S.M.A.C

Smart Mail Automated Center

Group 9
Shane Bramble-Wade
Tyler Rothenberg
Tyler Guerrero
Andre Villaran

1 Project Overview

A summary of our project management plans.

2 Design Choices

Hardware components selected for our design.

3 Administrative

Day-to-day activities that are related to financial planning, record keeping & billing.

Part 1
Project Overview
A summary of our project management plans.

Motivation

Porch pirates have become public enemy number one.

- In today's world, ordering packages and food from the internet is a way of life.
- Here in America, it turns out, 36% of people have experienced package theft.
- Many of these deliveries are stolen from front porches and building lobbies.

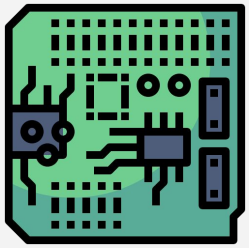
Solution

Success Always Belongs For Those Who Are Prepared

- The application will be able to log authorized packages into S.M.A.C.’s database, unlock it from a remote location.
- S.M.A.C is designed to provide peace of mind for homeowners from package thieves.
- When the delivery is made, the delivery driver simply scans the item and places the item in the box, then closes the lid.
- S.M.A.C will integrate a lot of security and smart features to add value to the box.

Team Members

Success Always Belongs For Those Who Are Prepared

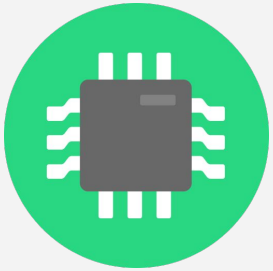


Shane Bramble-Wade

(CpE)

PCB, Lock, Barcode Scanner

Shane has a strong passion for computer hardware. He will be specializing in creating the PCB.



Ty Rothenberg

(CpE)

MCU, Camera, Fingerprint Sensor

Ty has a passion for embedded systems. He will be working on the microcontroller and sensors.

Andre Villaran

(CpE)

Power Systems, UV Light, Wi-Fi Module

Andre has a passions for network engineering. He will working on the different power systems and communication module.

Tyler Guerrero

(CpE)

Mobile Application, RFID Sensor

Tyler will be creating the Mobile App to interact with our lock box.

Goals and Objectives

Success Always Belongs For Those Who Are Prepared

Security

Packages will be locked and secure.

Notifications

A delivery notice will be sent to a user.

Database Storage

Database storage will be used for packages.

Rigid

Box will be bolted to the ground.

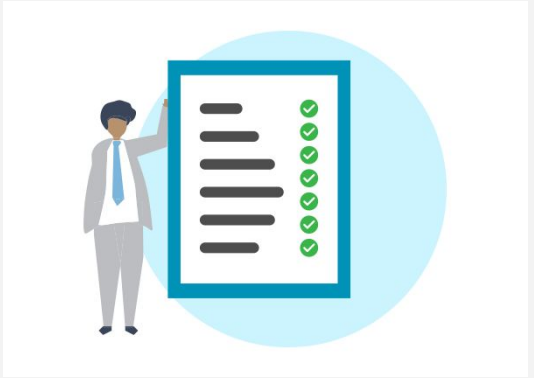
Responsiveness

Mobile app will interact with box.

Requirements Specifications

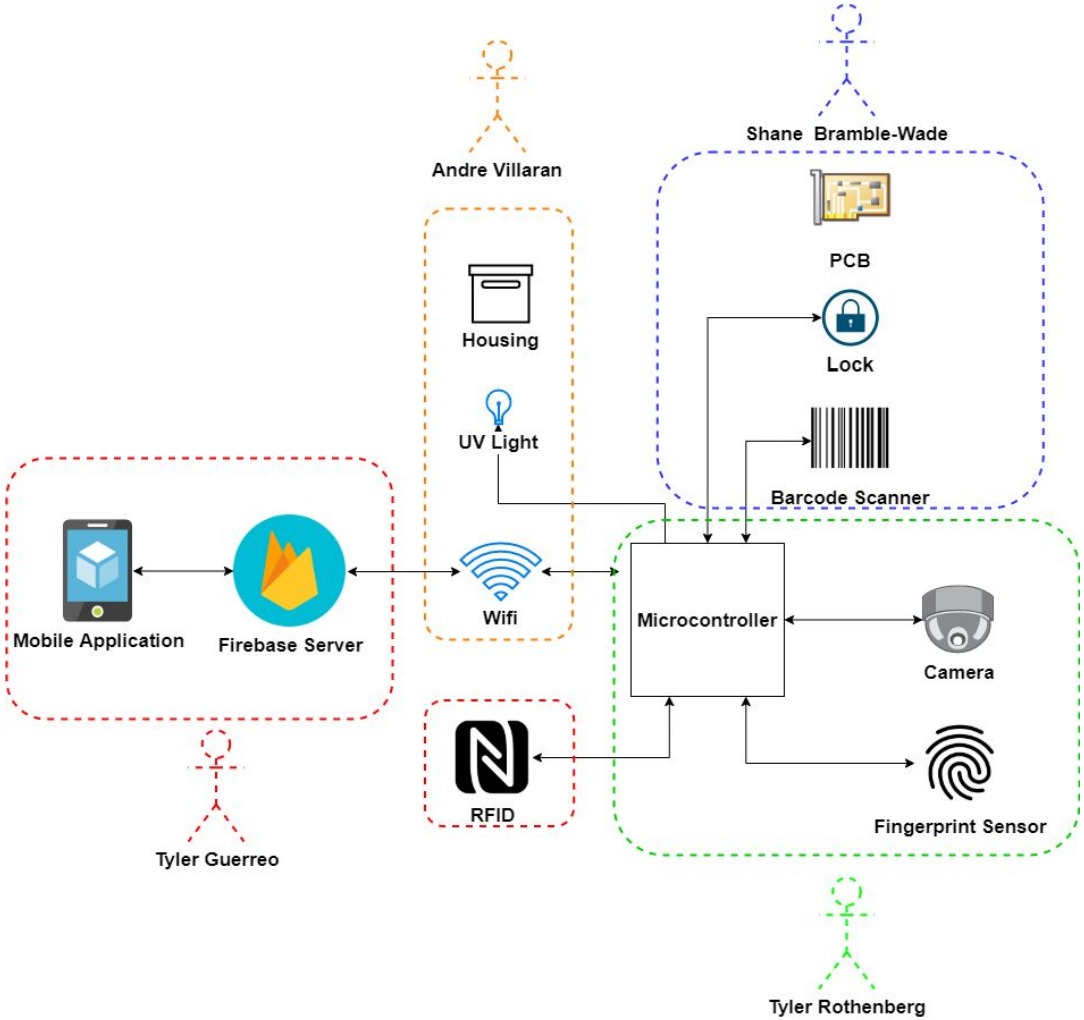
S.M.A.C Project Requirements

1. **Barcode Scanner Unlocks our S.M.A.C. system.**
2. **Unlocking our S.M.A.C. system via a RFID Card.**
3. **Unlock our S.M.A.C. system from a mobile application.**
4. **Enrolling and Unlocking our S.M.A.C. system via a Fingerprint Sensor.**
5. Using mobile application to take snapshot of scenery.



Block Diagram

Group Member	Main Responsibility
Tyler Guerrero	Mobile Application
Andre Villaran	Housing and WiFi
Shane Bramble-Wade	PCB and Lock
Tyler Rothenberg	Microcontroller



Part 2
Design Choices
Hardware components selected for our design.

Microcontroller - Ty

Microcontroller Selection

	MSP430FR6989	ATmega2560
I/O Pins	83	54
UART	2	4
I2C	2	1
SPI	4	5
Program Memory (KB)	128	256
SRAM (KB)	2	8
Architecture	RISC	RISC
Speed	16 MIPS	16 MIPS
Timers	5 16-bit	4 16-bit, 2 8-bit
Size	14 mm × 14 mm	16 mm x 16 mm
Manufacturer	Texas Instruments	Microchip
Cost	$3.61	$11.85

MSPFR6989

ATmega2560

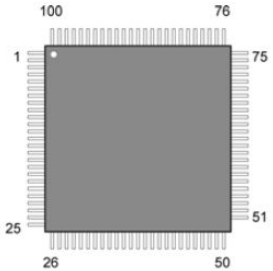
Microcontroller - Ty

Microcontroller Selection

ATmega2560 TQFP Package

Device	Flash	RAM	I/O	UART	ADC
ATmega640	64KB	8KB	86	4	16
ATmega1280	128KB	8KB	86	4	16
ATmega2560	256KB	8KB	86	4	16

ATmega2560 Model Options

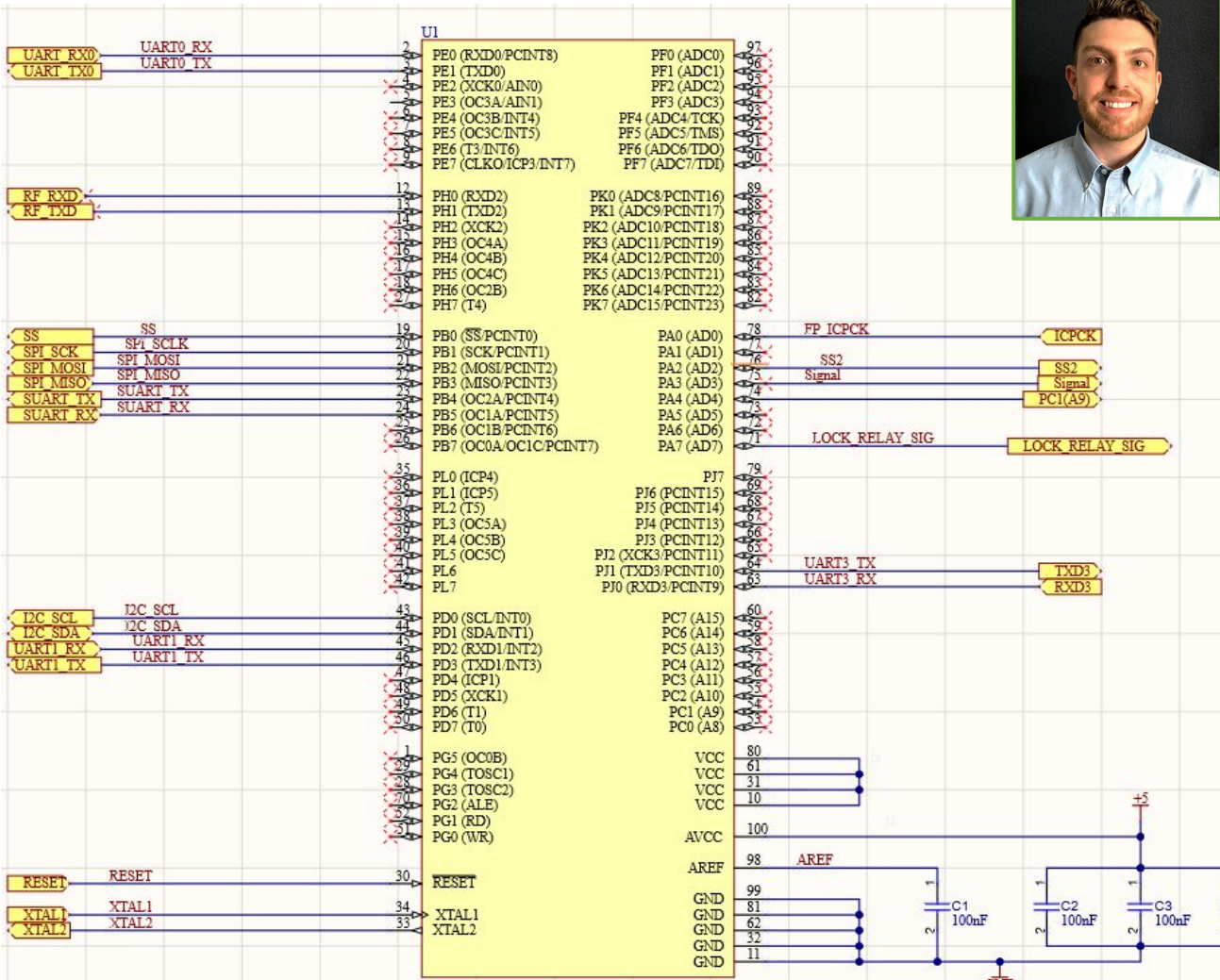


ATmega2560-16AU Specifications	
Operating Voltage	1.8-5.5V
Max Current	20-50mA
Communication Interfaces	4 UART, 1 I2C, 5 SPI
Program Memory Size	256KB
Ram Size	8KB
Chip Size	16 mm x 16 mm
Manufacturer	Microchip
Price	$11.85

ATmega2560 TQFP Specifications

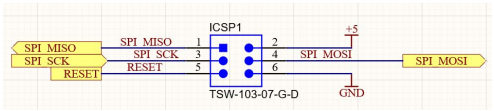
Microcontroller Schematic

Main Microcontroller Schematic

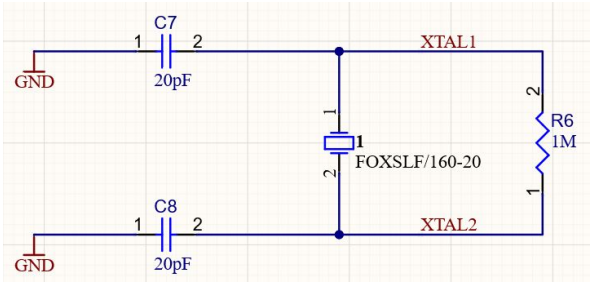


Microcontroller Necessities - Ty

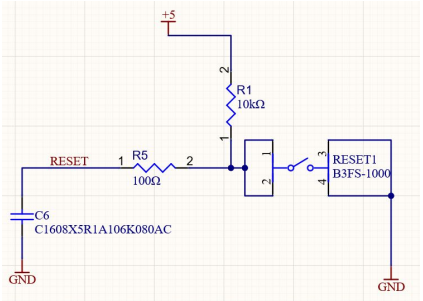
ICSP, External Clock, and Reset Button Circuitry



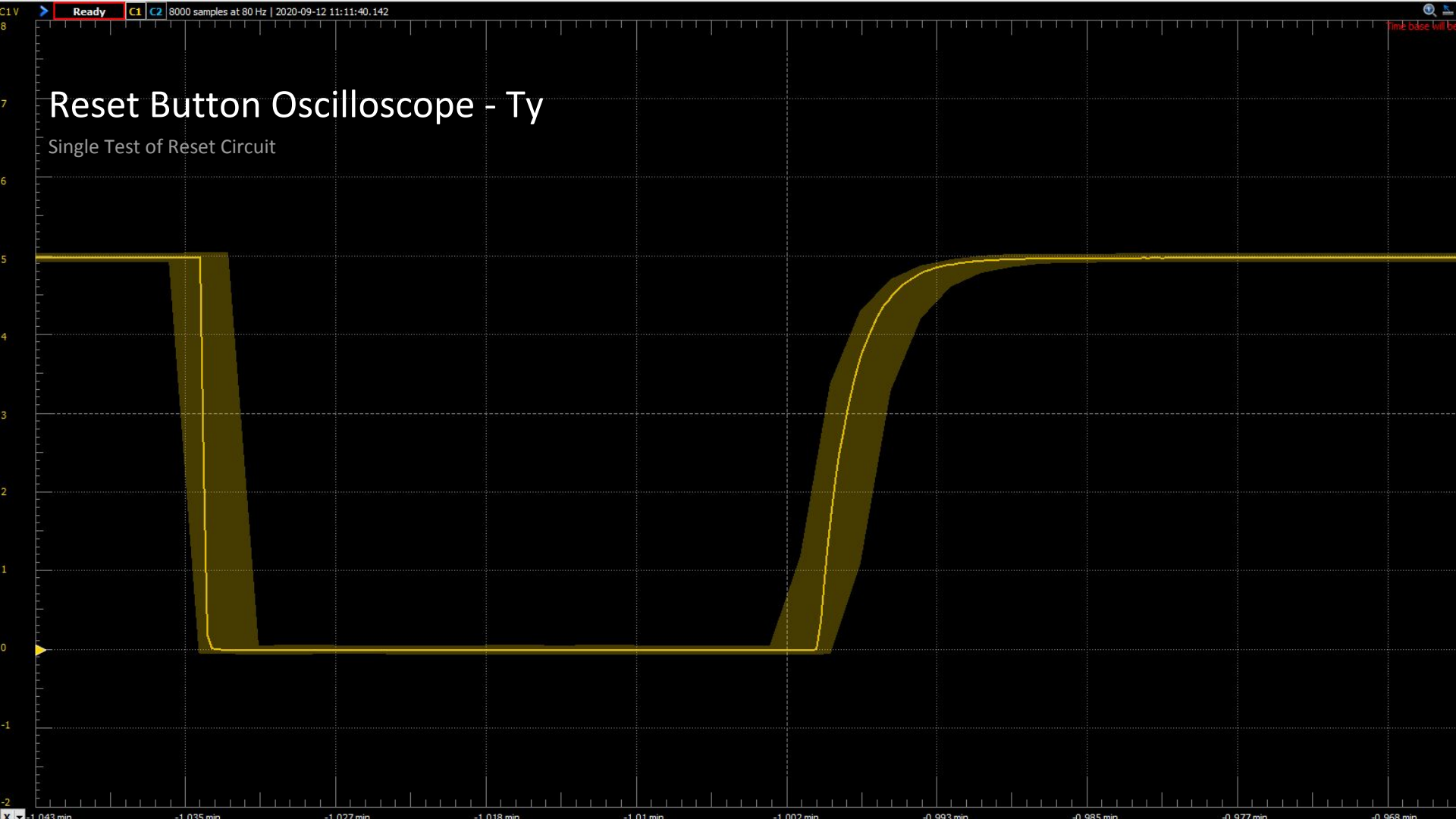
ICSP



External Clock



Reset Button


C1 V
Ready
C1
C2
8000 samples at 80 Hz | 2020-09-12 11:11:40.142
Reset Button Oscilloscope - Ty
Single Test of Reset Circuit
8
7
6
5
4
3
2
1
0
-1
-2
-1.043 min
-1.035 min
-1.027 min
-1.018 min
-1.01 min
-1.002 min
-0.993 min
-0.985 min
-0.977 min
-0.968 min

Fingerprint Sensor - Ty

Box will unlock when a valid fingerprint is scanned.

	Adafruit 751	Sparkfun SEN-14518
Baud Rate	57600	9600
File Size	512B	512B
Communication Protocol	UART	UART
Accuracy	99.999%	99.999%
Identification Time	<1 second	< 1.5 second
Operating Voltage	3.6-5V	3.3-6V
Operating Current	<120mA	<130mA
Cost	$49.95	$35.95
Size	56 x 20 x 21.5mm	36 x 21 x 4.38 mm
Manufacturer	Adafruit Industries LLC	SparkFun

Fingerprint Sensor - Ty

Box will unlock when a valid fingerprint is scanned.

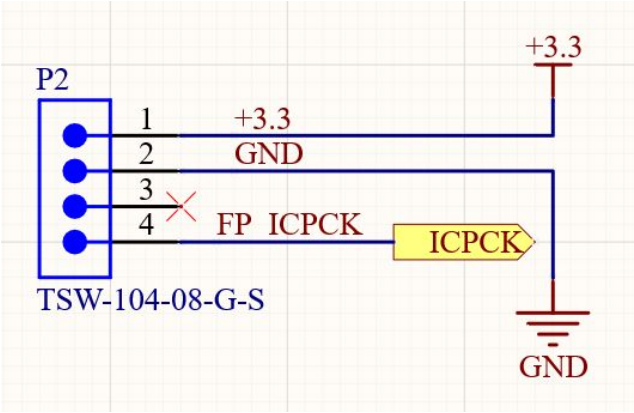
GT-521F32 Fingerprint Module

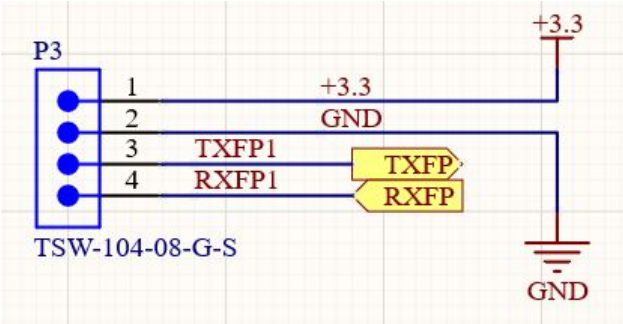
Specifications	
Supply Voltage	3.3-6V
Operating Current	<130mA
Communication Interfaces	UART
False Acceptance Rate	<0.001%
Identification Time	<1.5 Second
Baud Rate	9600
Board Size	36 x 21 x 4.38 mm
Manufacturer	SparkFun

GT-521F32 Fingerprint Module Specifications

Fingerprint Sensor Schematic - Ty

Box will unlock when a valid fingerprint is scanned.



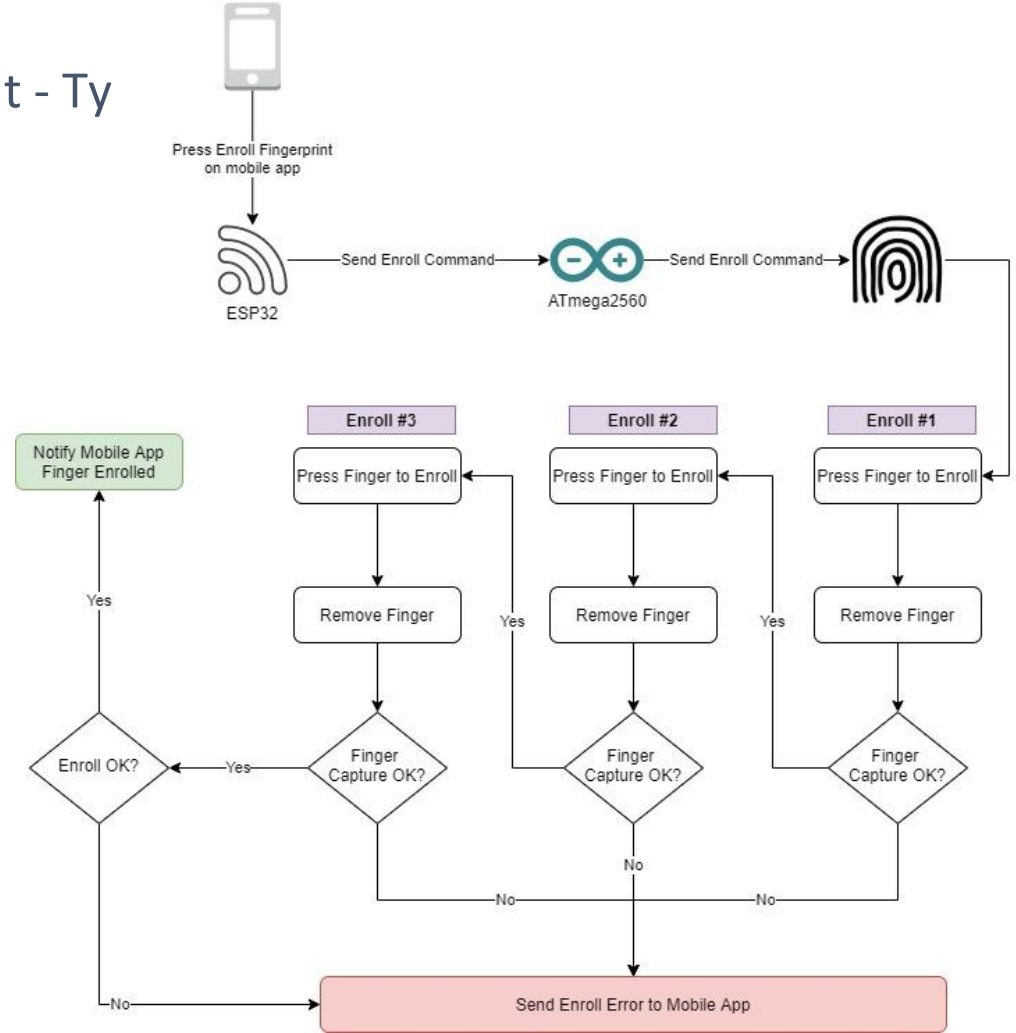


Pin	Label	Type	Description
1	VCC	POWER	3.3V Power Supply
2	GND	Ground	Power Ground
3	x	x	x
4	FP_ICPCK	Output	Hi / Lo output

Pin	Label	Type	Description
1	VCC	POWER	3.3V Power Supply
2	GND	Ground	Power Ground
3	TX	Output	Transmission Line
4	RX	Input	Reception Line

Enrolling New Fingerprint - Ty

General logic for enrolling a new fingerprint



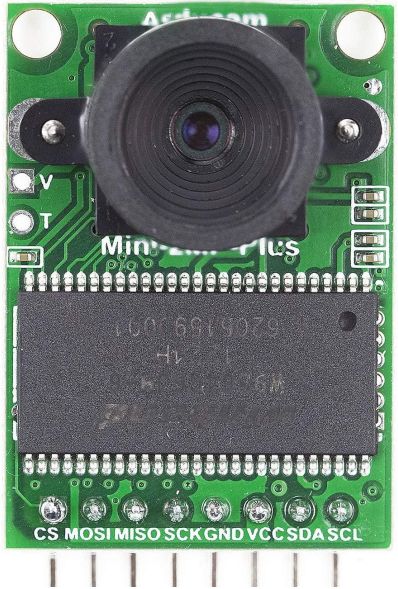
Camera Selection - Ty

Camera will take a photo upon any unlock attempt

	Waveshare OV5640	ArduCAM	OV7670 Camera
Communication Protocol	I2C	I2C	I2C
Max Resolution	640x480	1600 x 1200	2592x1944
Picture Format	RAW RGB, RGB, YUV, YCbCr	RAW, YUV, RGB, JPEG	RAW, RGB, YUV
Supply Voltage	3.3V	5V	3.3V
Size	23.9 x 35.7 x 3 mm	34 x 24 x 3 mm	35.16 x 34.29 mm
Manufacturer	Waveshare	ArduCam	Waveshare
Cost	$31.88	$39.99	$7.69

Camera Selection - Ty

Camera will take a photo upon any unlock attempt



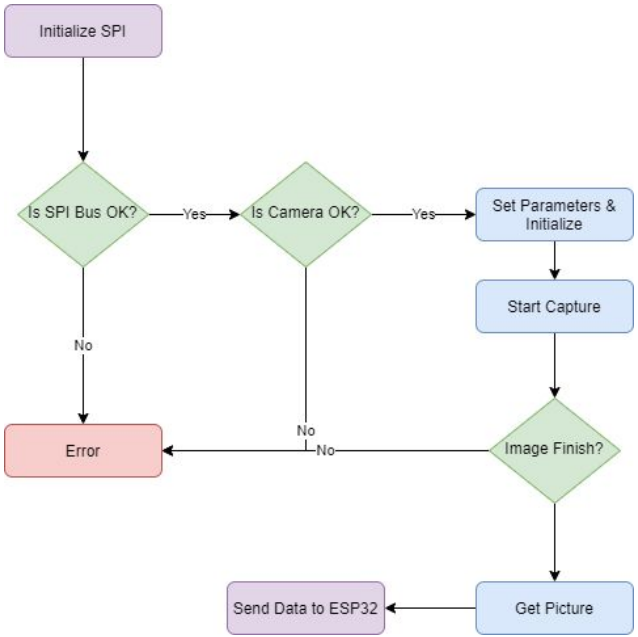
ArduCAM OV2640 Plus

Specifications	
Supply Voltage	5V
Operating Current	<140mA
Communication Interfaces	I2C & SPI
Max Resolution	1600 x 1200
Lens Size	¼"
Board Size	34 x 24 x 3 mm
Manufacturer	ArduCam
Output Format	•RAW •YUV •RGB •JPEG

ArduCAM OV2640 Plus Specifications

Taking a Picture - Ty

Picture logic



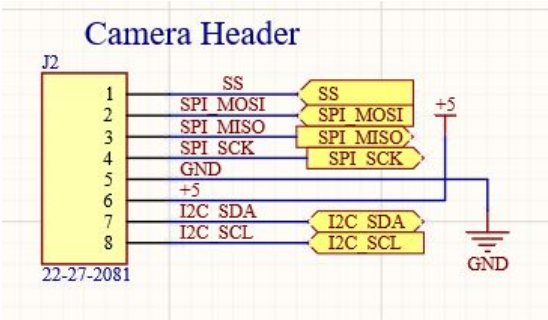
Picture Sample Data

Camera Schematic - Ty

Camera Pin header

Pin	Label	Type	Description
1	CS	Input	Slave select
2	MOSI	Input	Data output from master
3	MISO	Output	Data output from slave
4	SCK	Input	Serial Clock from master
5	GND	Ground	Power Ground
6	VCC	POWER	5V Power Supply
7	SDA	Bi-directional	Serial Interface Data I/O
8	SCL	Input	Serial Interface Clock

Detailed Pinout

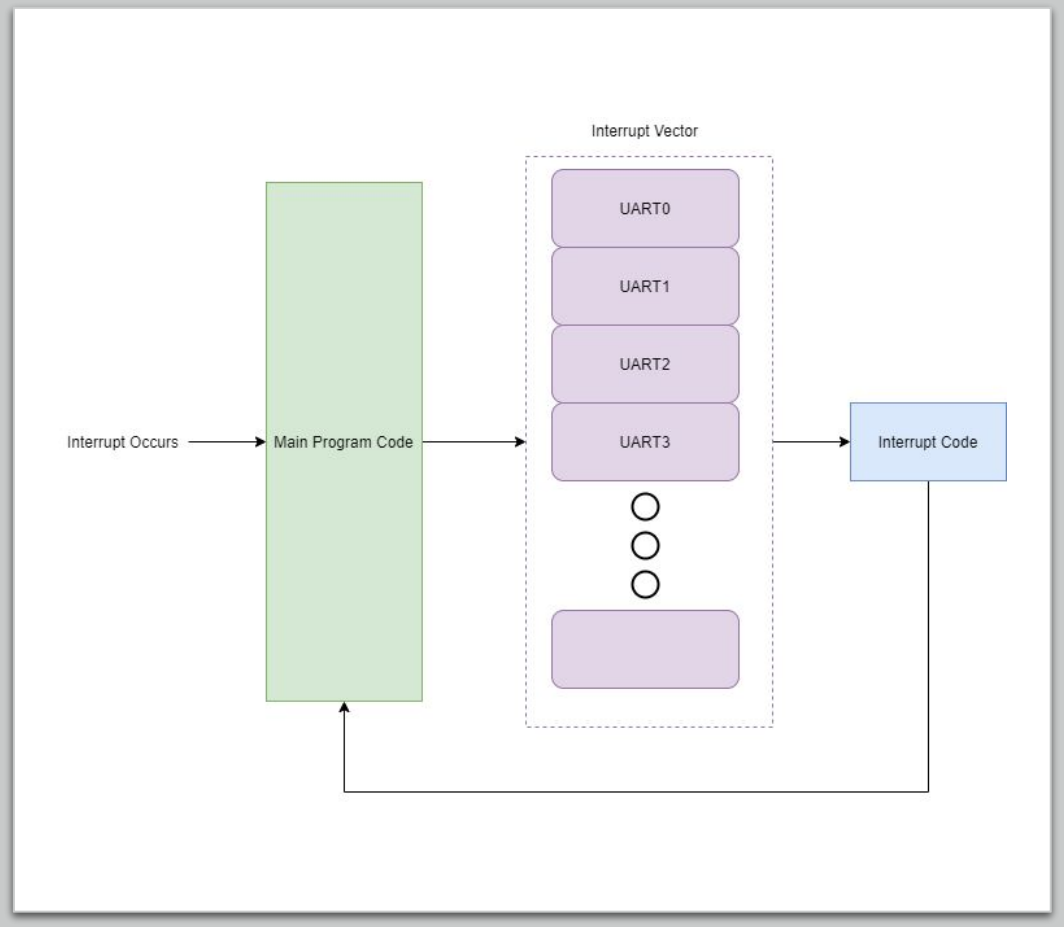


Camera Pin Header

Arduino Software Design

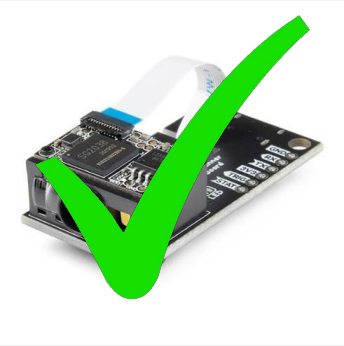
Interrupts will be used throughout

- Working with many 3rd party libraries opens the door for compatibility issues
- Plan to use interrupts for our Components



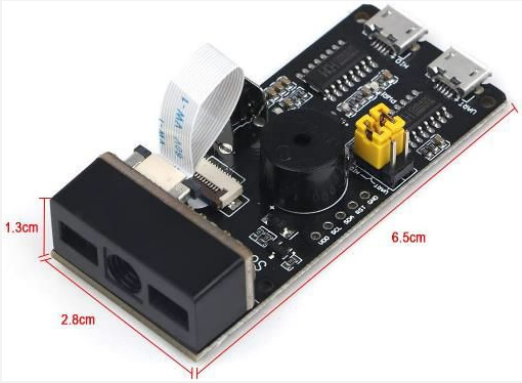
Barcode Scanner - Shane

Box will unlock when a valid package is scanned.



DYScan DE2120

Waveshare Barcode Scanner



MG65 1D 2D Code Scanner

Device	Voltage	Interface	Current	DOF	Price
DYScan	3.3V	UART	190mA	400mm	29.95
Waveshare	5V	UART	135mA	400mm	39.99
MG65	5V	UART	120mA	250mm	29.99

Left: 1D | Right: 2D

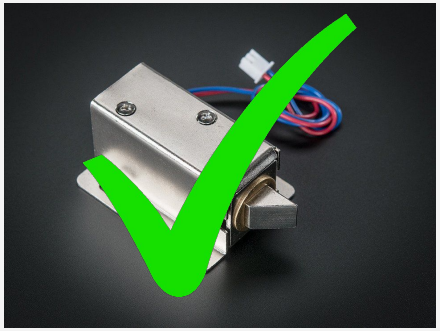
Solenoid Lock - Shane

An electronic lock used to open or close our box.

Smartphone-controlled, Deadbolt Actuator

Smock

Morning Industry RF-01SN

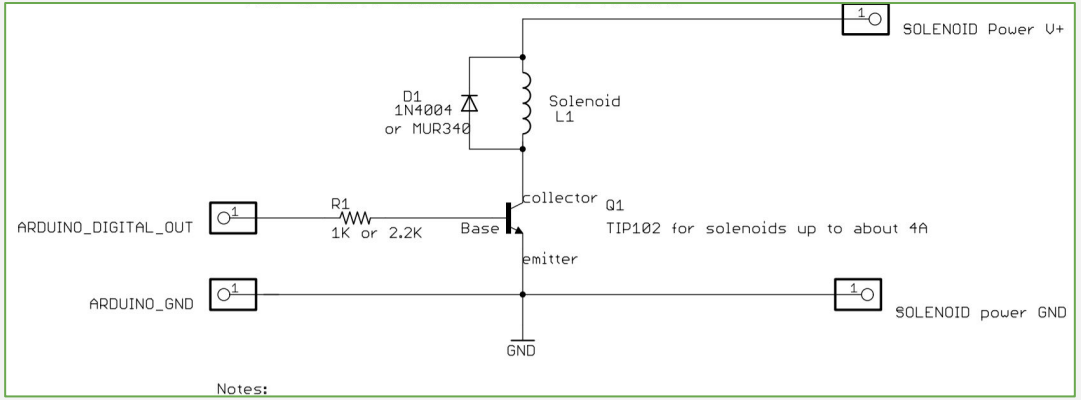


AdaFruit Solenoid Lock

- A supply voltage of 12V will be needed to energize our solenoid lock.
- A solenoid lock is commonly used in the tech field as an electronic lock, which provides a bunch of versatility and usability.

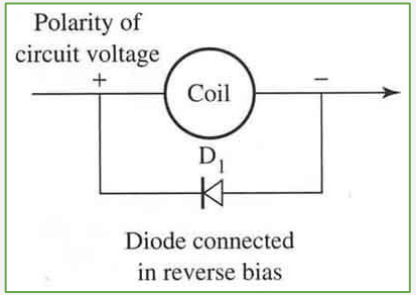
Solenoid Lock - Shane

An electronic lock used to open or close our box.



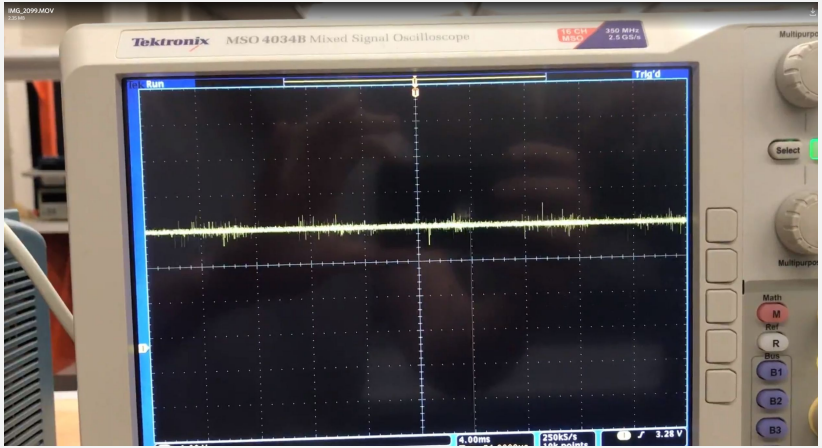
Mechanism of Solenoid Lock

- The lock solenoid draws 650 mA at 12V.
- For protection of the solenoid and other electrical components in our design, a Schottky diode is used.

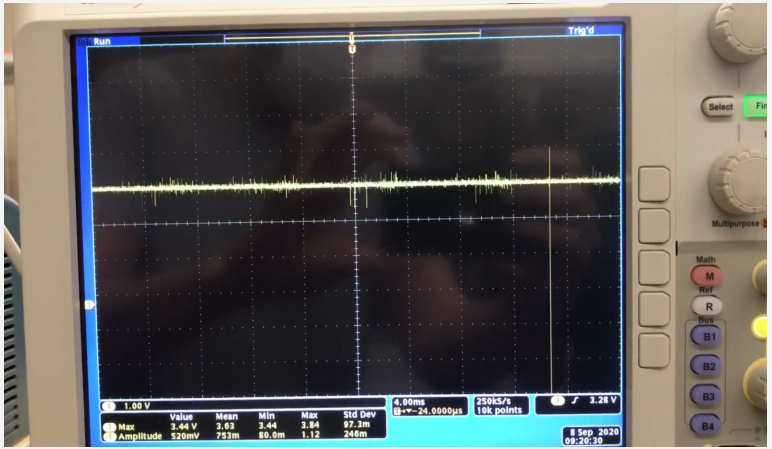


Solenoid Lock - Shane

An electronic lock used to open or close our box.



3.3V Power Line



Spike generated after unlock on 3.3V power line

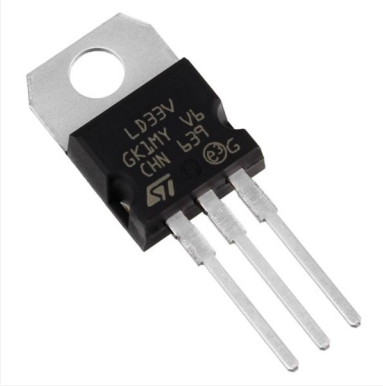
Power System Requirements - Andre

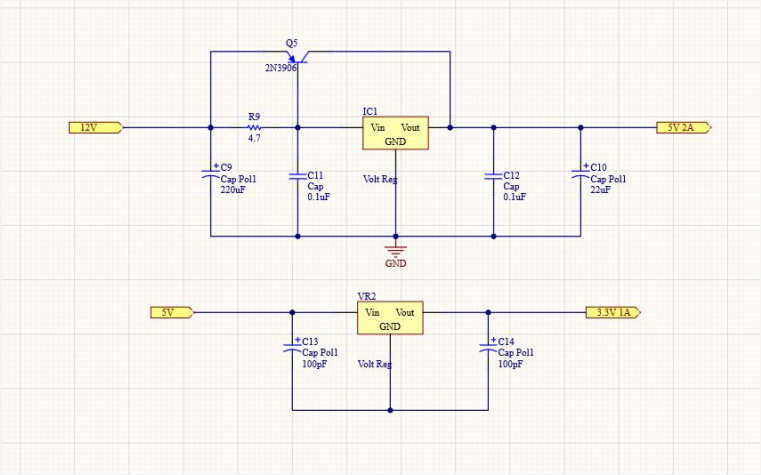
S.M.A.C. requires multiple components to work in harmony with a constant and steady voltage and current source to operate efficiently and securely. It also required a mix of multiple voltages to operate its plethora of devices. S.M.A.C. required the following voltages and currents to operate:

- 110-120V Power
- 12V
- 5V
- 3.3V
- Total of about 2A

Power System Design -Andre

- With the many different voltages and extensive constant power requirement. It was decided to use an AC power source and convert the voltage to a DC source accordingly. satisfying our reliable and constant inflow of power.
- The design was simple 120V AC source would be turned into 12V 2A power source then stepped down to a 5V 2A power source and from the 5V we would use a step down converter to 3.3V.
- This design will give ease of use and constant security for the box. Which would accomplish its main goal.

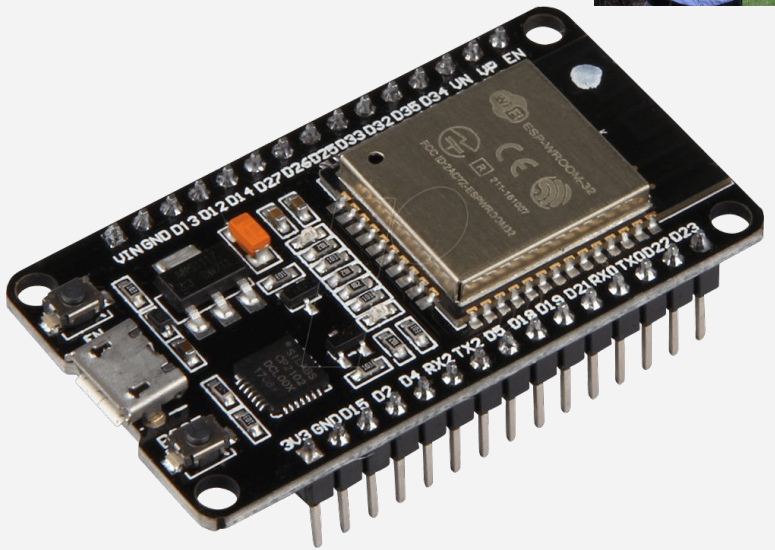




Communications Design - Andre

Communication was a huge part of the project. It had to allow for our device to have remote access and update its database remotely for ease of use and complete functionality of the box itself. The medium chosen is Wi-Fi as it allowed for remote and long range communication. The ESP32 was chosen for the following capabilities:

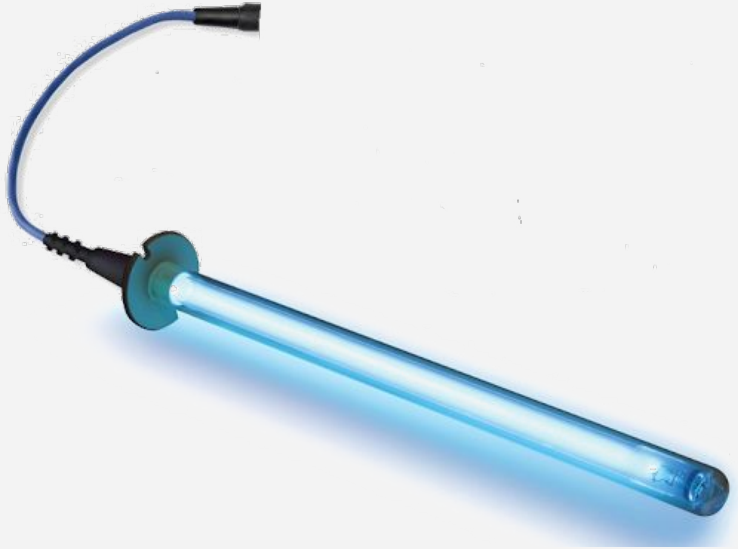
- 802.11 b/g/n
- SPI/UART/I2C/I2S
- 3.3V
- 150mbps
- Programmable



UV light - Andre

UV light's functionality comes from the programming of the relay. The light was going to be controlled by a relay module attached to the power source making it a "smart" light. The UV light itself still needed to meet some criterias as there are ranges of UV lights that work for different uses. The following were the requirements:

- 184-254 nm wavelength
- UVC
- Cold cathode
- long lifespan

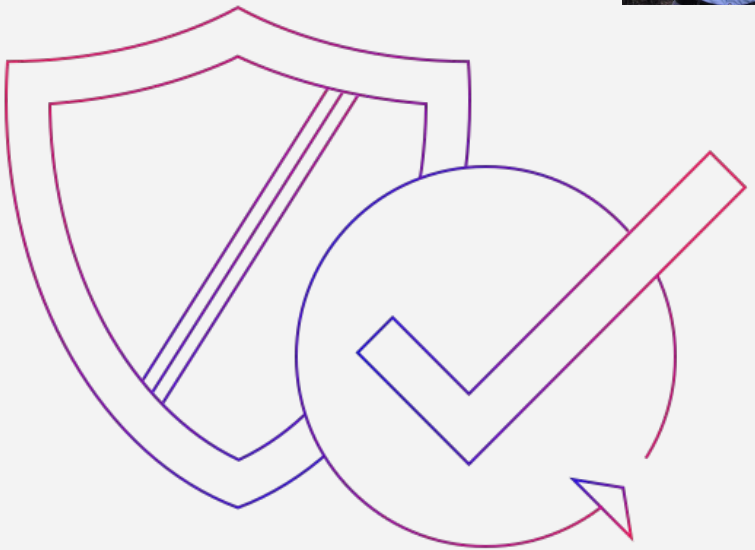


Housing Inspiration - Andre

Housing Goals - Andre

Housing was one of the most important aspects of the project. It would not only protect the boxes it would receive but also protect all its components that made it work. The following is a short list of goals the box needed to accomplish:

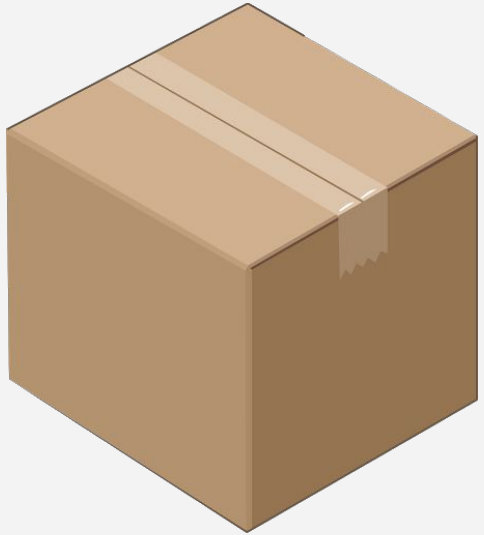
- Fit most boxes
- Secure
- Malleability
- Weatherproof
- Long lasting



Housing Choices - Andre

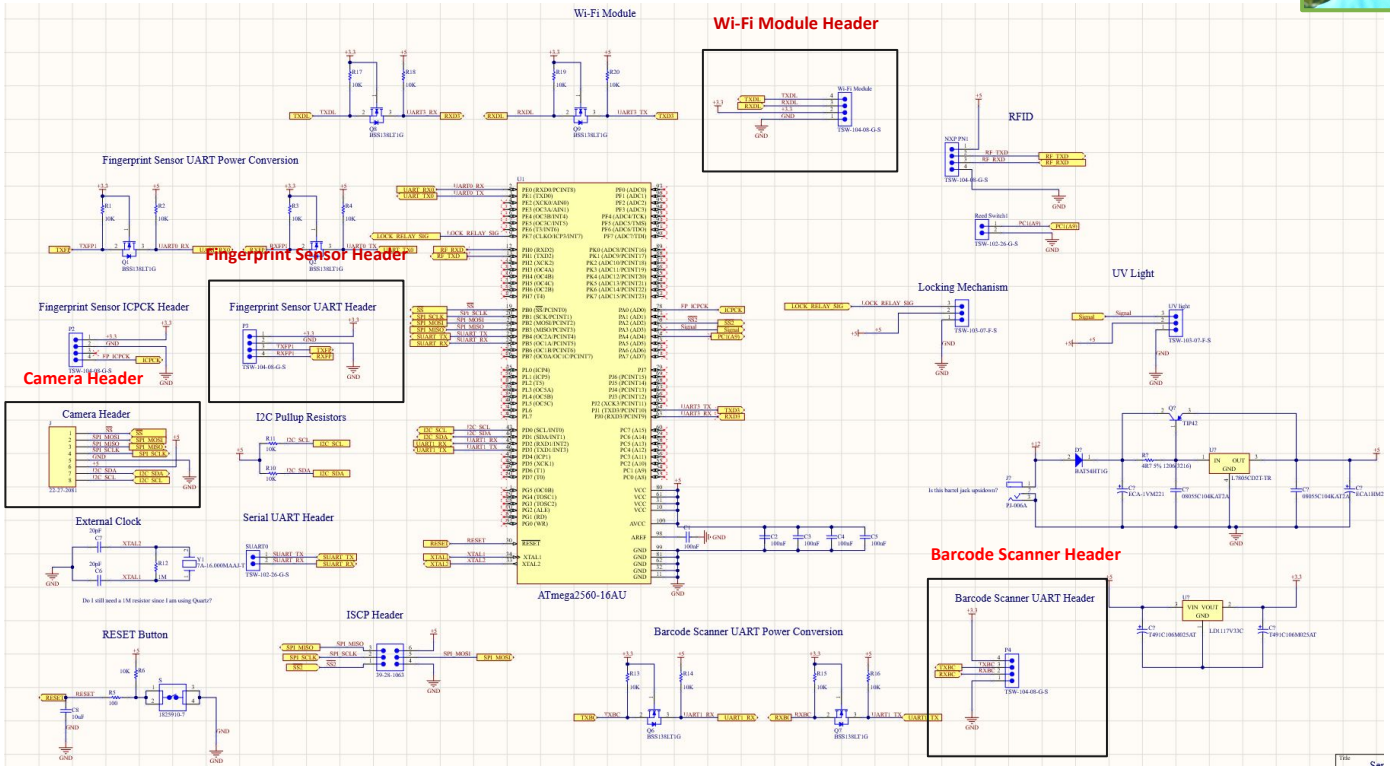
To accomplish all our goals extensive research had to be done to get the right dimensions and material to make the box. Research narrowed on a dimensions that would accommodate most boxes in the shipping industry. The material choice came down to how easy it would be to incorporate into the environment and malleability to work with. The narrowed specifications were as followed:

- Material: Wood
- Dimensions: 28 x 18 x 15



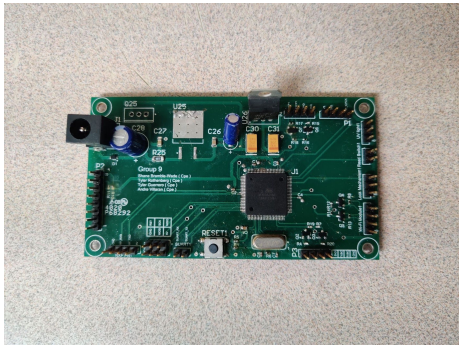
Altium PCB Schematic

Overall PCB Schematic of our Design Choices.

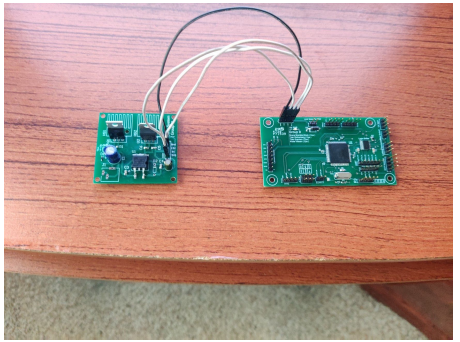


Custom PCB

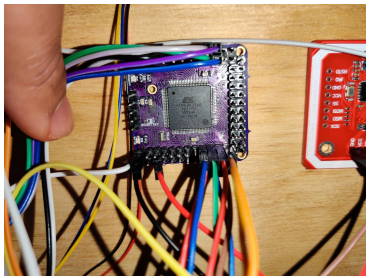
Overall PCB Schematic of our Design Choices.



First PCB



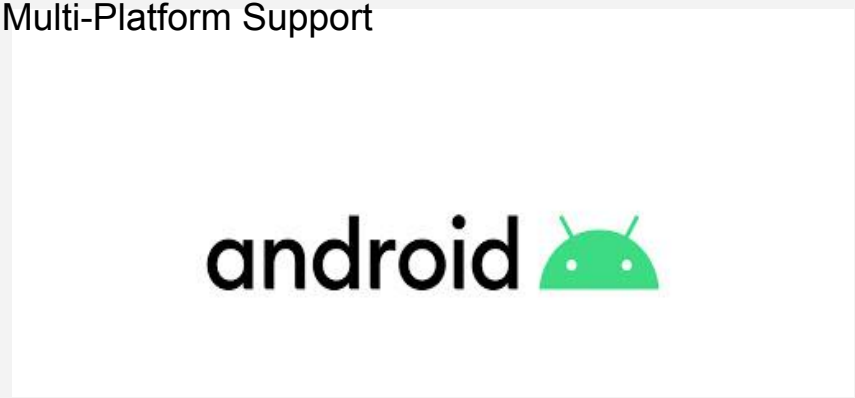
Second PCB



Final PCB

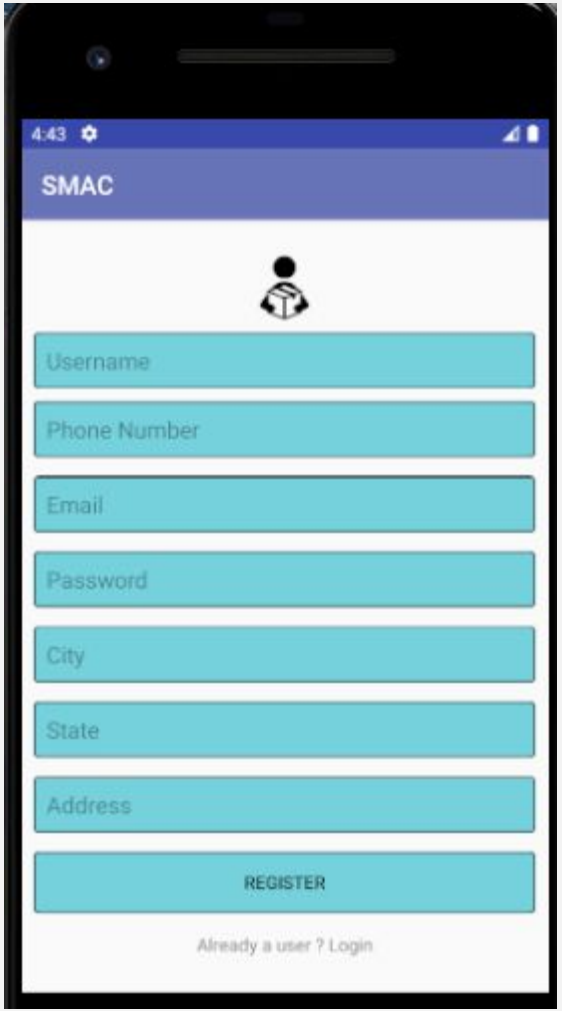
Android Operating System

- An open source Linux-based operating system that was released on November 5, 2007
- With Android you can either choose kotlin or java, we chose java.
- Java is one of the most used programming languages, so the resources to develop with Java are immense, which makes the process to develop smooth.
- With android development it provides a multitude of reasons to use it, some of the following below are the reasons we valued the most.
    - Zero/negligible development cost
    - Open Source
    - Multi-Platform Support



Login Graphic User Interface

Register Graphic User Interface



Mobile Application Features

- Delivery Log
- Profile
- Lock/Unlock your SMAC
- See a Photo capture after the box was unlocked
- UV Light

FireBase Real-Time Database

https://smac-7a161.firebaseio.com/Users

smac-7a161 > Users

Users

- **3onK8dMraeaUOivr5nlTzey0aRw2**
  - **bio:** ""
  - **email:** "test@gmail.com"
  - **id:** "3onK8dMraeaUOivr5nlTzey0aRw2"
  - **imgurl:** "default"
  - **name:** "Tyler"
  - **username:** "test"

Firebase

FireBase Authentication

Authentication

Users | Sign-in method | Templates | Usage

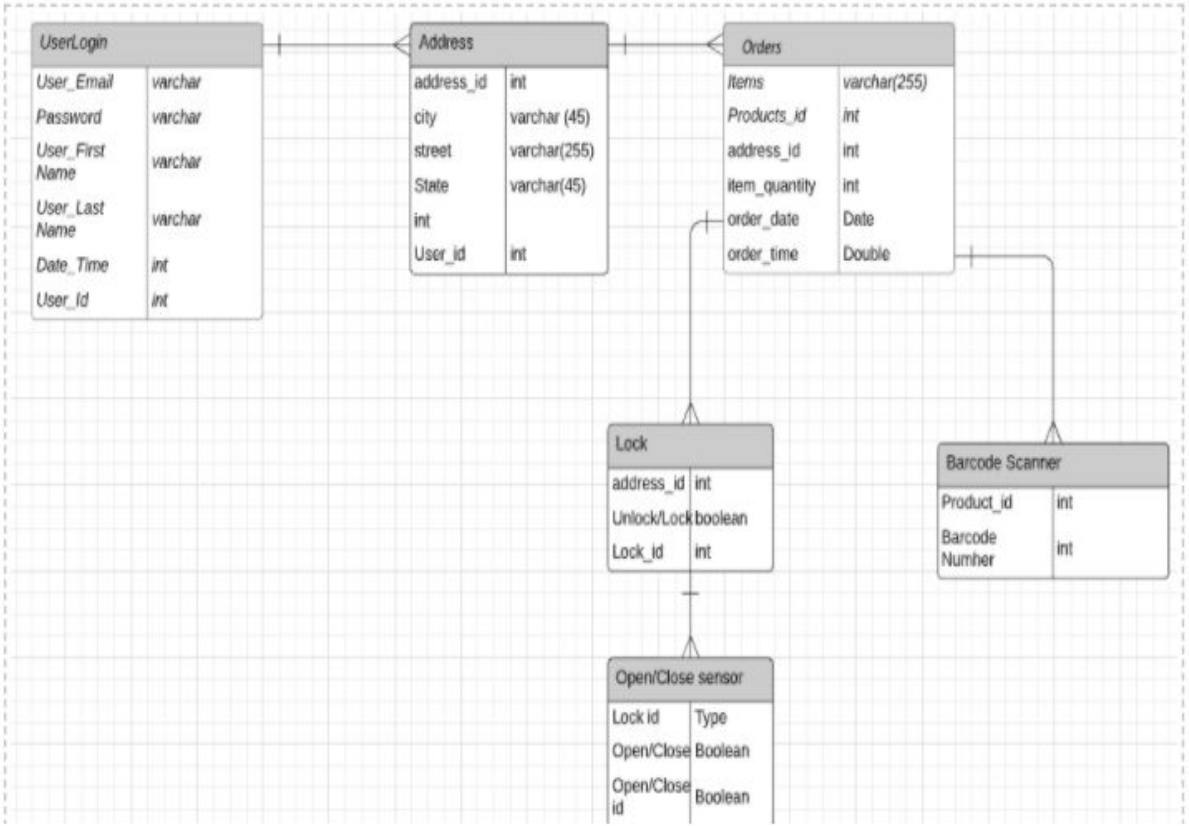
Search by email address, phone number, or user UID

Add user

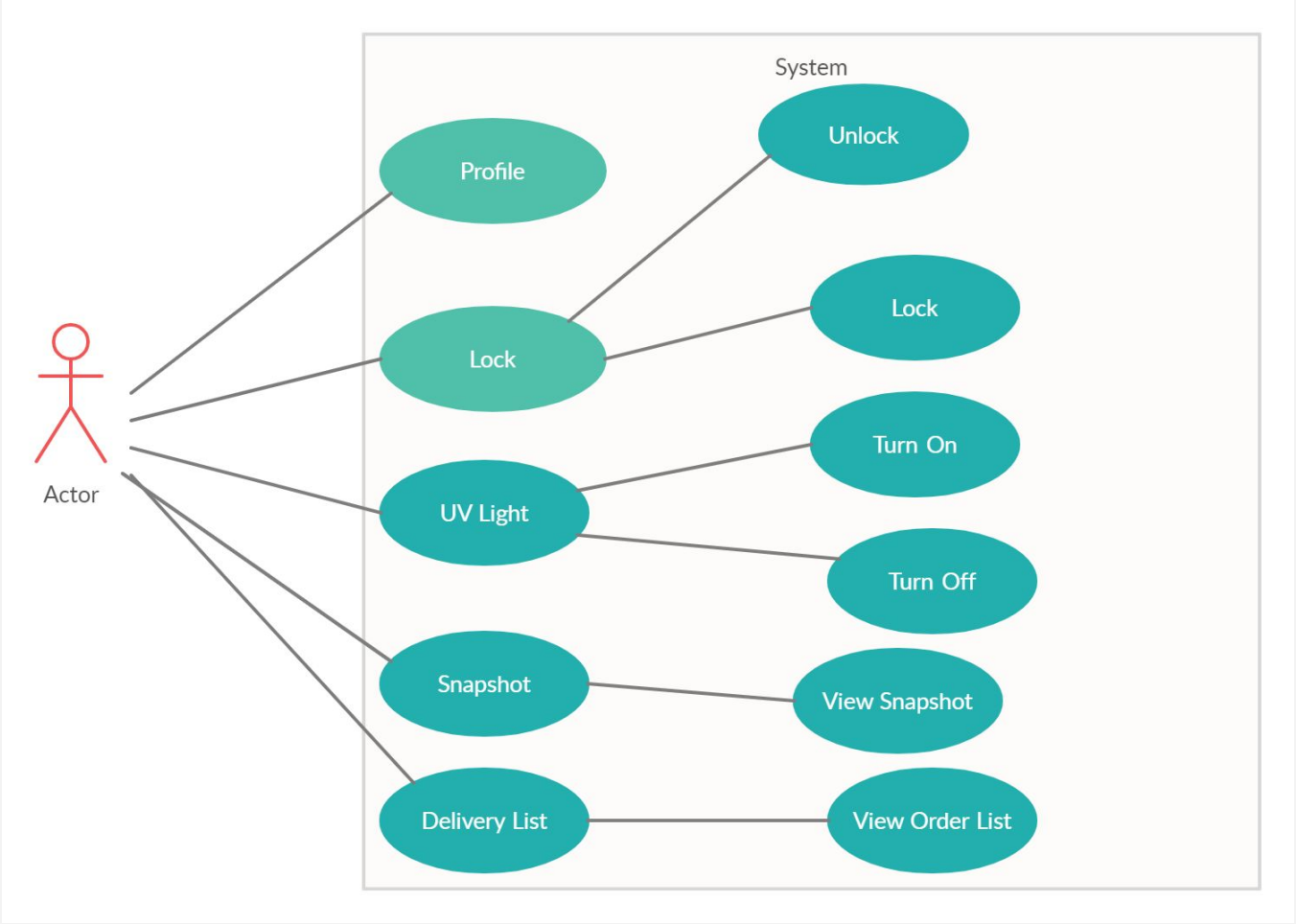
Identifier	Providers	Created	Signed In	User UID
test@gmail.com	✉	Sep 13, 2020	Sep 13, 2020	3onK8dMraeaUOivr5nlTzey0aRw2

Rows per page: 50 1-1 of 1

DataBase Diagram



Use Case Diagram



FireBase Cloud Functions

- A serveless frameless that lets you run your backend code with responses from your databases and HTTPS request.

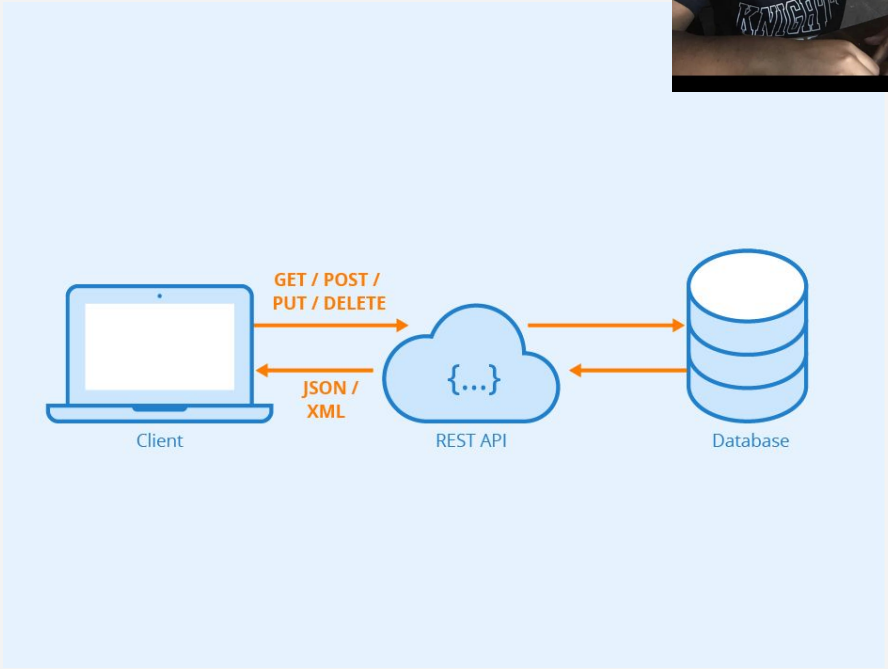
- In SMAC we used this framework to mainly communicate when a user would send request to our ESP32 or when we would want to send a response to our user.

- Our javascript server side code was stored in google cloud servers and was maintained and ran by google. We just used the platform to use their services

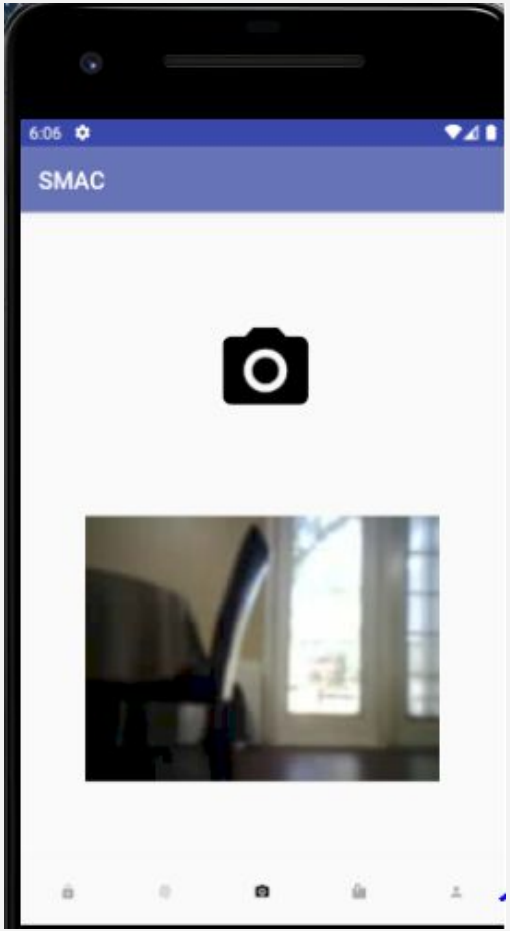
Cloud Function
for Firebase

Rest API

- For our project we create REST API's for all our features to properly communicate with our ESP32 to our app.
- With doing a REST API it provided us powerful functionality that made it possible to do the features we did.
- For example we used HTTP request to send our image byte array to upload it to firebase storage to display it on our app.
- For our Unlock/Lock, BarCode Scanner, RFID, and our camera they all had individual REST API's for proper communication between the app and the ESP32.



App Features



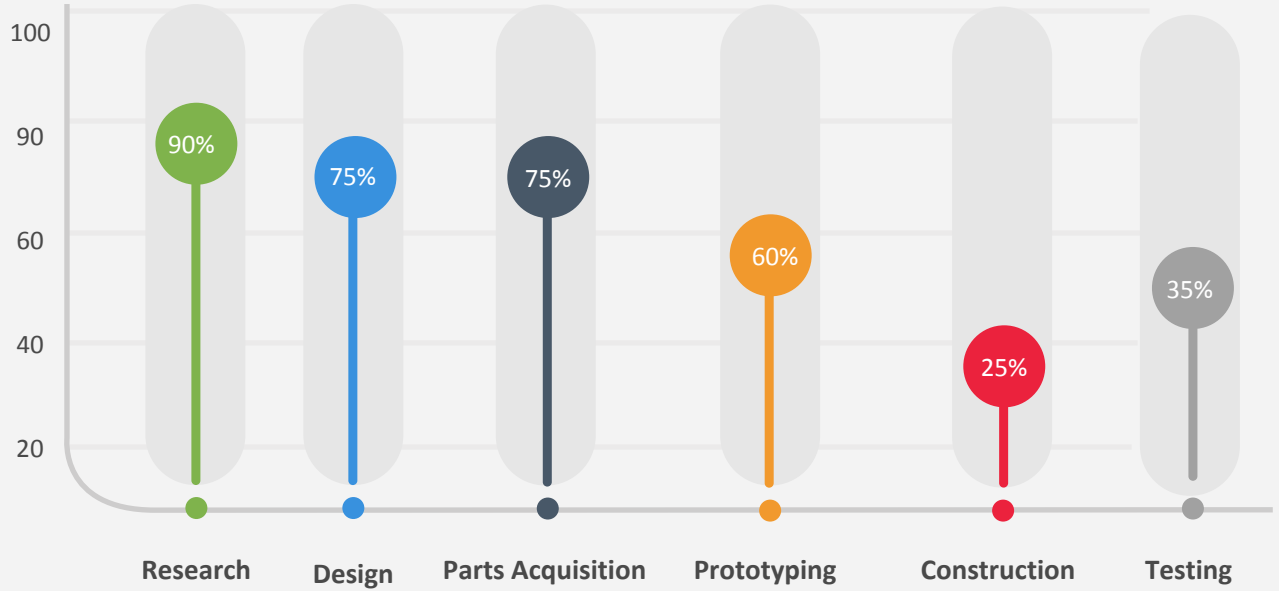
Part 3

Administrative

Day-to-day activities that are related to financial planning, record keeping & billing.

Project Progress - Ty

Current Project Progress



Project Expenses - Ty

Current Project Expenses

Tyler Rothenberg Current Expenditure			
Item	Amount	Supplier Link	Cost
ESP32	1	https://www.ama	$10.99
Arduino Mega	1	https://www.banc	$13.31
Waveshare Camera	1	https://www.banc	$31.05
Sparkfun Fingerprint Sensor	1	https://www.spar	$43.04
ArduCAM	1	https://www.ebay	$33.04
Quiic Cable Breadboard Jumper	2	https://www.spar	$3.00
Sparkfun Logic Level Converter	1	https://www.spar	$2.95
Breadboard Jumper Cables	2	https://www.ama	$11.58
Solder Practice Kit	1	https://www.ama	$9.99
Flux	1	ip.com/amtech-no	$8.99
PCB Board Tester	1	ttps://oshpark.com	$30.29
PCB Components	1	s://www.digikey.c	$9.16
SMD Practice Kit	1	)JYTM/ref=ppx_y	$6.98
Solder Wick	1	/VWJ8/ref=ppx_y	$6.88
Bluetooth Serial	1	W4FSI/ref=ppx_y	$7.39
USB to TTL Adapter	1	2CDL/ref=ppx_y	$11.99
ESP32 CAM	1	HYNM/ref=ppx_y	$10.99
Laser Infrared Thermometer	1	I632G/ref=ppx_y	$23.11
Lowes Supplies	1		$11.39
Walmart Supplies	1		$7.62
		TOTAL:	$293.74

Shane Current Expenditure			
Item	Amount	Supplier Link	Cost
Sparkfun Barcode Scanner V1	1	https://www.spar	$29.95
Sparkfun Barcode Scanner Module	3	https://www.spar	$134.85
Lock-style Solenoid - 12VDC	1	v.adafruit.com/pr	$14.95
ELEGOO MEGA 2560 R3	1	https://www.ama	$15.99
Mega +WiFi R3 Module ATmega2560	1	https://www.banc	$15.74
Youngneer 5v Relay Board Relay Mo	1	https://www.ama	$11.99
PCB Manufacturing	1	https://www.4pcb	$77.07
BNTECHGO 22 Gauge PVC 1007 So	1	https://www.ama	$12.98
NTE Electronics SW02-10 No-Clean S	1	https://www.ama	$6.88
PCB Board Kit | Jumper Wires | Sold	1	https://www.ama	$49.87
Digi-Key Mounting Components	1	https://www.digik	$26.74
PCB Mounting Components	1	https://www.arro	$101.00
0-2A 0-15V DC Power Supply	1	https://www.ama	$31.99
Carpet Flooring	1	https://www.waln	$12.59
5.1 Zener Diode (Through hole)	1	https://www.digik	$2.25
RES SMD 4.7 OHM 1% 1W 0805	1	https://www.digik	$6.50
Neiko 01902 Adjustable Helping Hanc	1	https://www.ama	$8.15
PCB Power System Design	1	https://www.4pcb	40.51
		TOTAL:	$600.00

Tyler G Current Expenditure			
Item	Amount	Supplier Link	Cost
ELEGOO MEGA 2560 R3	1	https://www.ama	$15.99
REED Switch	2	https://www.ama	$14.58
RFID Module	2	https://www.ama	$19.38
Heatsink	1		$9.80
TIP42	1		$6.99
PCB Printing	2		$185.96
PCB Components	1		$108.56
TIP42	1		$4.99
ESP32	1		$10.29
Random Components for Andre	1		$22.00
		TOTAL:	$398.54

Andre Current Expenditure			
Item	Amount	Supplier Link	Cost
ESP32	1	https://www.ebay	$10.29
3.3V Voltage regulator	3	https://www.ebay	$5.99
TIP42 PNP power transistor	4	https://www.ebay	$3.01
DC Power Jack 2.1mm	5	https://www.ebay	$5.44
Tolako 5V relay module	1	https://www.ama	$5.50
9V 1A power supply	1	https://www.ama	$6.79
Breadboard power supply	5	https://www.ama	$7.49
ATMega2560	1	https://www.ama	$15.99
Digital Multimeter	1	https://www.ama	$10.30
Logic Level Converter	10	https://www.ama	$7.49
Home Depot	1		$94.58
Fans	1		$16.54
UVC Ozone lamp	1	https://www.ama	$23.77
		TOTAL:	$213.18

Total Cost: **$1,505.46**

Project Progress

Success Always Belongs For Those Who Are Prepared

Team Members
Shane Bramble-Wade
Tyler Rothenberg
Tyler Guerrero
Andre Villaran
Everyone

WBS	TASK TITLE	Assigned To
	PHASE I - PREPARATION	
	PCB	Shane Bramble-Wade
	Housing Design	Andre Villaran
	Wireless Communication	Andre Villaran
	Fingerprint Readers	Tyler Rothenberg
	Locks	Shane Bramble-Wade
	Power System	Andre Villaran
	Barcode Scanner	Shane Bramble-Wade
	Open / Close Sensor	Tyler Guerrero
	RFID	Tyler Guerrero
	Mobile Application	Tyler Guerrero
	PHASE II - CODING	
	MCU	Tyler Rothenberg
	Wireless Communication	Andre Villaran
	Mobile Application	Tyler Guerrero
	Fingerprint Readers	Tyler Rothenberg
	UV Light	Andre Villaran
	Camera	Tyler Rothenberg
	Fingerprint Readers	Tyler Rothenberg
	Barcode Scanner	Shane Bramble-Wade
	RFID Module	Tyler Guerrero
	PHASE III - FINALIZING	
	Housing Design	Andre Villaran
	Website	Shane Bramble-Wade
	Presentation Video	Everyone
	Project Demonstration	Everyone
	Final Documentations	Everyone

Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Week 10 | Week 11 | Week 12 | Week 13 | Week 14 | Week 15

Final Documentation Due

Project Timeline

Success Always Belongs For Those Who Are Prepared

NAME	June	July	August	September	October	November	December
PCB							
Fingerprint							
App							
Housing							
Coding							
Barcode							

Closing
Questions ?