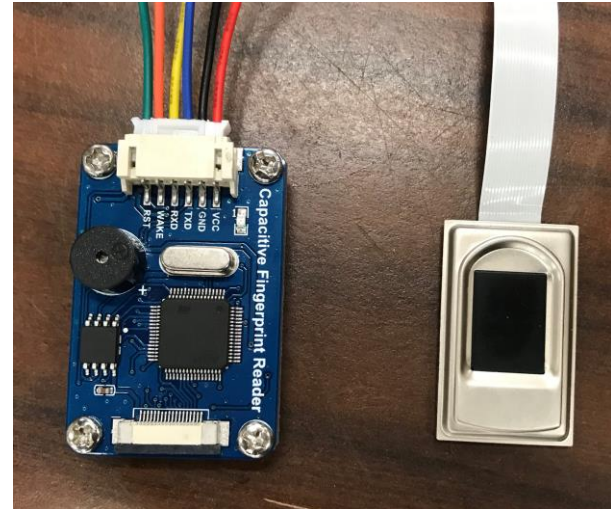


# Fingerprint Sensor Options

- Capacitive Fingerprint Sensor
  - Based on a complex pattern of electrical currents that forms the image of a fingerprint.
  - Durable.
  - Always require the actual fingerprint, so it won't work off a picture.
- Optical Fingerprint Sensor
  - Uses a camera to capture images.
  - Finite Resolution.
  - Easy to read images of fingerprints shows a weakness in security.
  - Expensive due to the camera.

# Fingerprint Sensor Choice

- We chose the capacitive fingerprint sensor sold by Waveshare.
  - Communicates in both USB or UART interface (UART is the main interface we will be working on)
  - Operating Voltage of 3.3V - 5V
  - Dynamic Current of 40 mA.
  - Dimensions of 45 mm x 30 mm for the module and 33.4 mm x 20 mm for the sensor.
  - Less than 0.1 % Rejection Rate



# Keypad Choice

- Sparkfun Basic Wired Keypad
  - 12 Key Keypad that contains 0-9 keys.
  - Keypress Resistance is between 10 and 150 ohms.
  - Relatively Cheap
  - Easy to implement to design.

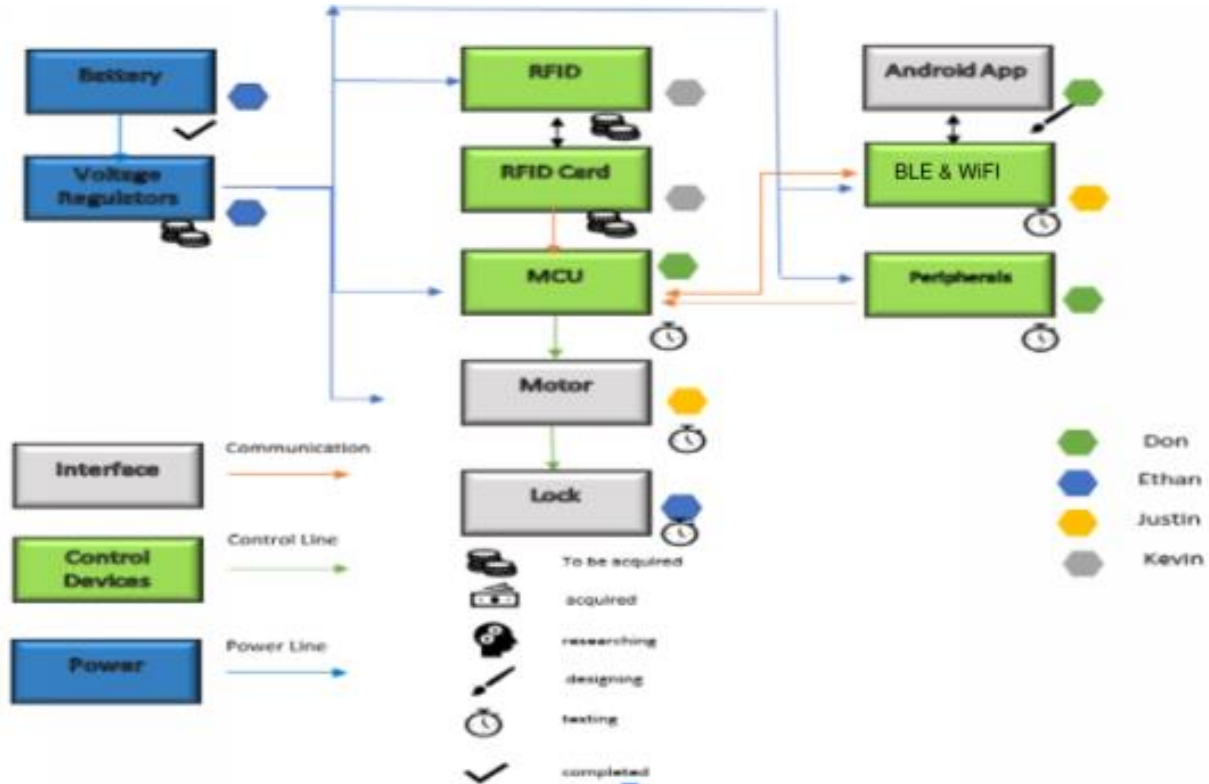


# System Housing

- Material: Wood
- Construction:
  - Lasercut
  - Gluing
  - Carpentry



# Block Diagram





# Division of Labor

Name	Power	Case	Motor	MCU	Bluetooth	RFID	Keypad	Fingerprint	Software	App
Don		2		2	2	2	2	1	1	2
Kevin					1			2	2	1
Ethan	1		1	1			1			
Justin		1			2	1	2	2	2	

Legend:

1-Primary Designer

2- Secondary Designer

# Budget

AR3606 HB Servo Motor	N/A
MFRC RC522 RFID-RC522	\$6.99
DSD HM-10	\$9.99
Capacitive Fingerprint Sensor	\$38.99
COM-14662 Keypad	\$4.50
ARDUINO MEGA 2560 REV3	\$38.50
Node MCU	\$8.39
PCB Manufacturing	\$5.00
Linear Regulator	N/A
Total	\$112.82

# Issues

- Time Management
  - Balancing other classes, work and internships.
- Originally planned to use a beagleboard, but its compatibility with arduino proved to be an issue, so we switched boards.
- Little to no experience in:
  - 3D Printing
  - PCB Design





Questions?