## Mail Gobbler 9000

Team 31

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## **Problem Statement**

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### **Ongoing Pandemic (1+ years)**

- 1. Package Security
- 2. Closing of retail stores
- 3. Transition to online shopping



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## **System Specs**

#### Mail Gobbler 9000 Specifications

- I. Barcode authentication functionality
  - A. barcode scanner and wi-fi communication with AWS backend
- II. Lock/unlocking mechanisms
  - A. unlock request from MG9K mobile app
  - B. correctly identified barcode scan
- III. Fully functional mobile application
  - A. unlock request,
  - B. system logs
  - C. reliable communication with backend
- IV. Ergonomic features
  - A. rechargeable batteries with long life span
  - B. wireless setup
  - C. physical backdoor
  - D. sensibility (system timings, security measures, size)

### **System Spec: Performance**

Performance	Specification	Value	
	Wake-up Response	<1 sec.	
	Authentication and Unlocking	<5 sec.	
	Grace Period	2 Min. Grace Period for Delivery.	
	Extended Battery Life	12V, est. 90 days.	
	Round Clock Operation	LED Allows for Night Time Illumination.	

### **System Spec: Security**

Security	Specification	Value	
	Data Security	AWS Cognito User Sign Up with Limited Privileges. Data Storage in AWS DynamoDB	
		Secured with Limited Write Privileges.	
	Hardware	Hidden Circuitry Inside the Dropbox.	

## **System Spec: Convenience**

Convenience	Specification	Value	
	Mobile App	Stable Mobile App with Full Functionality.	
	Unlocking Alternatives	Remote Unlocking via App and Physical Backdoor.	
	Envelope Compartment	Compartment for Envelopes with Arrival Notifications.	
	Wireless Set Up	No External Wires or Connections Outside of Box.	
	Dimensions	24" Height x 24" Width x 15.4" Length.	

## **Images of Final Prototype**

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### **System Overview**

- 1. The mailbox can be opened in 2 ways:
  - successful barcode scanned from delivery personnel.
  - user issued an unlock request via application
- 2. On a successful unlock, box will stay on for 2 minutes before turning off.
- 3. Mailbox communicate with AWS database wirelessly.
- 4. User app allows user to set up mailbox wifi manually.
- 5. Remains locked if the presented barcode does not exist.

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#### **Functionalities Overview**

### Hardware & Software

#### **Hardware Modules**

- □ ESP-WROOM-02 (WiFi Module)
- □ Microcontroller (ATMega328P)
- □ Barcode Reader (PS/2)
- Solenoid
- □ Rechargeable Battery (12-Volt 7AH)
- Miscellaneous: LED, Capacitors, Diodes, Resistors, and Inductors

#### Hardware Programming

#### Atmel Studio

#### **PCB Modules**

Altium PCB Designer Tool

#### **Backend Modules**

Amazon Web Services (AWS)

- □ IoT Core
- Lambda
- □ AppSynch
- DynamoDB
- Cognito
- SNS

#### **Frontend Modules**

- □ xCode (Swift)
- Google Drawing
- Github

#### Website Modules

- □ HTML/CSS
- Github
  - Pages







## **System Block Diagram**

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## **Software Diagram**





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## **Hardware Diagram**



## **Battery Decision**

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9V Cell Rechargeable Batteries 200mAH Ni-MH 80% capacity for 24 months

Cycle expectancy for 9V: ~23 hours - 36 hours

12-Volt Rechargeable Battery 7AH Sealed Lead Acid (SLA) "Can be used in enclosed/indoor environments without leak and maintenance"

Cycle expectancy for 12V: ~1460 hours - 2190 hours ~ 2 month - 3 months Dimensions: 5.94 inch x 2.56 inch x 3.94 inch (Cross section ~ small phone)

## **PCB Schematic**

Red (Major):

- U1: 3.3 V Regulator
- U2: ATMega328P uC
- U3: ESP-WROOM-02

Blue (Secondary):

- D1: Solenoid
- D2: Switch
- D3: Scanner
- D4: LED indicator

Gold:

• Z1: Headers



## **PCB Board Layout**

#### Red (major):

- U1: 3.3 V Regulator
- U2: ATMega328P
- U3: ESP-WROOM-02

#### Gold (connectors):

• Headers (6x)



<sup>↑</sup>Option 2. Placing at the edge with the antenna outside of the host board



### **Photos of PCB**





## **Atmel Studio vs Arduino IDE**

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External Tools	?	<				
		New Project				? ×
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both C and C++

Setting up Arduino environment as external tools

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## **FPR Deliverables**

Promised Deliverables for FPR:

- I. Functional integrated system situated within a physical dropbox
  - A. cardboard dropbox to avoid costly woodwork
  - B. conveys operational concept of the system
- II. Fully populated and functional PCB
- III. Robust prototype that avoids solderless breadboard
- IV. Prototype compliant to system specifications

## **Integration Failures**

#### Failures:

1. Barcode Scanner

The biggest hurdle was not knowing what our output was, so when we would scan a value, we had no way to see what data was being transmitted. Having an LCD display would've helped in this process. This was figured out too late in design.

2. Serial Communication

The only communication we have between the ATMega328P and the ESP-WROOM-02 is setting pins high and low. We were unable to have the UART communication occur. There were issues with our frequency and baud rate. This could be due to a lack of external clock, which was found too late in the design process.

### What We Learned

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#### Improvements:

- 1. More planning could have gone into the operation modes of ESP-WROOM-02 during CDR.
- 2. Should have put more thoughts into future stages.
- 3. Avoids tunnel vision.



Sample PCB circuit for WROOM configuration

## Integration Successes and System Upgrades

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#### Success:

- 1. Mobile application
- 2. Functional backend
  - a. Unlock request propagates to hardware
- 3. Populated PCB that avoids solderless breadboards (WIP)
- 4. System incorporated into physical mailbox

#### Upgrades:

1. Wi-Fi setup manager

- I. Introduction of mobile app: MG9K
- II. Walkthrough of backend and functionalities
- III. Physical box demo

### **MG9K WiFi Setup**

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### MG9K WiFi Setup



### **Demo: Back Up Recording**

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### \*NO BREADBOARD IN FINAL PROTOTYPE

### **Demo: Back Up Recording**



## **Changes since CDR**

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#### <u>Luan</u>

**PCB Soldering** 

- Solder SMT components
- Header Integration
- Verification and testing PCB

#### **Atmel Studio**

> Program ATMega328P

#### <u>Adam</u>

Integrate ATMega328P with

ESP-WROOM-02 in final prototype

#### **Physical Hardware**

- > Physical Box Remodel
- Circuitry Integration into Box

#### <u>Brendan</u>

ESP-WROOM-02

- Soldered Pins
- > Programmed ESP
- ➤ Wi-Fi Set Up process

**Collaborative Testing** 

#### <u>Jackie</u>

**Improved PCB** 

- > Added Headers
- Modified ESP Placement
- > Reroute Traces

**Mobile App Testing** 

- Test all Functionalities on iOS Phone
- Small Changes
  - Hide keyboard (on-screen keyboard)
  - Remove Redundant Package Log

## **Budget Expenditure**

Budget	Current Total Cost w	<b>Remaining Budget</b>			
\$500.00	\$353.33	\$146.67	2		
Circuitry Costs	Link	Status	Unit Price	Quantity	Total Cost w/Shipping
Rechargeable Lithium Battery	https://www.homedepot.com/p/M	Own	\$17.50	2	\$40.99
Battery Charger	https://www.amazon.com/Peleus	Own	\$10.99	1	\$10.99
ESP- WROOM - 02	https://www.digikey.com/en/prod	Own	\$2.70	10	\$51.66
USB Host BOB	https://www.digikey.com/product-	Own	\$4.50	1	\$4.50
Scanner	https://www.adafruit.com/product	Own	\$69.95	2	\$151.30
2-Layer PCB [80x62 mm]	jlcpcb.com	Own	\$0.40	5	\$19.80
CP2102 Module Usb to TTL	https://www.amazon.com/IZOKE	Own	\$7.89	6	\$23.67
Breadboard	https://www.amazon.com/DEYUI	Own	\$6.99	3	\$6.99
0022112092 Molex [9 Pin header]	https://www.digikey.com/en/products/de	Own	\$1.41	2	\$2.82
826926-2 [2 pin header]	https://www.digikey.com/en/products/de	Own	\$0.26	4	\$1.04
640456-5 [5 pin header]	https://www.digikey.com/en/products/de	Own	\$0.33	2	\$0.66
22232071 [7 pin header]	https://www.digikey.com/en/products/de	Own	\$0.44	2	\$0.88
90147-1314 [14 pin header]	https://www.mouser.com/ProductDetail	Own	\$3.30	2	\$6.60
1-826629-3 [13 Pin header]	https://www.mouser.com/ProductDetail	Own	\$1.67	2	\$3.34
Box Construction Costs	Link	Status	Unit Price	Quantity	Total Cost w/Shipping
12 oz. #P140-7 No More Drama G	https://www.homedepot.com/p/B	Own	\$5.98	1	\$11.97
Construction Box Materials	From Shira	Own			
Gorilla Dual Temp Mini Hot Glue Gun Kit	https://www.amazon.com/Gorilla-84015	Own	\$12.49	1	\$12.49
Masking Tape	https://www.amazon.com/Scotch-Office	Own	\$3.63	1	\$3.63

# Thank you!

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#### **Concluding Remarks:**

Thank you for a wonderful Senior Design Project:

- ≻ Time
- Constructive Feedback
- Empathy and Patience (regarding virtual demo)

## Questions?

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state the set

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### ESP-WROOM-02







Pins Needed	Connection To		
3.3V Power Supply (VDD)	3.3V Power		
EN - Chip Enable Pin	Pulled up to VCC (3.3V Power)		
IO15 - UARTO	GND		
IO0 - UART Download	GND		
GND	GND		
TXD	RXD of USB Interface		
RXD	TXD Of USB Interface		