# University of Central Florida

EEL 4914 Senior Design 1

Initial Project Document

*Divide and Conquer*

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# Safe Home Delivery


**Group F**:

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# The Current System

After researching the market on the team's idea, it was found that Amazon has a similar system that is worth mentioning for comparison. Amazon has created "Amazon Key" that allows in-home deliveries when homeowners aren't present. Amazon key allows couriers to enter a home scanning in a secure code. The current system must be installed in place of a customers' lock and a camera is set up inside to monitor activity. As for now the current use of the system is to simply open the front door and leave packages near the entrance, therefore the camera is setup to only view that scene.

# The Proposed System

## Brief Description

Safe, reliable, commendable in-home delivery system that allows homeowners to be absent and do their daily activities, while their groceries are delivered and put into place.

## Motivation

Expand grocery delivery market. Systems such as, Intercat, Shipt, Walmart Groceries, have started to expand grocery shopping giving the customer the opportunity to save time having their food ready and packed from them to pick up. Our proposal is to expand this commodity by delivering their products home safely using a reliable and trustworthy system.

Companies such as amazon suffer great losses because of customer claims that are associated with not receiving packages due to it being stolen outside front doors. Our proposal also takes care of such claims as now there's a safe and reliable delivery system that gets packages inside the house away from any possible destruction or theft.

# Introduction and basic system design concepts

For some time now there's been a great variety of grocery stores that have added a pick-up option to their online websites, so people who are busy can simply order all of their groceries online and set up a time for when they're available to go and pick-up them up. More recently some services have become available to pick-up your groceries and deliver them to your front door. However, these services are only able to deliver to your home when the homeowner is present.

What we aim to do with Safe Home Delivery is expand this commodity to the grocery delivery market by creating a reliable and trustworthy system to give a stranger

access to your home so they may deliver your groceries while you are either at work, the gym, taking your kids to sports practice or simply just busy doing things. In order to do this we expect to design a lockbox that the homeowner can place onto their front door knob, when they know they will have a delivery that day, that scans a QR code that will appear on the delivery persons smartphone application. This device will be similar to that of a keyholder that is frequently used in the real estate business. The Safe Home Delivery lockbox, will only dispense a key during a certain time frame that the delivery person designated that they will be at the home to deliver said groceries. If the delivery person is late or early, the lockbox will not dispense a key. This lockbox will be connected the homeowners network. Through the network, the lockbox will notify the homeowner via a smartphone application.

The way we intend to make our Safe Home Delivery reliable and a trustworthy system is by having the delivery person have a working body cam on them for when they enter the home. For as soon as they receive a key from the lockbox the body cam will then begin to record everything the delivery person does within the home up until they replace the key back within the lockbox, as of then the recording will then finish and the entire video will be placed in a repository that the homeowner can review within the application. The reason we chose to make it this way is because sometimes if you have a delivery set up for noon and you won't be getting to your home until later in the day, you would not want your dairy products to just be sitting on the counter in your kitchen. Hence why within our software we will add the option for having some products to be placed in the homeowners fridge by the delivery person. All of these options will be very useful to the homeowner who will be able to provide feedback on the delivery after watching the delivery video.

# Requirements:

- Website
    - User Account
        - Signin/Signup
    - Driver/Delivery Employee Account
        - Driver user interface
    - Database
    - Video Access
        - Livestream
        - Rewatch previous VODs.
    - API that connects key holder and sets new password
- Mobile Responsive Web Application
    - Should have everything that's in the website
    - Responsive for smaller screens
- Key Holder
    - Microcontroller
    - Finger ID scanner
    - Connects to Wifi

- Camera + Video Recording
    - Wifi
    - Camera attached to drivers clothing
    - Connect to the Key Holder
        - Start livestream on scan of fingerprint
        - End livestream when key is placed back inside

# Hardware Details

# Intro

The main objects needed for the hardware side would ideally be the microcontroller and a lockbox that can possibly hold the microcontroller, it can be a standard lockbox MasterLock or KeyGuard both of these locks are made of steel and contains rubber casings to prevent damage occurring on the door. The only problem would be taking out the main interface due to the fact it is an object made of steel depending on whether its a dial combination, push button locks, and etc. but it shouldn't be a huge challenge to surpass. Once this is achieved a casing has to be made whether using a Finger ID scanner or a QR scanner which requires a camera or a barcode scanner. Taking the approach of a finger id scanner the main electrical components would be a LCD screen if (optional), switching regulator (buck converter) that is voltage controlled, 3D printed case (can be made in the TI Lab), copper wires, but these are the main components listed. With this general list these components are not hard to obtain.

## Microcontroller

The microcontroller that will be used for this project is the Arduino MKR WAN 1300 this board has WIFI capability and its also working with a SAM D21 that is a series of low-power microcontrollers using the 32-bit ARM Cortex-M0+ processor, it has a price of thirty nine dollars. The operating voltage is between 1.26 volts through 3.3 volts which is an upside compared to other boards which needs a regulated voltage of 5 volts. This device can be powered by different factors such as AA or AAA batteries with a nominal voltage of 1.5 volts, can also power it from the Vin pin if needed and this is where the output of the buck regulator will lead to, and it can also be used to supply 3.3 volts by an onboard voltage regulator, but for this project it shouldn't be needed. Comparing this device to the other selections such as Texas Instruments SimpleLink WIFI CC32200 and the Arduino Uno it has a downside it has less digital Input / Output pins than the other boards listed above, it only has 8, but it does have 12 PWM pins, but these pins won't be used as of now, this could be incorrect there might be a purpose for these pins later on. It contains one of each of these pins: Universal asynchronous receiver- transmitter (UART), Serial peripheral interface (SPI), and one for a integrated circuit pin (I2C). For the analog portion it contains one pin which can take 8/10/12 bits of

data and it also has analog output that handles 10 bits, which is also a Analog to Digital converter.

The memory specifications are next, the project that was researched they used a Arduino Uno which is the entry level Arduino and as long as the parameters are similar to this basic Arduino then the microcontroller will be suitable for this project. The Arduino MKR has a flash memory of 256 kilobytes which is greater than the Arduino Uno which has a flash memory of 32 kilobytes, has a SRAM of 32 kilobytes, but it does not have the memory specification of the EEPROM. The last two memory specifications are the clock speed and the real time clock option,the clock speed is measured at 48 megahertz and the real time clock which is used for keeping track of real time, has a speed of 32.768 kilohertz. Previously mentioned this device is WIFI capable, it has an antenna power of 2 decibels, a carrier frequency of 433/868/915 megahertz, but keeping in mind the GSM antenna that we buy has to able to be compatible with these frequency ranges.

On to the power consumption of this device, on the website Arduino claims this device operates at less than 20 milliamps with a operating voltage of 3.3 Volts. Now I'm not sure if they accounted for the number of pins that were being used because each pin accounts for 7 milliamps and when looking in the the datasheet they have different power consumptions for different algorithms for example if the board is running a infinite while loop or any while loop (non-zero integer) the max current consumption is 4.12 milliamps and this is operating at a voltage of 3.3 volts; therefore, the max power consumption without the use of any pins, which won't be the case, is 13.596 milliwatts. There are two other algorithms that were bought up which is the Fibonacci algorithm and a CoreMark algorithm. Also all these programs are working with a clock speed of 32 megahertz and the more complex the algorithm is, the higher the power consumption becomes. Now accounting for the total power consumption going through the research the researcher used eight pins on the Arduino Uno, two for the Fingerprint Scanner which are pins three and four, which are the pulse width modulator pins and six pins for the WIFI module which contains pins: 2,5,10,11,12,13. The Arduino Uno consumes or can deliver 20 milliamps from its input / output pins, but in this case it is consuming and the operating voltage is 5 volts; looking at the power consumption that is 800 milliwatts. Now since the Arduino MKR WAN has a built in WIFI module it only needs two pins which are three and four, I checked and the pins three and four are the same for both boards. Now since each pin accounts for 7 milliamps that is 14 milliamps in total and accounting for the voltage of 3.3 volts that is 46.2 milliwatts and adding that to the power consumption of the microcontroller running the while loop algorithm which was 13.596 milliwatts that is a total power consumption of 59.796 milliwatts.

## Fingerprint Scanner

The first fingerprint sensor is the Fingerprint Scanner TTL (GT-521F32) which contains a 32-bit ARM Cortex M3 processor and it also has a onboard optical sensor.

The  price for this device is $31.95 before shipping and handling. This device can store up to 200 different fingerprints and the database of fingerprints can also be stored which can the be used to pull raw images from the optical sensor. It has a resolution of 450 dpi which translates to 450 ppi, in terms of just pixels it is 258 by 202 pixels. Now for security purposes it has a false acceptance rate of less than 0.001% as well as a false rejection rate of less than 0.1%. It also needs less than 1.5 seconds to identify a unique fingerprint and takes less than three seconds to enroll three fingerprints, another small detail it works well with dry, moist, and even rough fingerprints which will be tested once received. It also has a baud rate of 9600 bps which isn't the highest compared to the other Fingerprint Scanner sold by AdaFruit™.

The next topic is the power consumption this device operates at a operating voltage of 3.3 volts to approximately 6 volts and the maximum operating current is 130 milliamps; therefore, the power consumption for both cases are: at 3.3 volts the power consumption is 429 milliwatts and for the 6 volts the power consumption is 780 milliwatts. Also there is a section of the touch screen that requires a consumption of 3 milliamps and accounting that with the 3.3 volts that is 9.9 milliwatts and once the device is standby mode it consumes less than 5 microamps which is a power consumption of 16.5 microwatts. Accounting for the total power consumption by this device at 3.3 volts is 438.9165 milliwatts and at 6 volts the total power consumption is 786.03 milliwatts.

The last consideration is the fingerprint sensor sold by AdaFruit™ it is quite similar to the previously mentioned fingerprint sensor, it has the same fingerprint security level which is at a level of 3. The main upside to this sensor is if the programmer were to run into any trouble there are files already made which coincides with different projects and they are designed in the Arduino library and the Circuit Python library. The price of this device is $49.95 it is at least 18 dollars more than the Fingerprint Scanner TTL, but it does operate at a higher baud rate of 56,700 bps and the baud rate is just how fast information is transmitted in a communication channel.

The power consumption of this device is quite similar to the Fingerprint sensor TTL it operates at a voltage of 3.6 volts between 6 volts DC and a operating current of 120 milliamps and the peak current is 150 milliamps. Accounting for both cases the typical value of power consumption at both the minimum and maximum voltages are 432 milliwatts and 720 milliwatts respectively. For the maximum value of power consumption, for both the minimum and maximum voltages are 540 milliwatts and 900 milliwatts respectively. Comparing this to the Fingerprint Scanner TTL this device is a little bit more efficient, but at the maximum characteristics this device is a little less efficient.

## DC-DC Converter

The first buck regulator is the LM2575-3.3 ADJ/NOPB manufactured by Texas Instruments™, it is a step-down converter meaning the the input voltage supplied is brought down to a given output voltage, in this case we will need 3.3 volts to be regulated. The minimum voltage used most likely will be 9 volts, but that can change when testing occurs. There are different cases for the input voltage right now a battery is the most common, but a solar cell device is being looked into as of now. The next thing is the load current for this device which is 1 amp, the Arduino MKR needs at least around 20 milliamps to operate at 32 megahertz and the way to account for this is to place a resistor with a value of 50 ohms at the output, but this also accounts for the total power consumption of the whole project; it isn't a large value its around 217.8 milliwatts of power consumption, there is also some noise voltage to account for but it shouldn't be a huge ordeal. Some other characteristics of this device it has a 52 kilohertz fixed frequency internal oscillator and a price of $3.22.

The power dissipation of this device at 9 volts with a load current of 1 amp, a quiescent current of 10 milliamps, and a max saturation voltage of 1.4 volts is around 603.3 milliwatts. If we were to look at the efficiency of this device we can take the given output power which is the 3.3 volts times the load current of 1 amp which makes 3.3 watts and divide that by the input power which equals the output power plus the power dissipation which is a value of 85% which is a very nice number compared to linear regulators. Now the efficiency does change with the voltage that is inputted, so if the voltage is dropped the efficiency drops as well for example if seven volts were to be used the efficiency becomes 82% and if the voltage were to increase the efficiency rises as well.

The other buck regulator is the TPS62050 which is also manufactured by Texas Instruments™, it is also a step down converter, but the output is adjustable it can be ranged from 0.6 volts to 6 volts, but a special circuit has to be designed to implement this and the voltage range is from 2.7 volts to 10 volts. This device has a couple of upsides compared to the LM2575-3.3, the oscillator frequency of this devices is much greater it has a value typical value of 850 kilohertz compared to the 52 kilohertz, the efficiency is 93% this is 8% higher, but this is if the input voltage used is 5 volts and the output is regulated to 3.3 volts which is perfect because that is the output needed, it also has a lower output current and quiescent current of 300 milliamps and a typical value of 12 microamps respectively. The same step will have to be taken of placing a resistor at the output of the regulator to drop the current to about 20 milliamps in this case a lower resistor will have to be used in this case which is 15 ohms which can be a hassle to obtain, because the tolerance allowed can not be high compared to higher resistor values.

# Block diagrams:

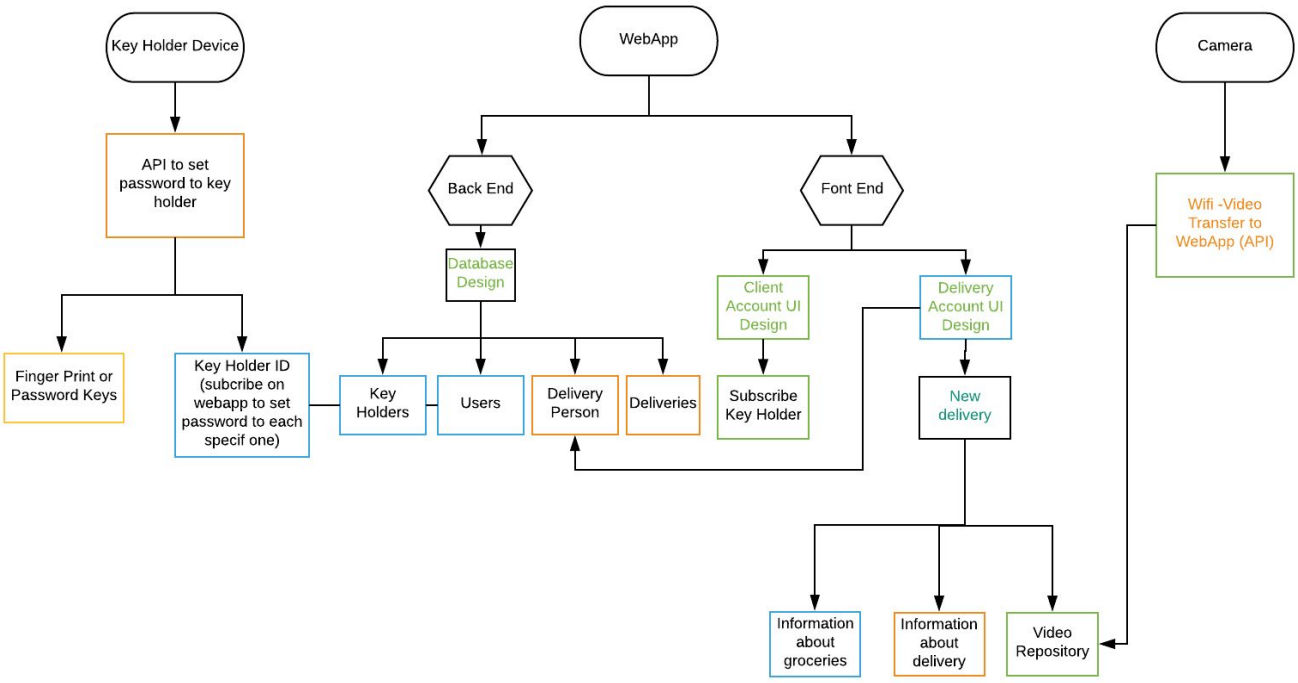


Figure 1: Software Block Diagram

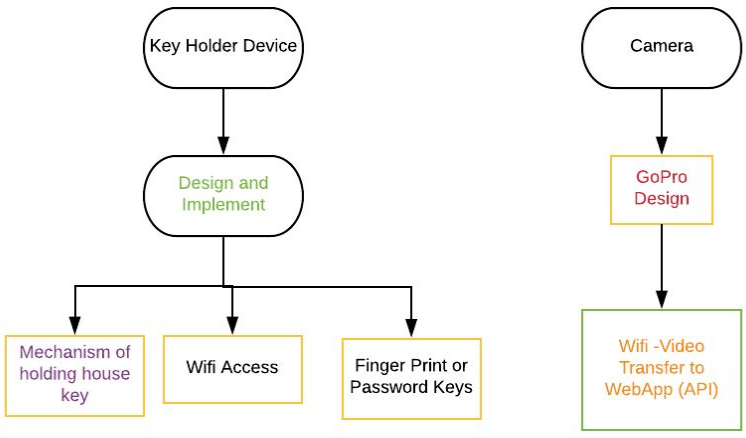


Figure 2: Hardware Block Diagram


Figure 3: Block status

*Note: only blocks that are applicable to have a status are mentioned below*

*database software: regarding the database containing video streams, delivery persons' information and identity, customers information, and other delivery information is thought to be done on a cloud computing service such as AWS (Amazon's web services) though other services are being compared.

# Table 1: Estimated project budget

| **Item** | **Estimated price** | **Details if applicable** |
|---|---|---|
| Gopro | $0 | Donated acquired |
| AWS (database) | $0 | Free 12 month trial used |
| Lockbox | $50 | Might buy 2 |
| Microcontroller | $39 | Arduino MKR WAN 1300 |
| DC-DC Buck Converter | $3.22 and RS | LM2575T and TPS560200 |
| Fingerprint Scanner 5V | $31.95 | TTL (GT-521F32) |

# Project milestone:

## Overview of milestones per semester

Spring 2018 semester

Indepth research for what exact technologies will be used for the project. The mechanical aspect of the keylock would be designed and somewhat tested for the design decision . Team members will spend most of the semester self-learning web app development, working with APIs, implementing databases as well as getting familiar with the database service that will be used. The graphic aspect of the webapp would be designed by the end of the semester as well.

Fall 2018 semester

By the end of the semester have the keylock prototype ready and all software designs implemented and in network.

## Milestone timesheet

**Note: does not include all deliverables as it will be later updated.**

| No: | Task | Deadline | Status | Responsible |
|---|---|---|---|---|
| **Senior Design I (Spring 2018)** | | | | |
| 1 | Ideas | January | Done | Team |
| 2 | Project selection | January | Done | Team |
| 3 | Initial divide and conquer paper | February | Done | Team |
| | **Research and Design** | | | |
| 4 | Camera system to use | March-April | Researching | N/A |
| 5 | Server to use | March | Researching | Dena |
| 6 | Microcontroller to use | March | Researching | Karl |
| 7 | Video streaming methodology | March | Researching | Ana |
| 8 | Lockbox details | March | Researching | Karl |

| | | | | |
|---|---|---|---|---|
| 9 | Power Supply | March | Researching | Karl |
| 10 | UI draft design | March | In-progress | Team |
| 11 | Programming languages | March | Researching | Dena, Ana, Fabio |
| 12 | PCB layout | April | In-progress | Karl |
| 13 | Final 120 page report | May | In-progress | Team |
| **Senior Design II (Fall 2018)** | | | | |
| 154 | Build lock box prototype | September | In-review | Team |
| 15 | Software implemented | October | In-review | Team |
| 16 | Testings | November | In-review | Team |
| 17 | Final report | TBA | In-review | Team |
| 18 | Final presentation | TBA | In-review | Team |

# Specifications

The following specifications are related to the system and will be verifiable upon testing. Specifications have been formatted as follows in figure 7.0

| |
|---|
| No: <unique requirement number> |
| Statement: <the "shall" statement of the requirement> |
| Source: <source of the requirement> |
| Dependency: <list each other requirement on which satisfaction of this requirement depends. (May be "None")> |
| Conflicts: <list each other requirements with which this requirement conflicts. (May be "None")> |
| Supporting Materials: <list any supporting diagrams, lists, memos, etc.> |
| Evaluation Method: <How can you tell if the completed system satisfies this requirement? > |
| Revision History: <who, when, what> |

*Figure 7.0 : specifications format*

| No: 3000 |
| --- |
| Statement: The system shall be both web and mobile friendly. |
| Source: Team |
| Dependency: None. |
| Conflicts: Consistency |
| Supporting materials: CSS software and UI design |
| Evaluation Method: define UI designs for both views (web and mobile) |
| Revision History: Check all information is added to the UI and system is friendly and clear to all customers in web and mobile UIs. |

| No: 3001 |
| --- |
| Statement: The system shall allow items to be delivered inside the house. |
| Source: Team |
| Dependency: Lockbox implemented and set up in the house. |
| Conflicts: security system is turn on.<br>Delivery person decided not to enter the house for personal reasons. |
| Supporting materials: None. |
| Evaluation Method: End prototype done with all its tests. |
| Revision History: Dr Richie will be checking the final prototype at the end of the semester. |

| No:3002 |
| --- |
| Statement: The system shall prompt user to either sign in or sign up in order to access the program. |
| Source: Team |
| Dependency: None. |
| Conflicts: None. |

| |
|---|
| Supporting materials: Some sketches of the Desktop and mobile version have been created in the following figures 3.20-3.23: |

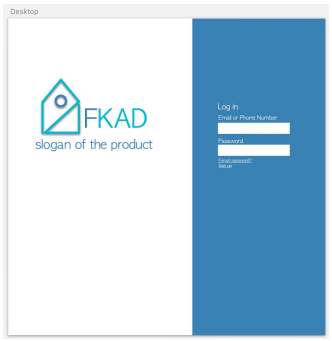


*Figure 3.20: Desktop log-in*


*Figure 3.21: Mobile log-in*

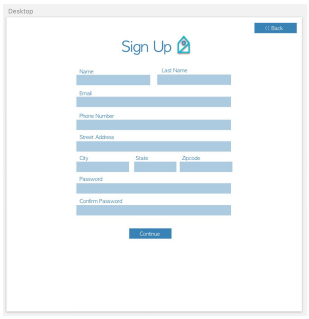


*Figure 3.22: Desktop sign-up*


*Figure 3.23: Mobile sign-up*

| |
|---|
| Evaluation Method: Both prompts will be tested. |
| Revision History: The team will be confirming the follow up functionality of the prompts. To be expecting sign in/ sign up pages. |

| |
|---|
| No: 3003 |
| Statement: The system shall retain customer information. |
| Source: Team |
| Dependency: Database implemented. |
| Conflicts: None. |
| Supporting materials: |

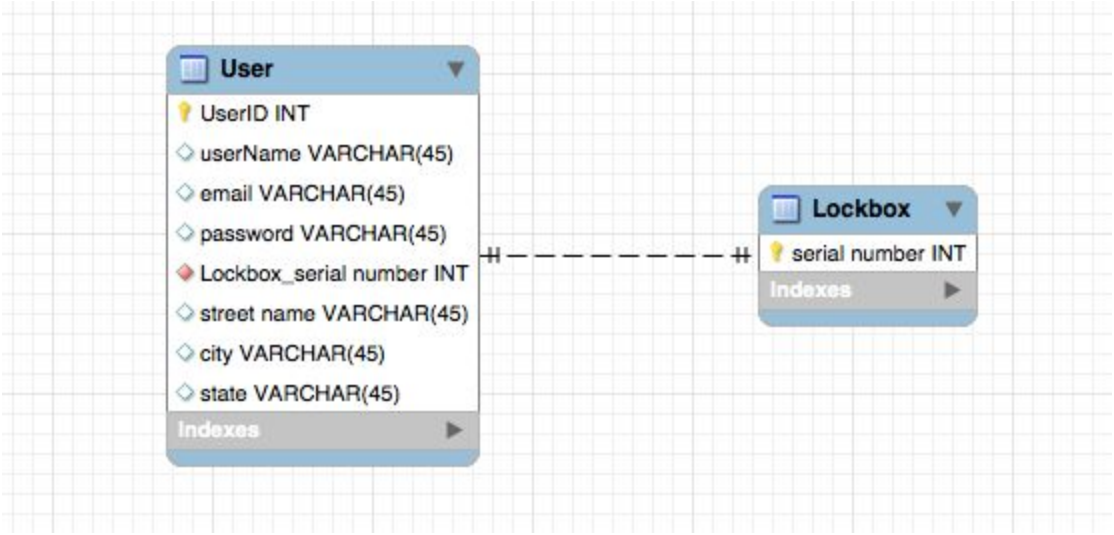


*Figure 3.3: ER diagram draft of the user table*

| |
|---|
| Evaluation Method: Test database once a new customer is signed up. |
| Revision History: Dena will be checking the database for proper implementation. |

| |
|---|
| No:3004 |
| Statement: The system shall identify each lockbox and activate specific fingerprints. |
| Source: Team |
| Dependency: Lock serial number (id) |
| Conflicts: Cannot differentiate between lockboxes. |
| Supporting materials: API or special algorithm to create connection to software and identification |
| Evaluation Method: Test different fingerprints to different locks |
| Revision History: The team will test once software and hardware is completed. |

| |
|---|
| No: 3005 |
| Statement: The system shall retain video recordings of delivery for a restricted amount of time for customers to review. |
| Source: Team |
| Dependency: Setting up a network to send recordings from the camera to the server (database). |
| Conflicts: Not obtaining a method to send recording from camera. |
| Supporting materials: None as of now. |
| Evaluation Method: Check if recordings are available for customer viewings on their account. |
| Revision History: A mock delivery will be made to collect all the data needed. |

# Table 2:The Engineering-Marketing Tradeoffs Matrix

Tradeoffs and marketing requirements are essential to develop an idea. These tradeoffs and marketing help to redefine the requirements and objectives of the system.
Engineering Requirement:

| | | Power Consumption | Efficiency | Weight | Dimensions | Cost |
|---|---|---|---|---|---|---|
| | | - | - | + | - | - |
| Low Power | - | ↑↑ | ↑↑ | ↑ | ↑ | ↑ |
| Portability | + | ↑ | ↓ | ↑↑ | ↑↑ | ↑ |
| Simplicity | + | ↓ | ↓ | ↓↓ | ↓ | ↑↑ |
| Durability | + | ↑ | ↑↑ | ↓↓ | ↓ | ↑ |
| Targets for Engineering Requirements | | <12 Watts | >83% | <10 pounds | 9x6 inches | <$200 |

Legend for the table above:

↑ = Positive correlation
↑↑ = Strong positive correlation
↓ = Negative correlation
↓↓ = Strong negative correlation
\+ = Positive polarity Increasing the Requirement
\- = Negative Polarity Decreasing the Requirement

# Legend:

**NPN:** Is a Bipolar Junction Transistor (current controlled device). The NPN stands for Negative-type region (electrons), Positive-type region (holes, Negative-type region (electrons) and these three regions are placed parallel of each other.

**LCD:** Liquid Crystal Display, this is optional it would just show a welcoming message.

**API:** Application Programming Interface.

**RS:** Request Sample

**BPS:** Baud Rate per Second

**PPI:** Pixel per inch

**DPI:** Dots per inch