SECURE PHONE LOCKER WITH INTEGRATED NOTIFICATION TRACKING (SPLINT)

Group D

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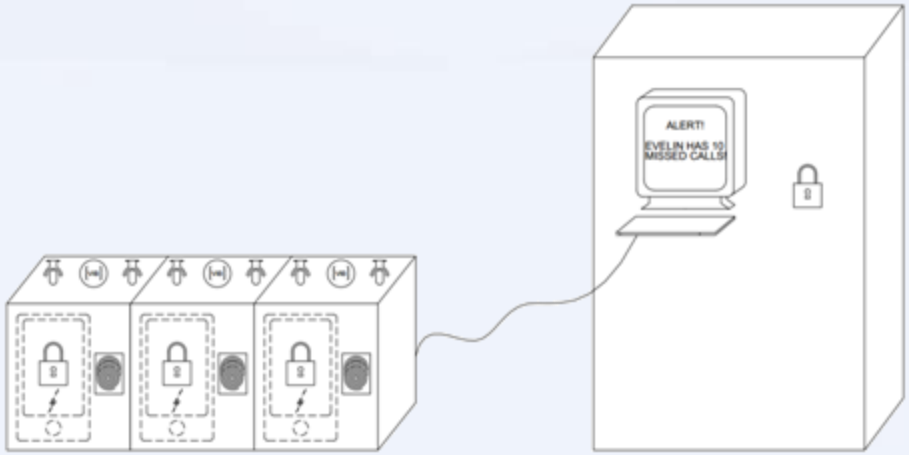


The Problem We Observed

- Some Facilities Have Cell Phone Restrictions
  - RF Testing
  - Sensitive Information
  - Distractions & disruptions

- Current solutions are inefficient
  -Phones left unsecured
  -Has Potential to be stolen or damaged
  -Lacks any means of relaying emergency notifications

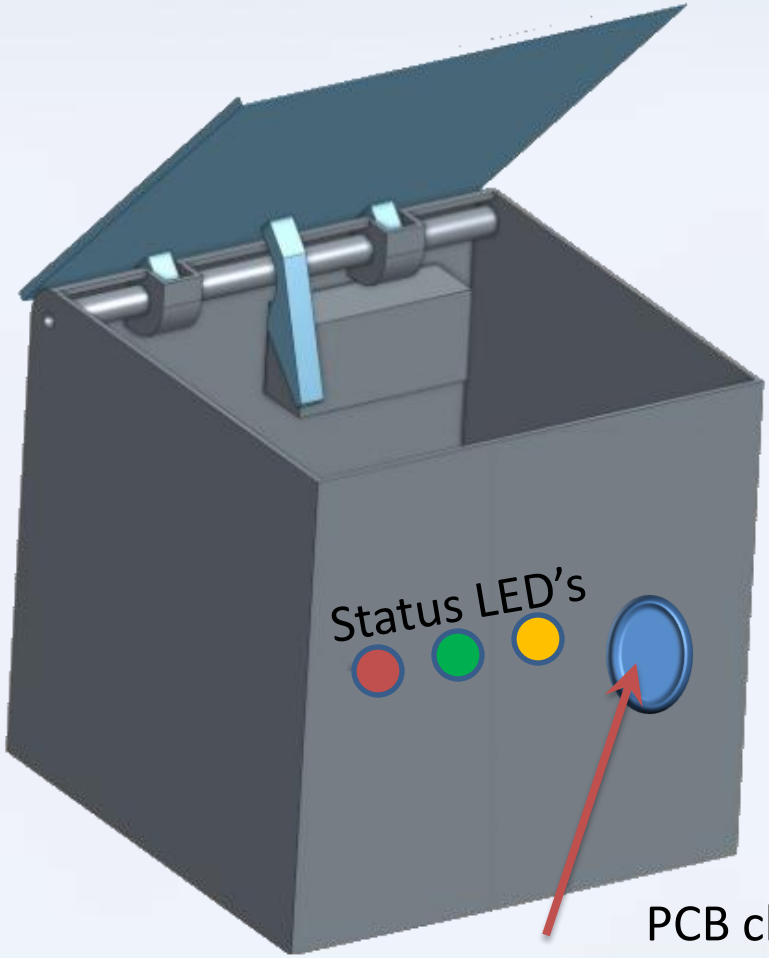
Our Solution to the Problem

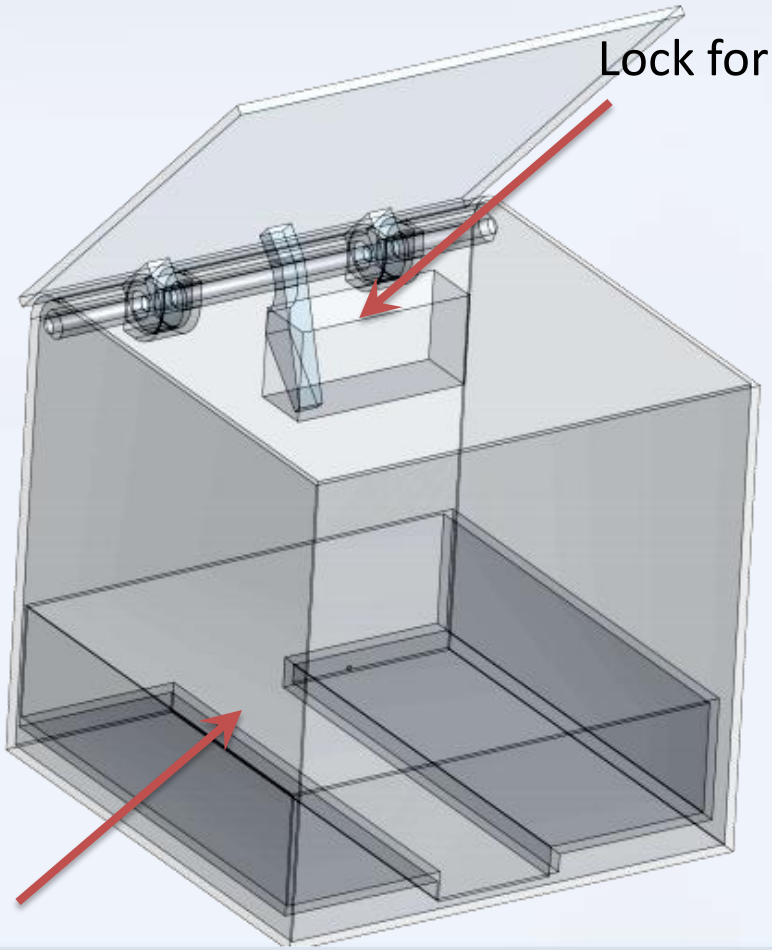
- Keep your phone safe & secured
- Keep phone charged
- Detect Important Notifications
- Relay the detected notifications to a computer terminal.

Engineering Requirements

Specification	**Requirement**
Power Consumption	< 400 Watts
Microphone detection	80+ dB
Vibration Detection	10Hz-400Hz
Damping Between Compartments	10dB
Fingerprint Detection Accuracy	>90%
Single locker footprint (maximum)	12“ L x 12“ W x 12“ H
Sensor Actuation-Transmission Delay	<5 seconds

Our Current Locker Model

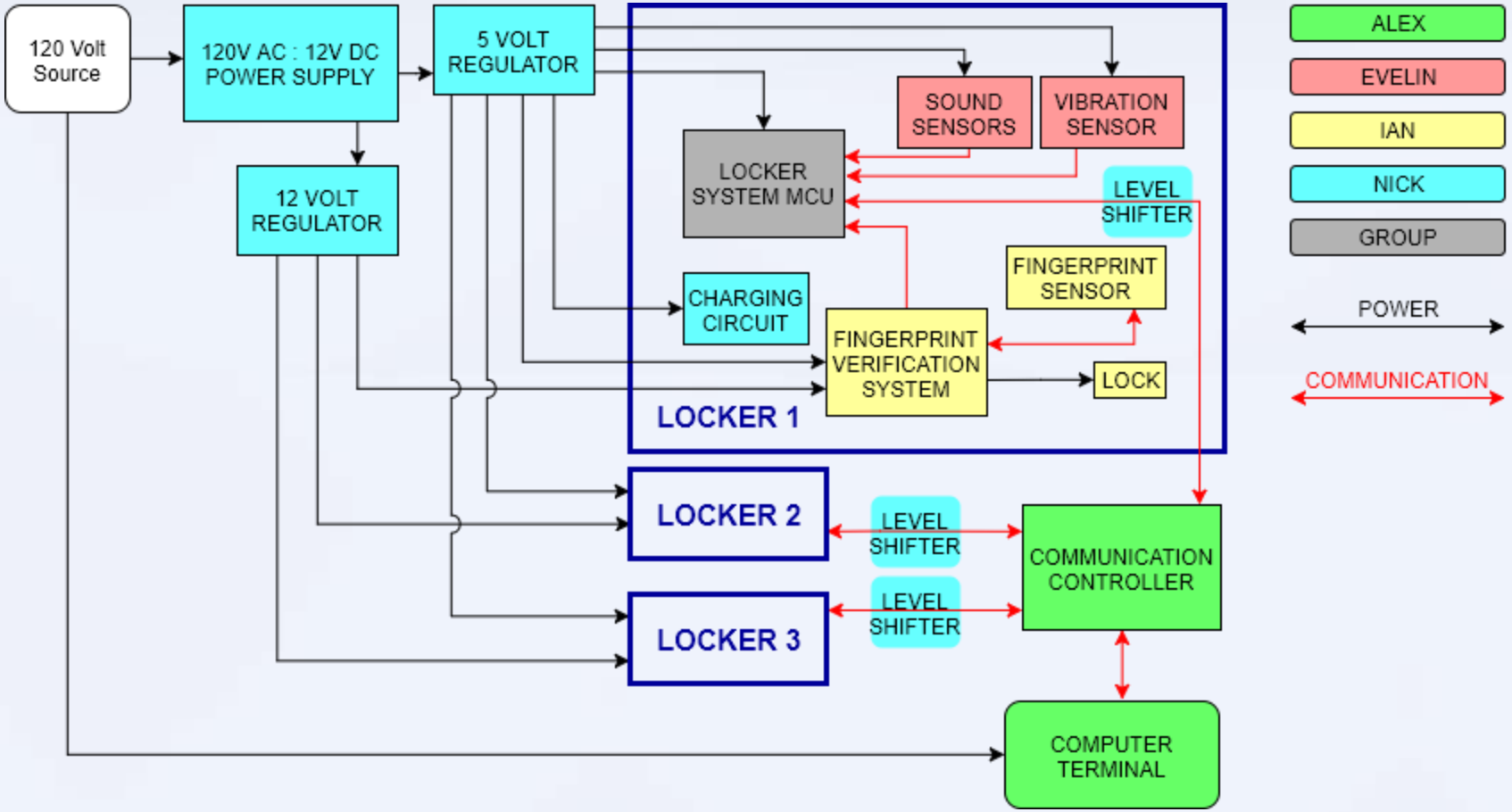




Our Design Approach

- Widely Applicable
  - Low Cost
  - Minimize Overhead
  - Modular and Expandable
  - Nothing Device Specific

Block Diagram



Security Design Decisions

Goals

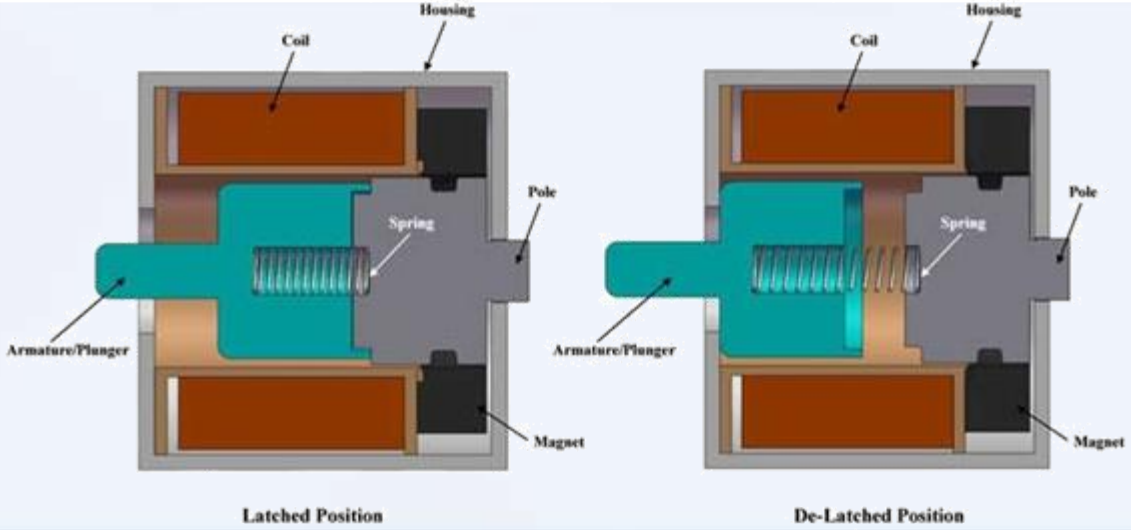
- Electrically Controlled Locking Mechanism
- Strong and Secure Authentication Method
- Low Cost Design

Locking Mechanism Selection

Type	Pros	Cons
Electromagnetic	•Tamper Resistant •Strength increases with current	•Requires Constant Power •Expensive & Large
Linear Solenoid Bolt	•Low power requirement •Inexpensive •Small in Size	•Not very heavy duty •Locked out if power is lost
Motorized Electric Latch	•Only requires power during state change •Allows manual key override	•Large in size •Moving parts
Linear Solenoid Latch	•Power effective •Cost effective •Small yet Strong	•Can be locked out if power is lost

Lock Selection

Product	Voltage DC (Volts)	Current (Amps)	Dimensions (cm)	Price
Uxcell Open Frame Type Solenoid for Electric Door Lock	12	1.3	6.6 x 4.2 x 3	$16.14
Uxcell 10mm Stroke Force Open Frame Type Solenoid for Electric Door Lock	12	1.0	6.4 x 2.6 x 2	$9.92
Amico 0837L Open Frame Type Solenoid for Electric Door Lock	12	0.6	6.6 x 4.0 x 2.7	$6.21
ATOPS Ultra-Compact New Cabinet Door Solenoid Electric Lock Assembly	12	.35	2.7 x 2.9 x 1.8	$4.75
UHPPOTE File Display Cabinet Drawer Latch Assembly Solenoid Electric Lock	12	.6	5.45 x 4.1 x 2.8	$12.50



Authentication Method Selection

Goals

- Difficult to Falsify or Cheat
- Easy to Setup
- User Friendly
- Cost effective

Authentication Method Selection

Type	Pros	Cons
Integrated Circuit Card	•Low power requirement •Can incorporate Some Existing Company ID's •Inexpensive	•Card can be misplaced, lost or stolen. •Work •Wears out and needs replacement
Numeric Keypad	•Low power requirement •Inexpensive to implement	•Requires memorization •Vulnerable to eavesdropping •Takes up a lot of space
Near Field Communication (NFC Chip)	•Very compact •More secure than keypad •Low power requirement	•Can be misplaced, lost or stolen •Might not be allowed in some buildings
Fingerprint Scanner	•Highly Secure •Cant be misplaced •No memorization required •Difficult to replicate or fool	•Can't be shared •Costs more than other methods

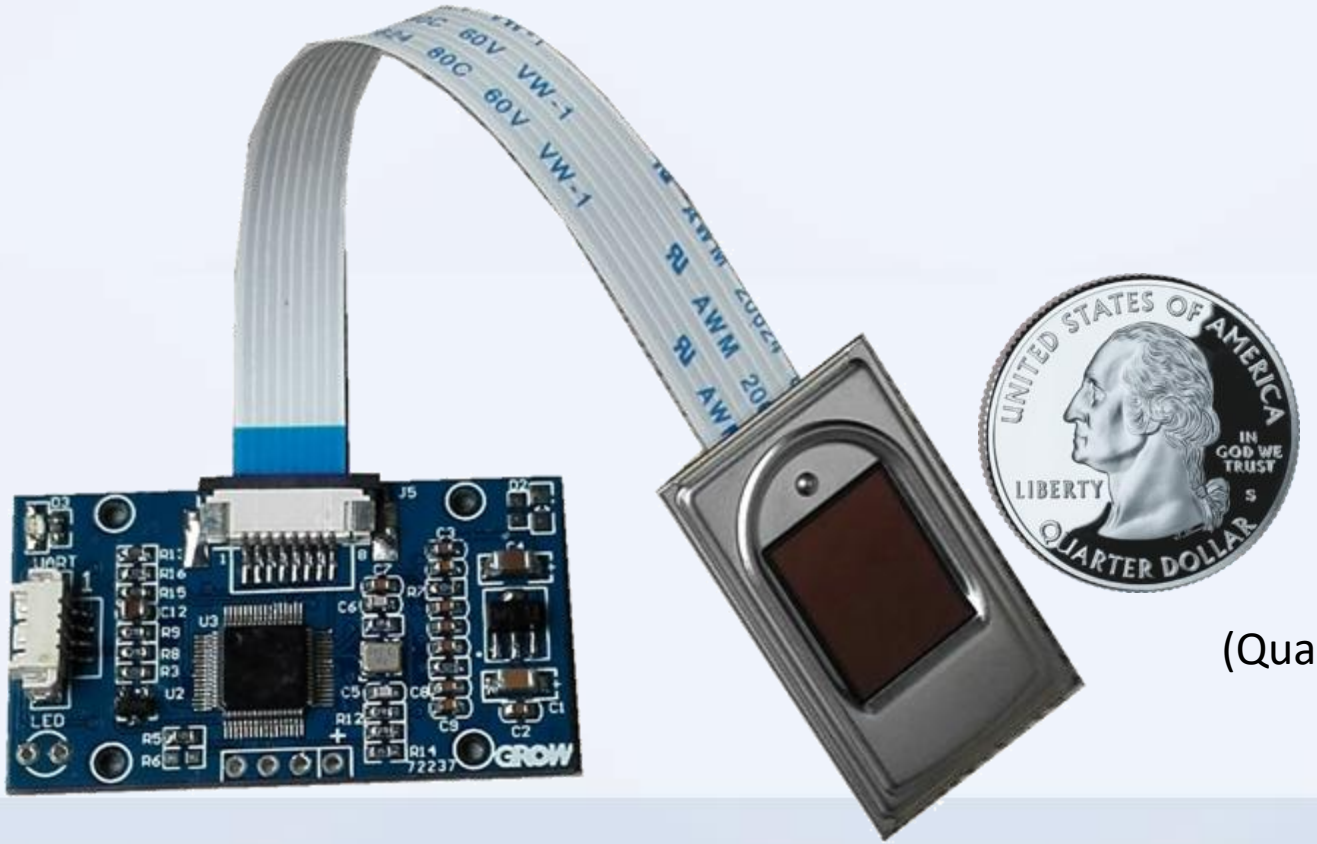
Fingerprint Module Selection






Fingerprint Scanner	GT-511C1R	R303	R306	EM406
Manufacturer	ADH-Tech	Grow	Grow	HF Security
Type	Optical	Capacitance	Capacitance	Optical
Communication	UART	UART	UART	UART
resolution(dpi)	450	508	363	508
Price	$31.95	$28.00	$38.00	$42.99
Operating Current(mA)	<100	<55	<60	<100
Fingerprint Storage #	20	1000	1000	1000
Voltage (V)	5	5	5	5

R303 Sensor Module



(Quarter For Scale)

Security Microcontroller Selection

Controller Requirements

- UART for Fingerprint Module
- Enough GPIO pins for:
  -Buttons
  -Status LED’s
  -Lock Trigger
  -Lock State Output

Security Microcontroller Selection

	MSP430G2553	MSP430FG4618	ATMEGA328	ATtiny417
CPU	MSP430	MSP430	AVR	AVR
Non-volatile Memory (KB)	16	116	32	4
GPIO Pins (#)	25	80	23	6
UART	1	1	1	1
ADC Channels	8	12	8	4
Active Power (uA/MHz)	330	400	200	200
Wakeup Time (us)	1.5	13	60	60
Price	$1.50	$7.54	$2.88	$0.80

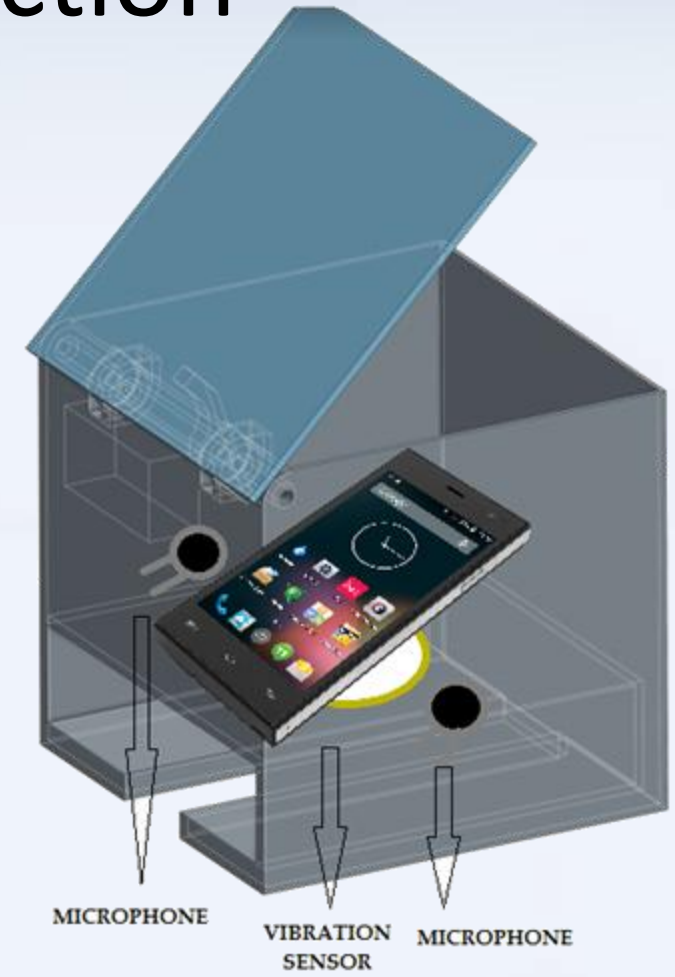
Sensors Selection

- Sound Sensor:

Detecting a ringtone

- Vibration Sensor:

Detecting vibrations

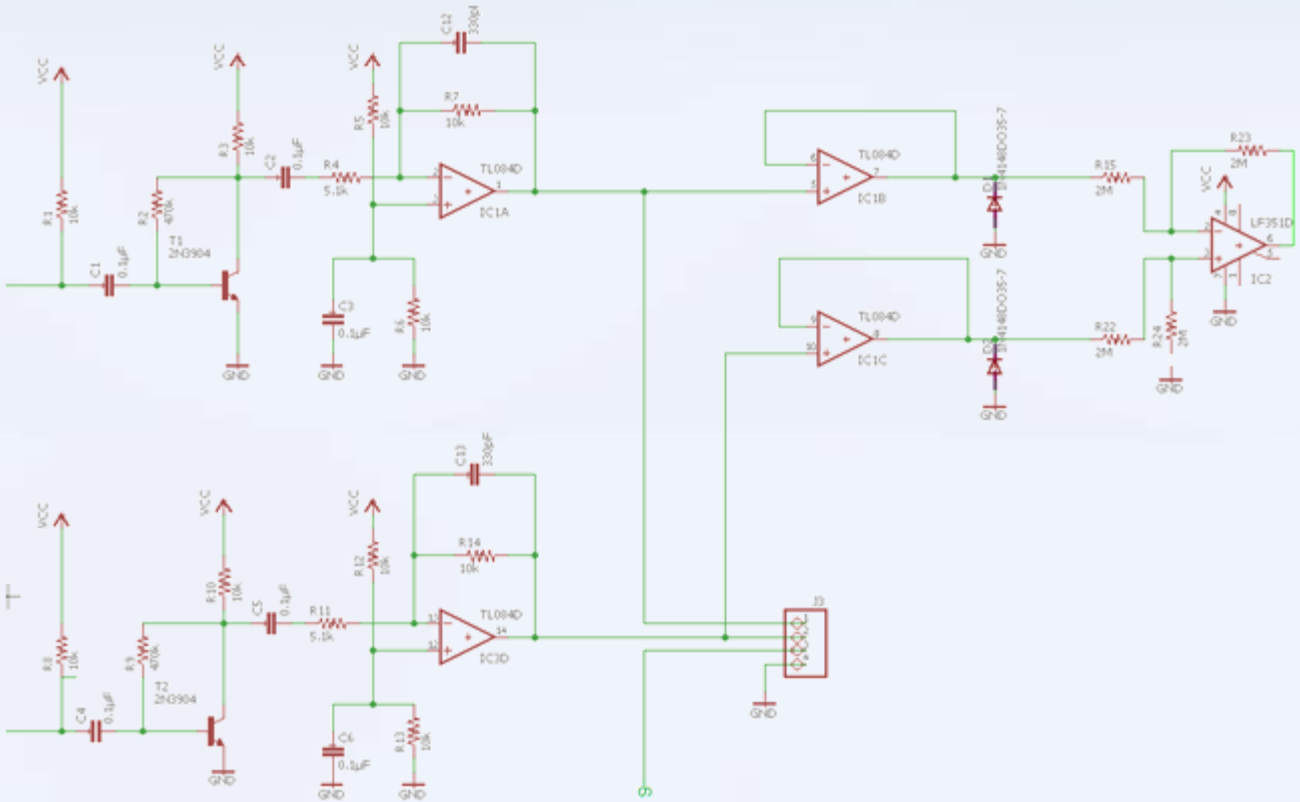


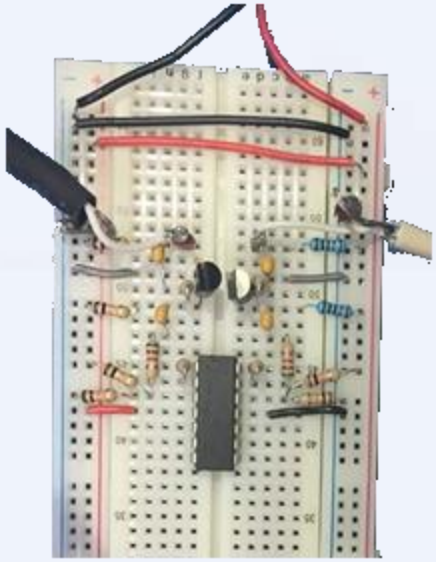
Sound Sensor Options

Chosen: Electret Microphone

Electret Microphone	**Piezoelectric Microphone**	**MEMS Microphone**
Analog Output	Analog Output	Analog or Digital output
Low Cost	High Impedance	Comes with preamp
High Performance	High electrical output	High electrical output
Frequency range 10Hz-20khz	Frequency range 20kHz-10Mhz	Frequency Range: 100Hz-6Khz
More sensitive	Less sensitive	Less sensitive than electret by 12dB

Sound Sensors Circuit





Vibration Sensor Options

- **Chosen:** Piezoelectric sensor disc
- **MEMs Accelerometer:** Lower Range, High Sensitivity. Good for structural monitoring & acceleration measurements.
- **Piezoelectric disc:** Low Sensitivity, Wider Range. Best for converting sound pressure into voltage.

(Quarter For Scale)

Vibration Sensor circuit

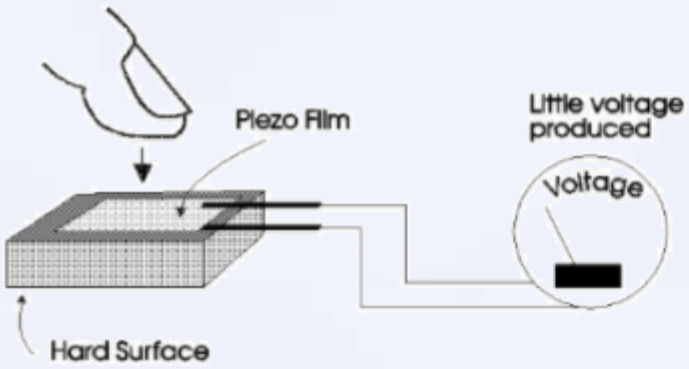
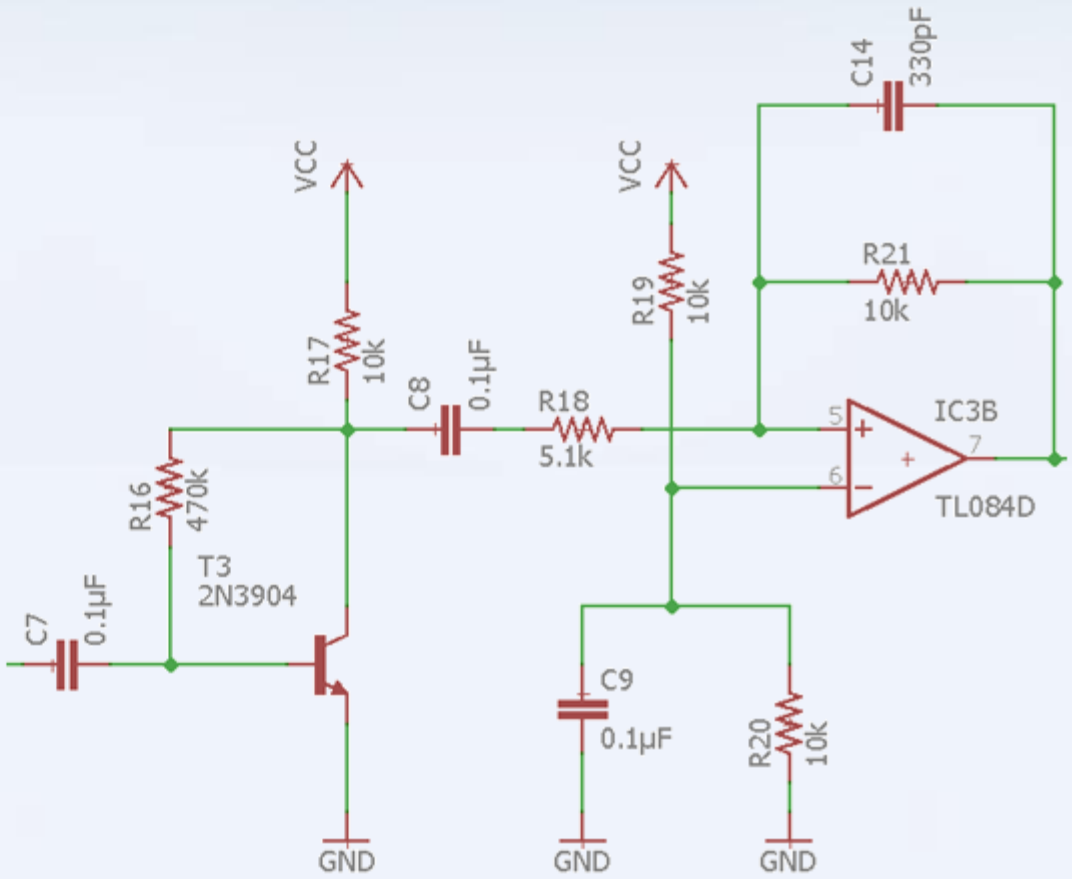
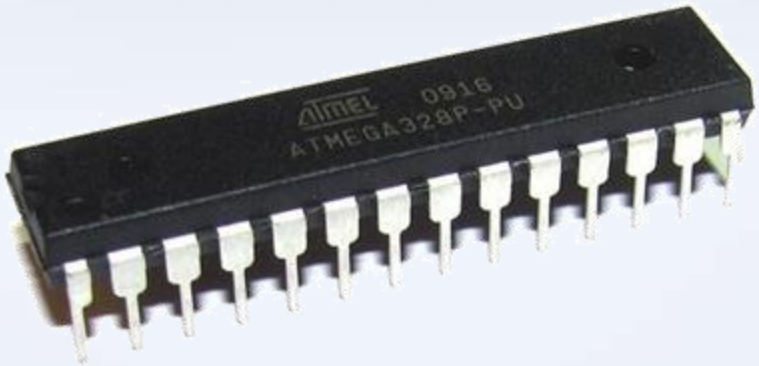


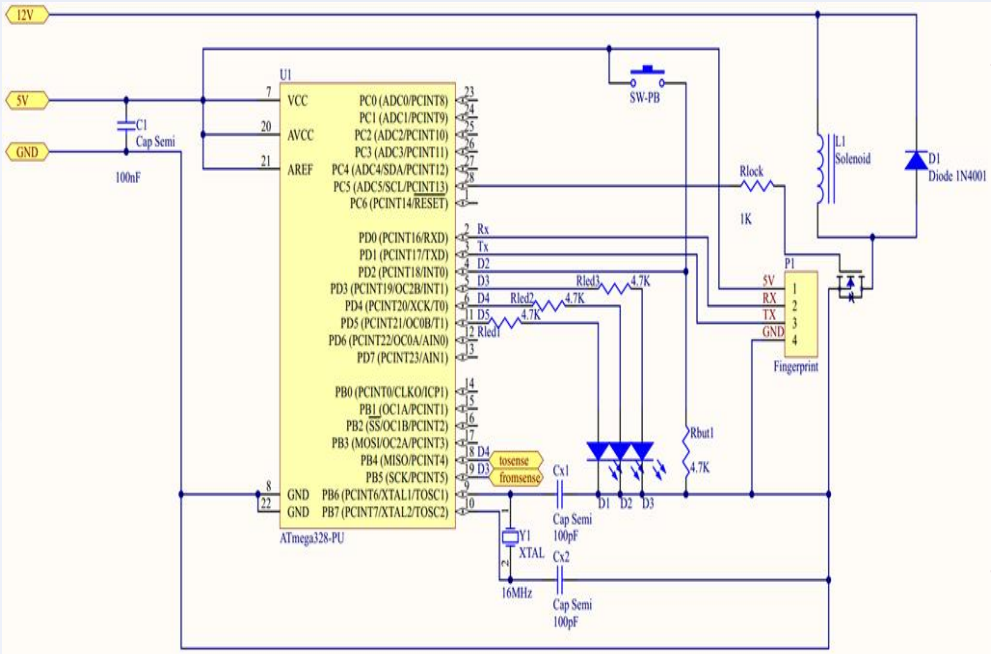
Figure 21 - Piezoelectric Sensor Structure

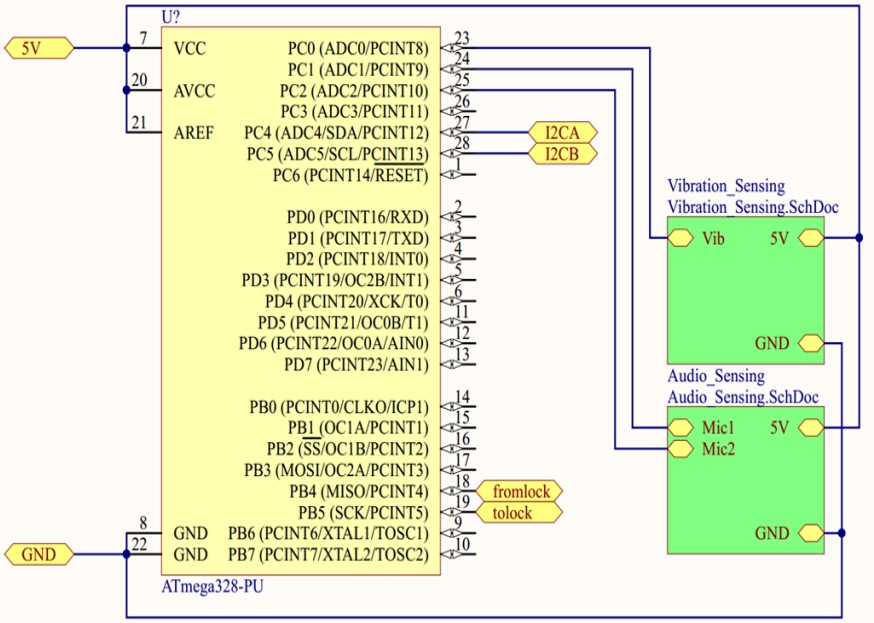


Sensing Controller Selection



- ATMega328P-PU
- Well Documented
- Previous Familiarity
- Readily available libraries for I2C
- Plenty of built in ADCs and Digital pins
- Low cost

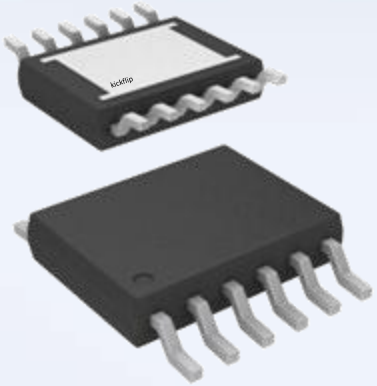




Locking Subsystem

Sensing Subsystem

USB Charging



- LT8608EMSE
- Limits current
- Specially designed for USB power
- Keeps load off of the 5V regulators
- Small footprint
- High Efficiency

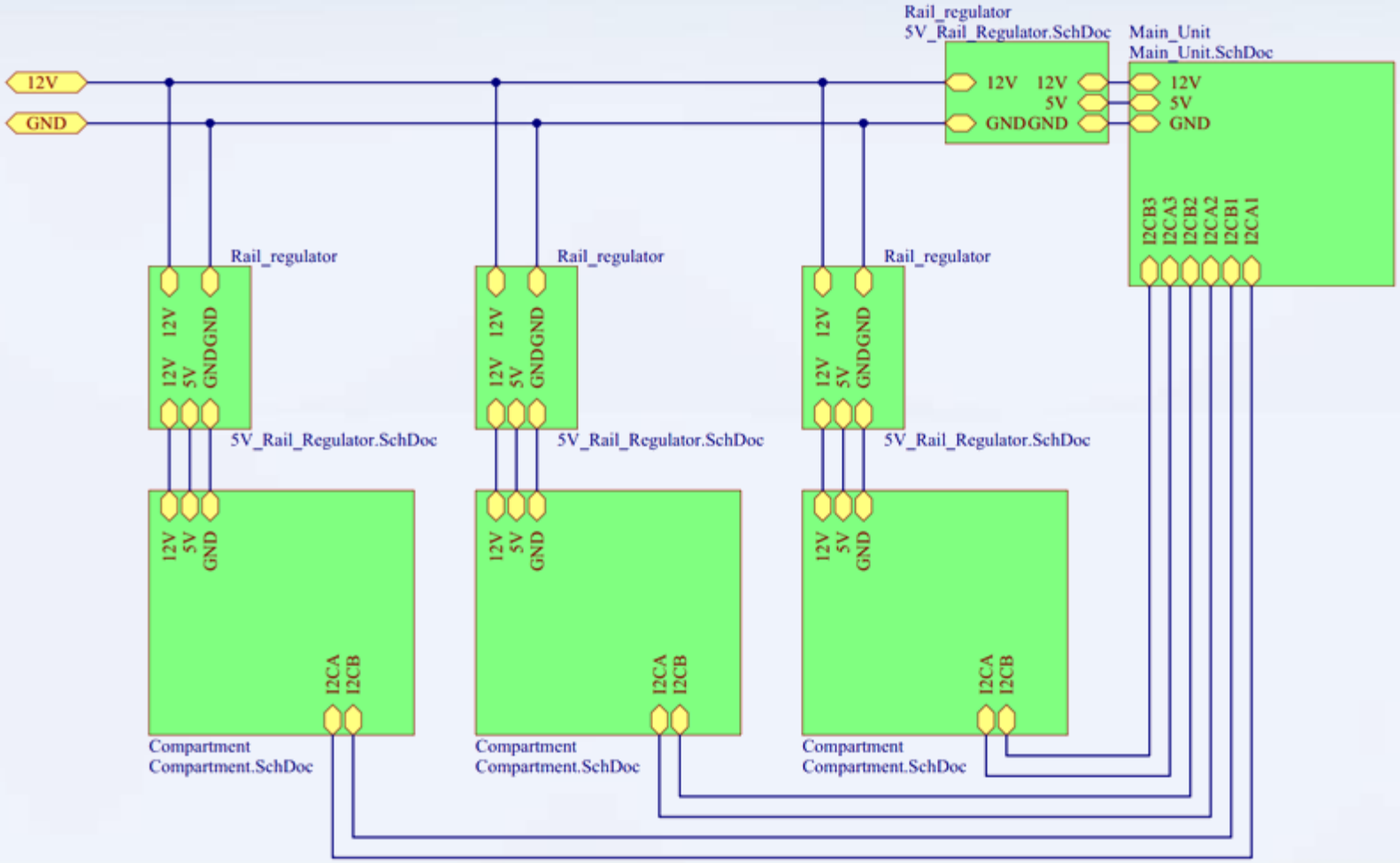
But What About Power

Component	Voltage Required	Power Consumption
Atmega328	5V	Low
Beaglebone	5V	Low
Level Shifter	5V & 3.3V	Low
Sensing circuit	5V	Low
Fingerprint sensor module	5V	Low
Latch	12V	High
USB port	5V	High

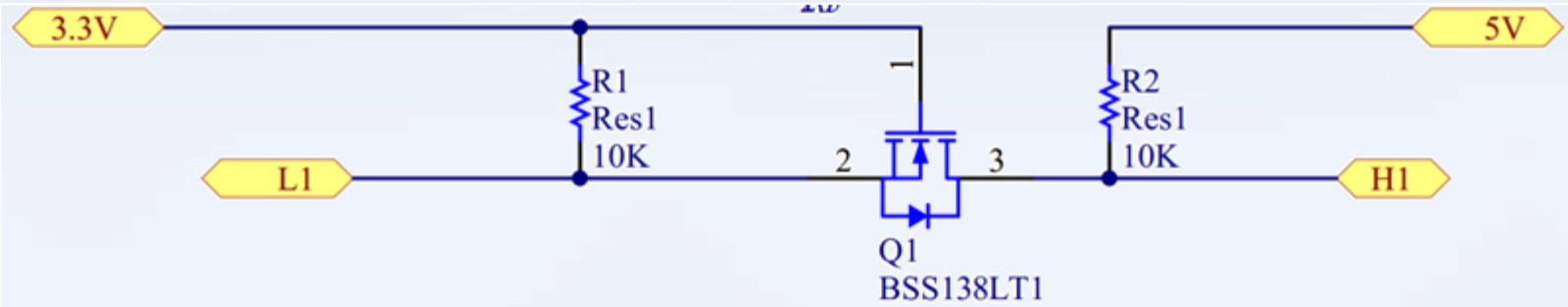
Rail Connections

12V	5V
Latch	Atmega328
USB power module	Beaglebone
	Sensing circuit
	Fingerprint sensor module
	Level Shifter

Overall Top Level Power Circuit



Level Shifter



- Minimize necessary components
- Allow for mixed logic levels
- Bi-directional

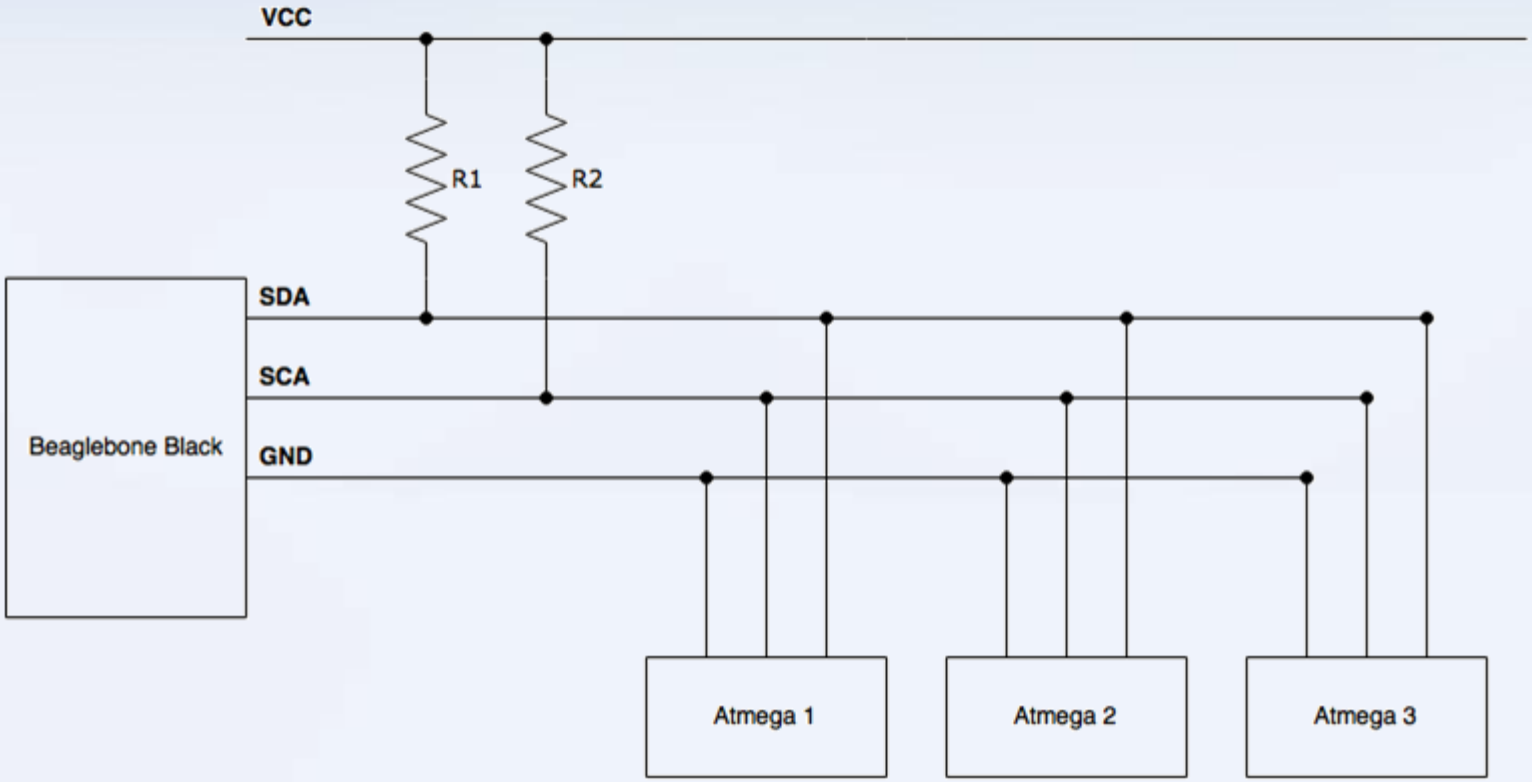
Communication Controller

Controller	Advantages	Disadvantages
Arduino ATMega	Cheap Easy to Use Power Efficient Multiple Analog/Digital Pins	Slow Low Level Low Memory
Beaglebone Black	Fast Processor Multiple Analog/Digital Pins Ethernet Linux & Android compatible	Poor Documentation High Cost
Rhasberry Pi	Fast Processor Large RAM USB	No analog GPIO pins
MSP430	Power Efficient Scalable Small Size Many GPIO Pins	Slow Low Level Low Memory

I2C Communication

- BBB and ATMega both support I2C communication.
- Only requires two bus lines.
- We have two topologies for setting up I2C:
  - Single Master Multiple Slave
  - Multi Master Single Slave

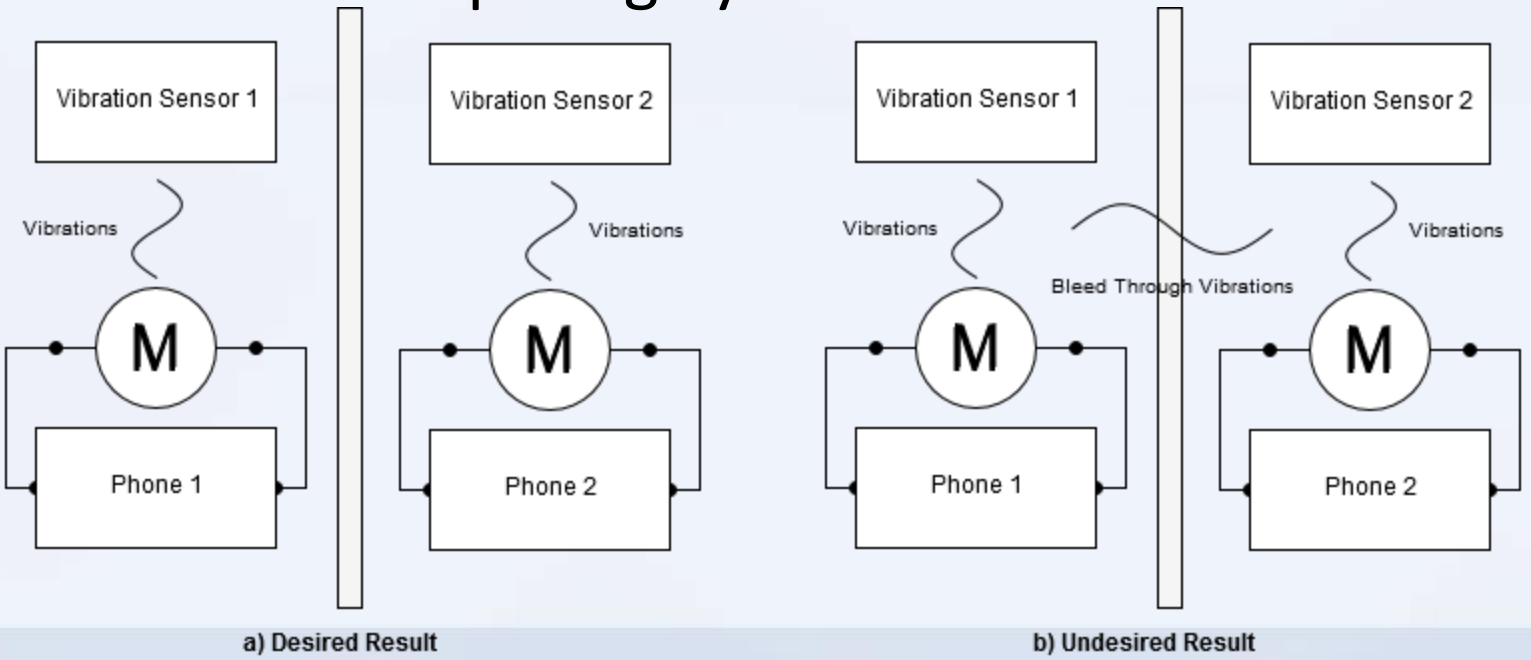
I2C Communication



Multi Master Single Slave Topology

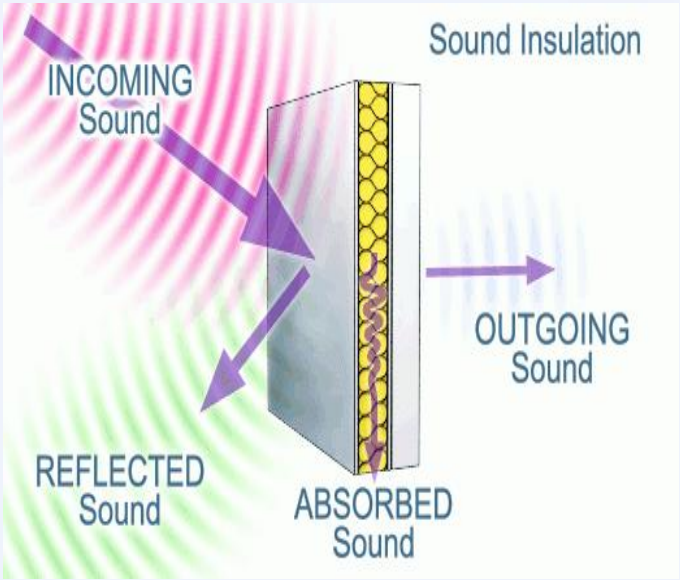
Damping Problem & Solution

- Noisy Neighbor Problem
  - Proposed Solution:
    - Damping Pads
    - Sound Comparing System



Sound Damping

- There are multiple mechanical methods for damping sound.
  - –Sound blocking material
  - – Structural damping
- Problems arise.
  - –Sound comparing circuit



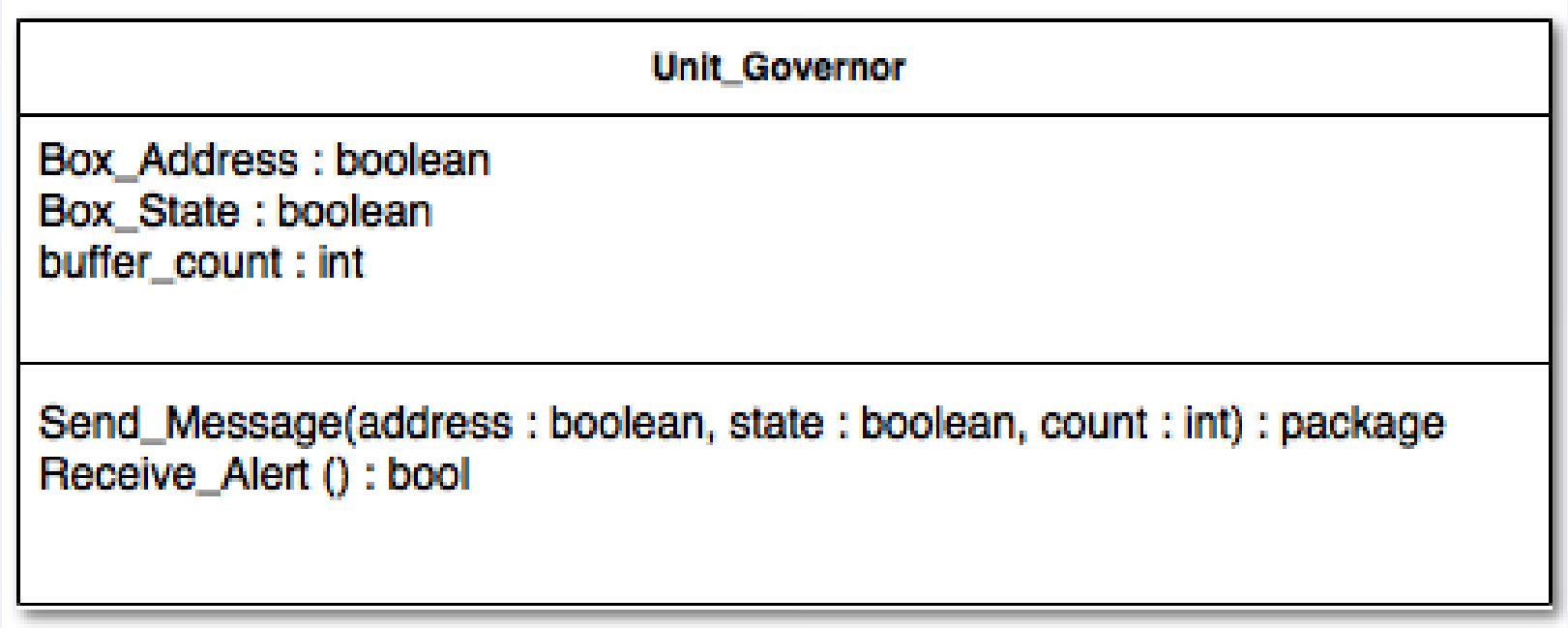
Damping Pads

Rubber	Advantage	Disadvantage
Urethane	Resilient Flexible in Form Anti-ESD Low-High Load Bearing	Very Expensive Temperature Sensitive
Neoprene	Temperature Resistant Corrosion Resistant	Very High Load Bearing
Sorbothane	Temperature Resistant High Damping Low-High Load Bearing Cheap	Load Bearing Not Low Enough

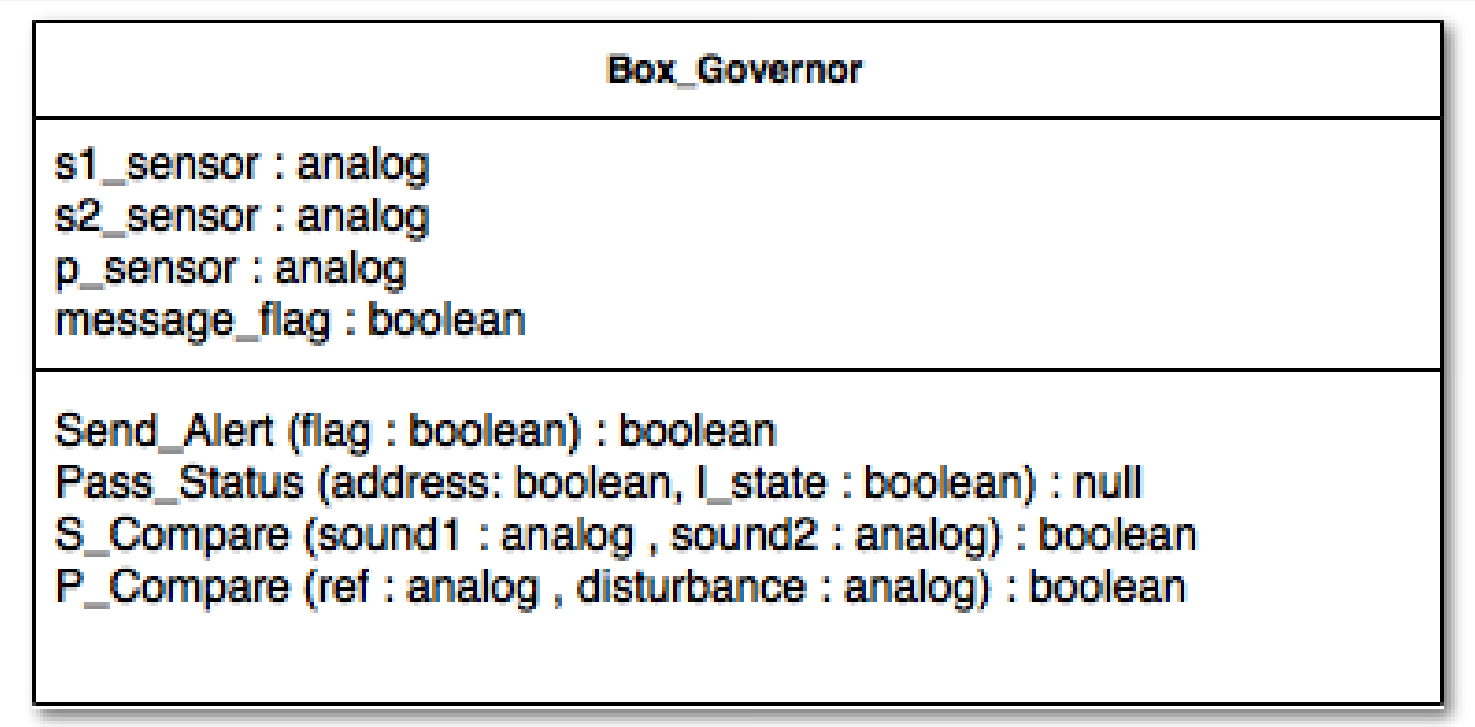
System Software Overview

- Five major components to class diagram.
  - Unit Governor
  - Box Governor
  - Lock Controller
  - Locker Indicators
  - Fingerprint Scanner
  - Terminal (varies)

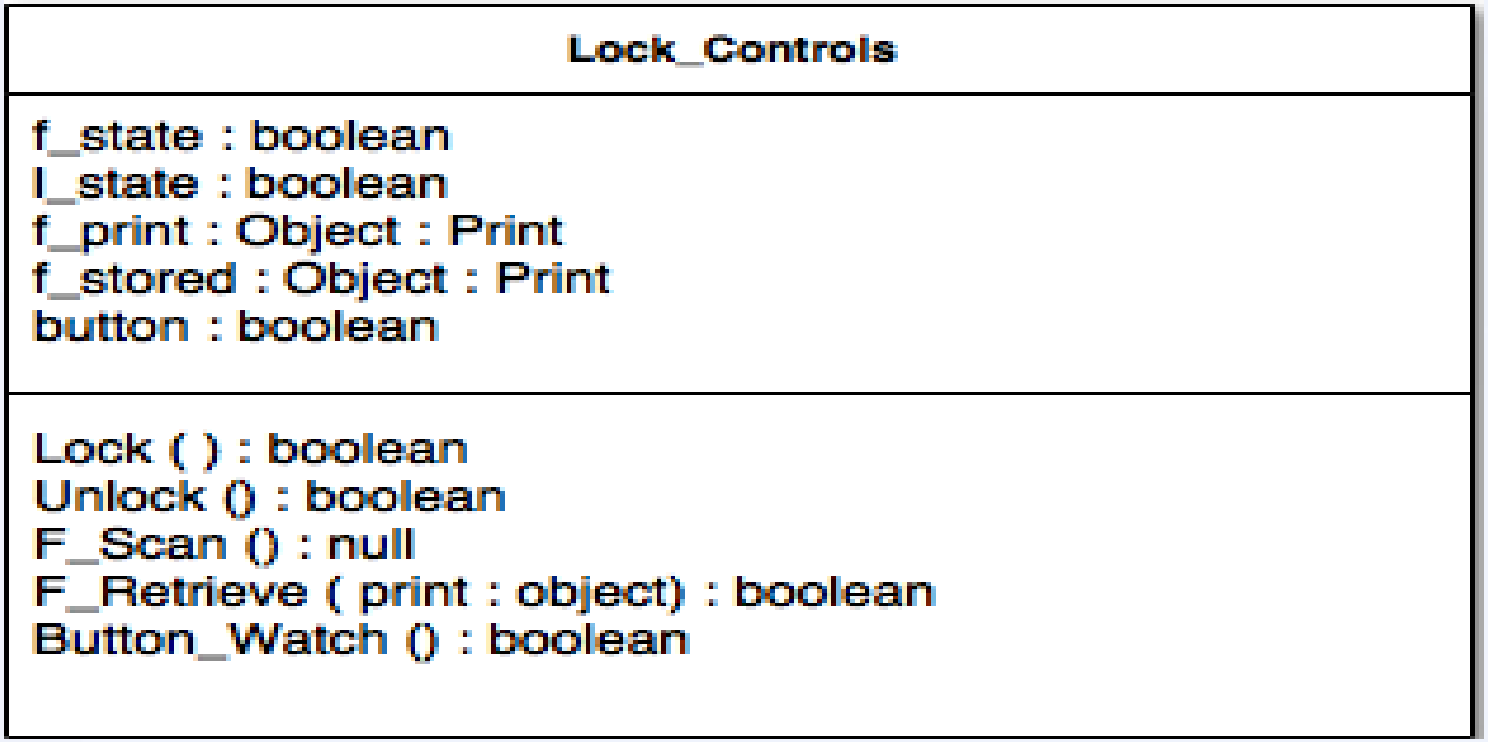
Unit Governor



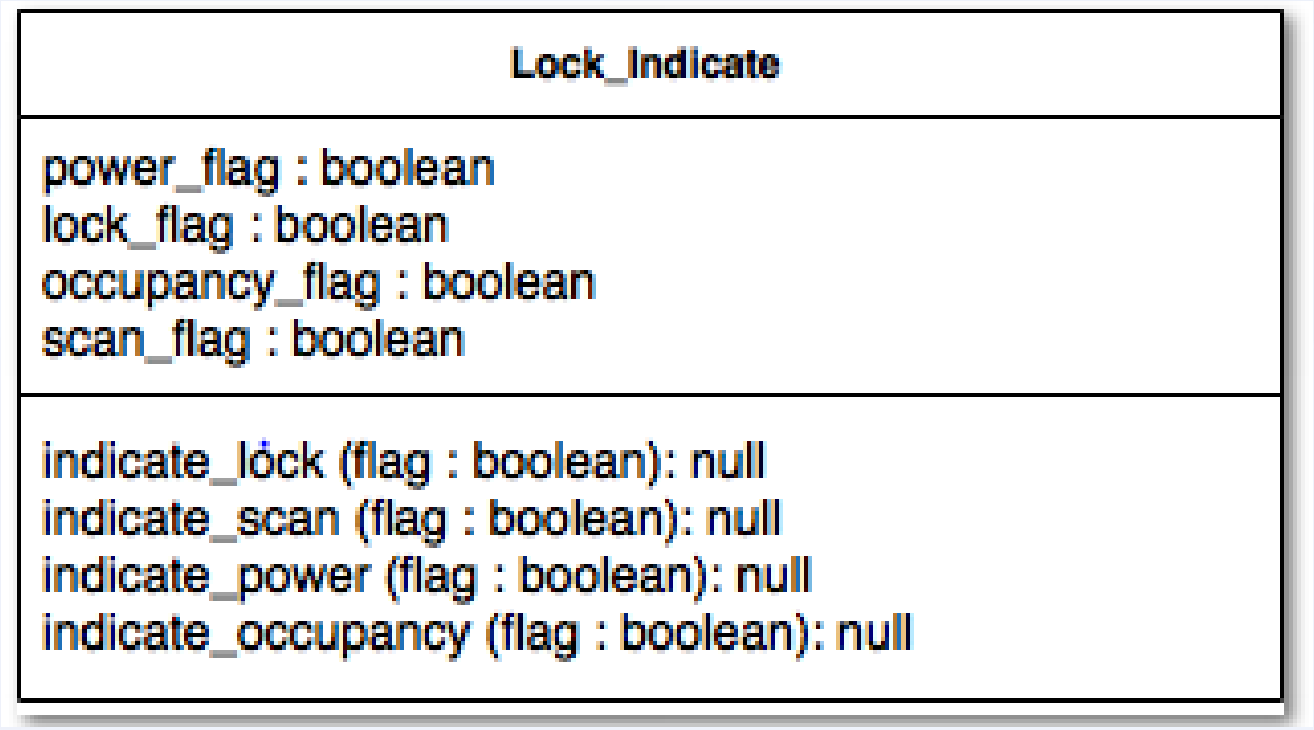
Box Governor



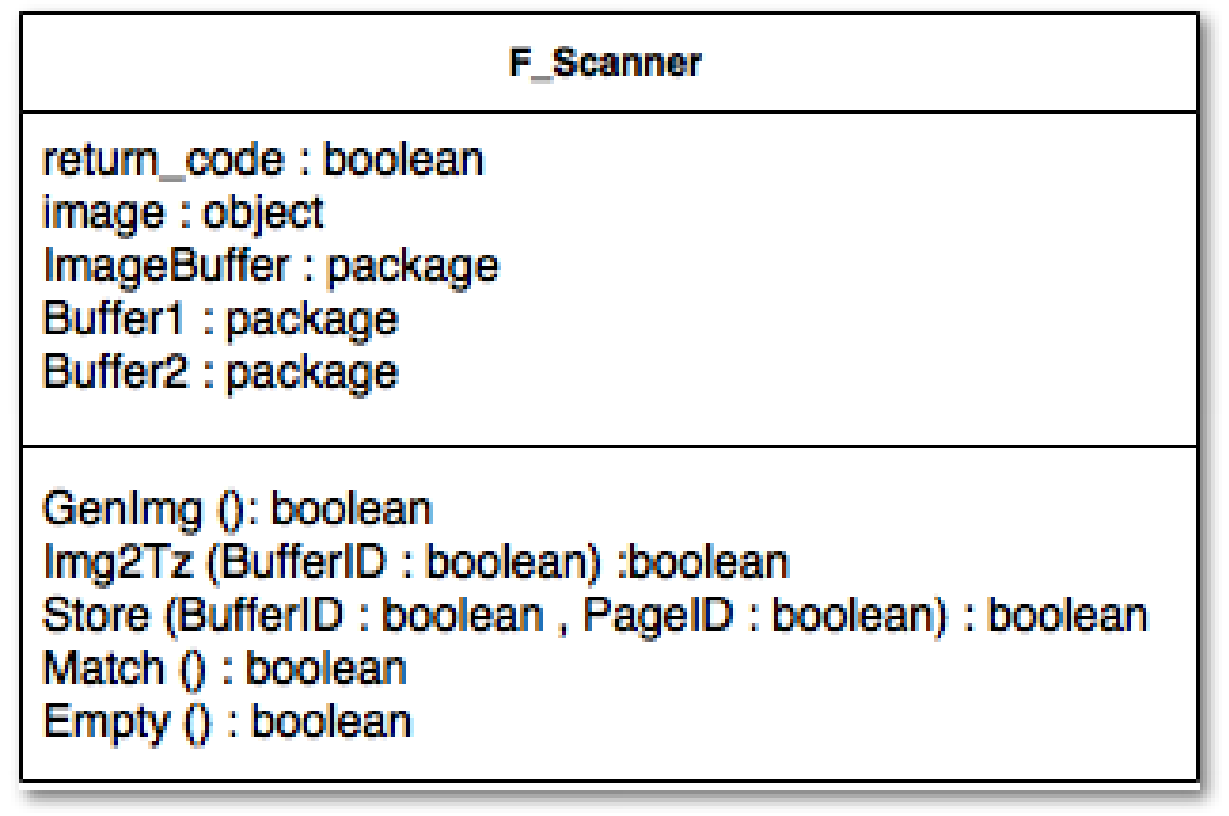
Lock Controller



Locker Indicator



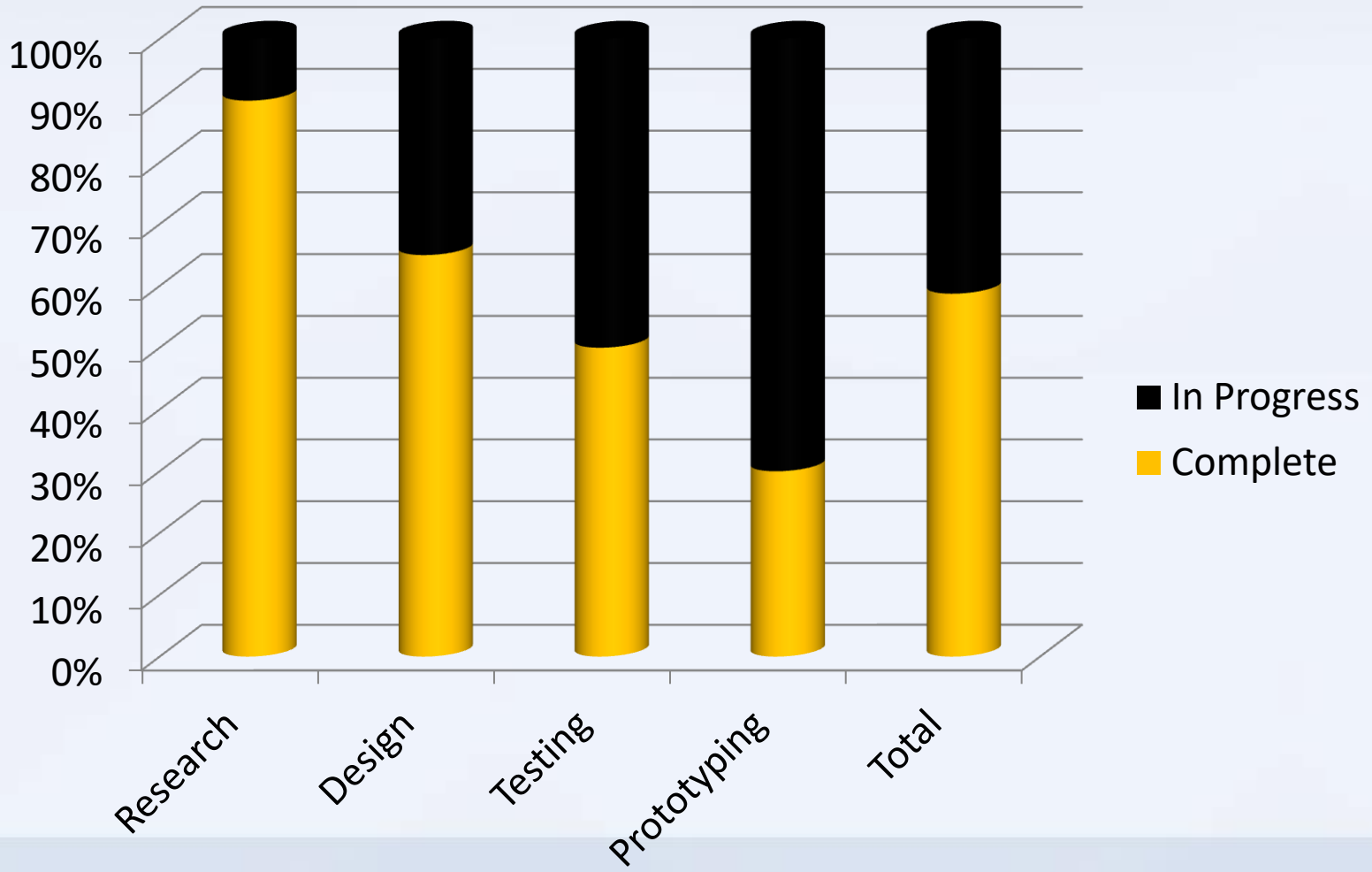
Fingerprint Scanner



Alternative Implementations

- Multiple Observer Methods
  - Lobby Desk Worker
  - Company Monitor System
  - Network Messaging

Progress


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Research
Design
Testing
Prototyping
Total
In Progress
Complete

Work Distribution Priority

Name	Power System	Security System	Sensors	Programming
Ian	Secondary	Primary		
Nick	Primary	Secondary		Secondary
Evelin			Primary	Secondary
Alex				Primary

Plan for Completion

Complete By	Task
09/28/2017	Verify Circuits Work Together
09/29/2017	Send out for first PCB
10/06/2017	Print Locker for Testing
10/13/2017	Test PCB/Make any necessary design modifications
10/14/2017	Order Final PCB's
10/21/2017	Finalize Locker Design and Print
10/30/2017	Mid Term Demonstration
11/17/2017	Submit Conference Paper
11/27/2017	Final Presentation to Committee
12/04/2017	Website and Finalized Updated Paper

Issues

- What issues are we having with the project?
  - Finding good documentation.
  - Lack of MCU experience.


ANY QUESTIONS?