S.M.A.R.T. Lock

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Presentation Points

- Introduction
- System Design and Overview
- Hardware Design
- Software Design
- Testing and Integration
- Project Management
- Summary

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Section 1: Introduction

Problem Statement

- The SMART Lock provides a more feature rich alternative to the intelligent locking systems currently on the market
- Due to the types of technologies used, the SMART Lock is more advanced than a standard electronic door lock
- Chosen as a senior design project both to challenge ourselves and to build something we would want in our own homes

Project Background

Early Prototype

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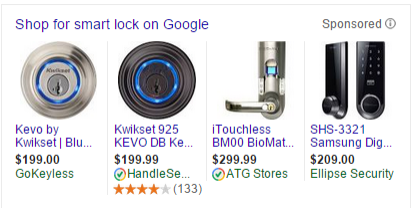
- Smart lock technology is a growing market



- Quick internet search will bring up dozens of different brands and technologies
- These range from simple electronic dead-bolts to smart phone controlled systems
- The SMART Lock is another addition to the Internet of Things

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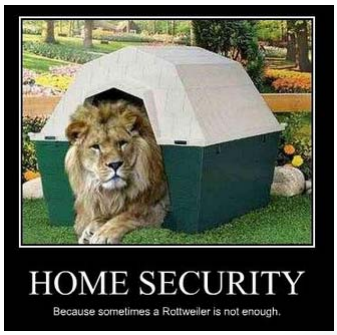
System Requirements

- Access
  - All entry attempts will be logged
  - Only unlocks to authorized user
  - Features a security light
- Ease of Use
  - Will take no longer than 3 seconds to unlock electronically
  - RFID allows for a more seamless entry
- Environment
  - Residential grade electronic bolt lock
  - No visible wires in the final product
  - RFID Key sense range of 1m



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Constraints

- Cost
  - The project cannot exceed the funds available to members of the team; budgeting must be taken into account
- Schedule
  - The project must be complete by December 12, 2014; this deadline is non-negotiable
- Technology
  - The project must stay within the bounds of what is technologically feasible at this point in time

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Other Considerations

- Security
  - There is a certain expectation of security in building an intelligent locking system
  - The SMART Lock must provide proof it is an adequately secure product
- Parameters
  - The physical size of the SMART Lock should not be extraordinarily large or small
  - It should fit a standard front door and be adjustable to left and right hand installation

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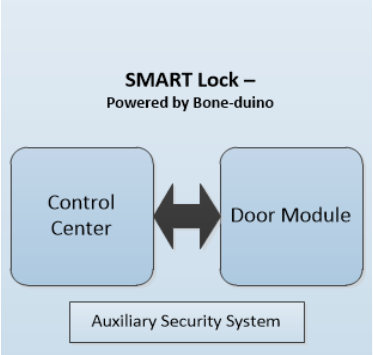
Section 2: System Design and Overview

System Architecture

- Two main components
  - Control Center
  - Door Module
- Third sub-system
  - Auxiliary Security System
- Large amount of integration



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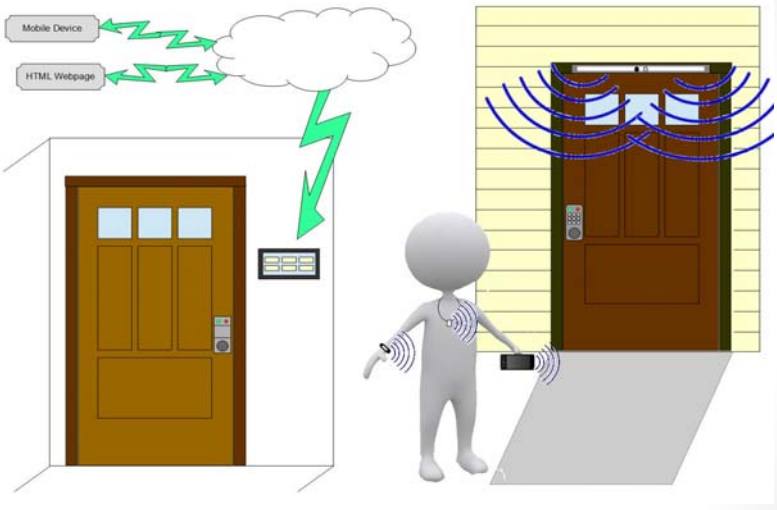

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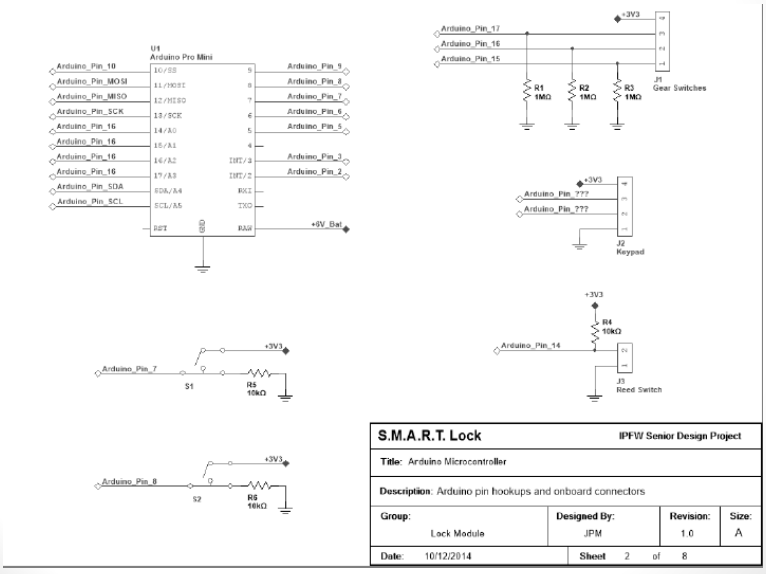
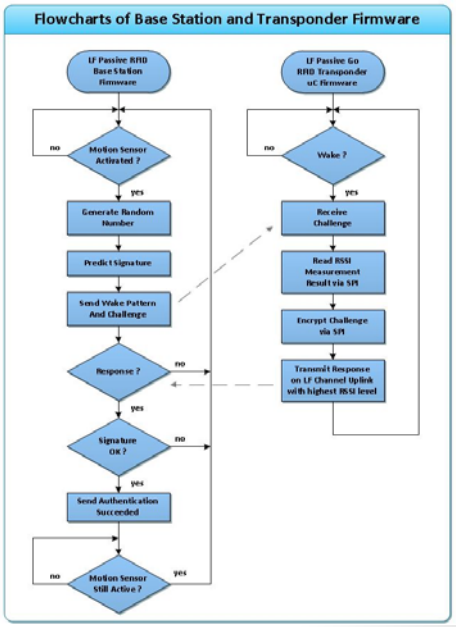
Section 3: Hardware Design

Circuit Design



RFID

- Downlink read distance (from base station to transponder) dependent on the one directional antenna
- Different from swiping a standard key card



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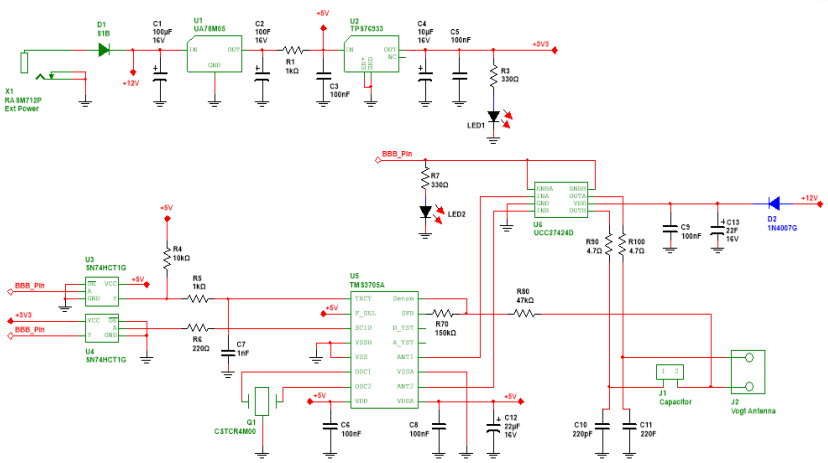
RFID Cont.

- Base Station



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Section 4: Software Design

Software Components

- Debian (OS)
- PHP5 (Sever side scripting)
- HTML (Client side scripting)
- MySQL (Database)
- Lighttpd (Webserver)
- FastCGI Mod (PHP/Lighttpd Connector)
- C++ (Arduino and BeagleBone Black code)

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- Remote administrative console uses PHP and HTML to create a local website for the end user

- Running on port 3000

- PHP for server-side scripting

- HTML, CSS, and Javascript for client-side

```
// If successfully unlocked, display results and
if ($conn->query($sql) === TRUE){
    echo "Door is now UNLOCKED!";
    }
else {
    echo "Error: " . $sql . "<br>" . $conn->error;
    }

// Close Connection to db
$conn->close();


?>

<!-- 'Return' button -->
<form action="admin.php" method="post">
<input type="submit" value="Return" name="udb1"><br>
</form>

</body>
</html>
```

Unlock_door.php

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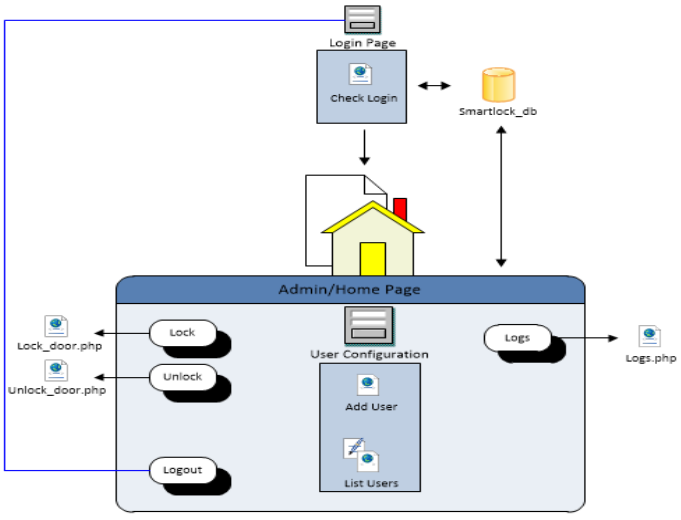
Admin Web Console - Architecture



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Section 5: System Testing and Integration

Testing

- New Requirements

1	Operational	System shall unlock to authorized user without cylindrical tumbler door key	Demonstration	Cylindrical tumbler door key = standard door key with 'teeth'
2	Operational	System shall log authorized entry attempts to residence	Demonstration	
3	Functional	System should use RFID technology in place of tumbler key	Test	
4	Functional	System shall use a microprocessor to log access	Test	Microprocessor will be the BeagleBone Black
5	Performance	System shall unlock door each time authorized user attempts entry	Demonstration	
6	Performance	System should lock user out after 10 failed attempts for 5 minutes	Demonstration	Should' because this will be tricky to implement; applies the the administration console login
7	Functional	System shall feature a security light	Inspection	LED Neopixel lightstrip that is programmable
8	Physical	System should not contain visible wires	Inspection	It is likely the final prototype will have visible wires, though a final 'product' would not
9	Environmental	System shall be designed for use residential applications	Analysis	
10	Environmental	System shall include a commercialized electronic door lock that is designed to work on the outside of a residence	Inspection	Unsure of the Locks NEMA rating
11	Environmental	System should function between approximately -20 deg. F and 120 deg. F	Analysis	
12	Operational	System shall prevent unauthorized access	Demonstration	
13	Operational	System shall log unauthorized entry attempts to residence	Demonstration	
14	Functional	System should make authorized access faster than with a standard cylindrical door key	Demonstration	
15	Performance	System should unlock to authorized user in 2.3 seconds	Demonstration	Takes around 2.3 seconds for the lock to change state
16	Functional	System should have a form of LED lock status indicator	Demonstration	Shows whether the lock has changed in status; e.g. locked to unlocked
17	Operational	System should have a smart phone application that interfaces with the lock	Demonstration	This has become a 'should' because it is low priority and may not be completed
18	Functional	System shall allow the use of cylindrical door keys to unlock the door in the event of a power failure	Demonstration	
19	Performance	System shall have an RF key sense range of 1m	Analysis	
20	Functional	System shall include a touch screen as a part of the interior control center	Inspection	Used for system administration in tandem with the web app
21	Physical	System shall include a keypad attached to exterior door	Inspection	
22	Environmental	System shall implement Debian OS created for the BeagleBone Black	Demonstration	For use with the control center; Debian was chosen because it works better with the BBB
23	Environmental	System shall implement MySQLi for the databse	Demonstration	MySQLi instead of SQLite because of the integration with PHP5 and Debian

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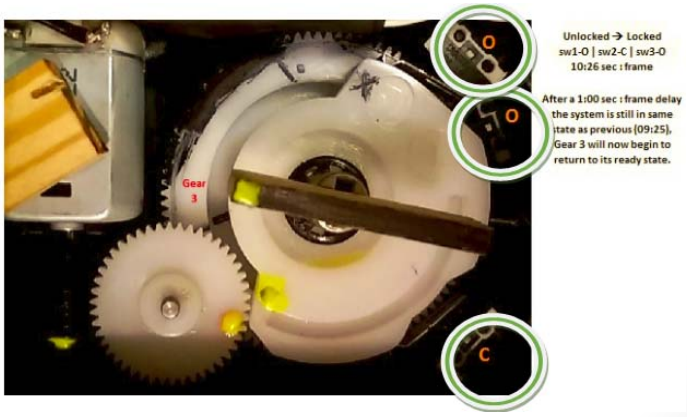
Testing Cont.

- Breaking down the Electronic Deadbolt



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System Integration

- Numerous components involved
- Using SPI to communicate to the NRF transceivers
- Touchscreen with extra cape mounting pins
- Powered USB Hub to connect multiple devices
  - Neopixels
  - Wi-Fi Adapter
  - Room for expansion

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Troubles

- Time
- Door Handle ----->
- RFID
  - Acquisition
  - Researching
  - Availability

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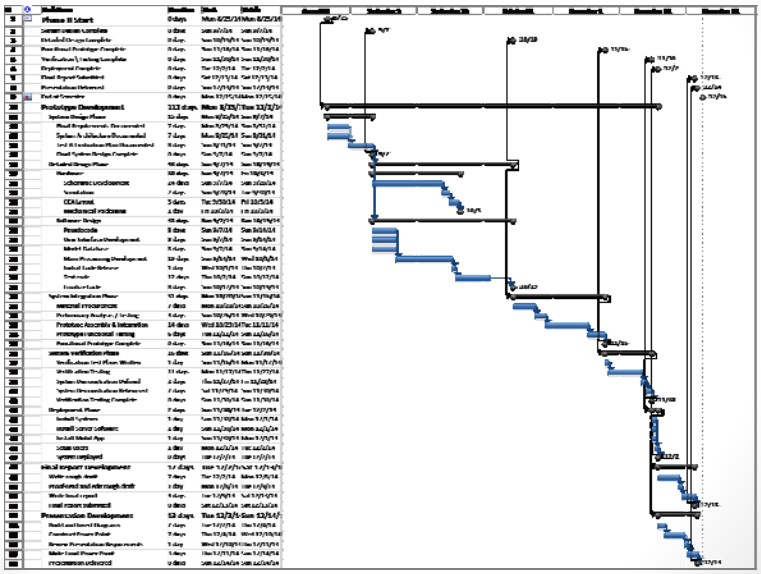
Section 6: Project Management

Project Scope



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Project Cost

- Original Project Material and Tools Cost

Material/Tool Cost				
Item	**Qty**	**Cost Each**	**Total Cost**	**Comments**
RFID Reader	1	$ 100.00	$ 100.00	Includes all components necessary to build the RFID reader
RFID Digital Keys	10	$ 4.00	$ 40.00	
Microprocessor	1	$ 45.00	$ 45.00	Beagle Bone Black
Powered Bolt Lock	2	$ 89.00	$ 178.00	
LED Light Strip	2	$ 30.00	$ 60.00	
4in. Touch Screen	1	$ 89.00	$ 89.00	
Batteries	1	$ 20.00	$ 20.00	Used within lock mechanism & as backup for power failure
Touch Sensor	2	$ 5.00	$ 10.00	
Proximity Sensor	1	$ 5.00	$ 5.00	
Hardwired Power Supply	1	$ 10.00	$ 10.00	
Wifi Dongle	2	$ 10.00	$ 20.00	For Internet connectivity
Flash Drive	1	$ 16.00	$ 16.00	Used for data logging
Miscellaneous Parts (Solder, Wire, etc.)	1	$ 25.00	$ 25.00	
Microcontroller Chip (CPU)	2	$ 50.00	$ 100.00	Chip for our door lock mechanism
		Material Total	**$ 718.00**	

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Project Cost Cont.

- Current Project Material and Tools Cost

Material/Tool Cost				
Item	**Qty**	**Cost Each**	**Total Cost**	**Comments**
RFID Reader	1	$ -	$ -	Includes all components necessary to build the RFID reader
BeagleBone Black	2	$ 55.00	$ 110.00	Beagle Bone Black
Powered Bolt Lock	2	$ 89.00	$ 178.00	
LED Light Strip	2	$ 24.95	$ 49.90	
7in. Touch Screen	2	$ 89.00	$ 178.00	
Touch Sensor	2	$ 7.95	$ 15.90	
Proximity Sensor	2	$ 1.50	$ 3.00	
Hardwired Power Supply	1	$ 20.00	$ 20.00	
Wifi Dongle	2	$ 13.95	$ 27.90	For Internet connectivity
8GB SD Card	2	$ 16.00	$ 32.00	Used for data logging
Miscellaneous Parts (Solder, Wire, etc.)	1	$ 100.00	$ 100.00	
Arduino Pro Mini + FTDI Programmer	2	$ 24.90	$ 49.80	Chip for our door lock mechanism
USB Extension	2	$ 15.95	$ 31.90	
NRF Transceiver	2	$ 7.95	$ 15.90	
PTB RFID Trimmer	1	$ 600.00	$ 600.00	
Board Parts for Door Module	1	$ 300.00	$ 300.00	
	Material Total		**$1,712.30**	

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Labor Cost				
Task / Activity	**Cole**	**Jason**	**Mike**	**Project**
Prototype				
Schematic Development	5	7	10	22
Simulation	4	5	8	17
Mechanical Packaging	2	12	12	26
User Interface Development	25	10	5	40
Model Database	10	10	0	20
Main Processing Development	15	15	3	33
Intitial Code Release	7	7	3	17
Test Code	20	10	3	33
Finalize Code	18	18	3	39
Material Procurement	6	8	8	22
Preliminary Analysis/Testing	15	15	15	45
Prototype Assembly/Testing	12	35	35	82
Prototype Functional Testing	10	10	15	35
Verification Testing	7	7	7	21
System Demonstration Defined	3	3	3	9
System Demonstration Rehearsed	5	5	5	15
Install Systems	9	9	11	29
Install Server Software	8	3	0	11
Project Demo Unit	1	13	15	29
Set Up Users	3	3	1	7
Written Report				0
Write Rough Draft	6	6	6	18
Proof-read and Edit Rough Draft	2	2	2	6
Write Final Report	5	5	5	15
Presentation				0
Construct PowerPoint	5	5	5	15
Review Presentation Requirments	2	2	2	6
Construct Final PowerPoint	3	3	3	9
Labor Totals	**208**	**228**	**185**	**621**

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Summary

- The SMART Lock Project was mostly a success
  - Requirements were changed to accommodate scheduling problems
  - Level of difficulty was higher than estimated
  - Functional prototype that paves the way for a highly advanced product

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Questions?

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-Demonstration-

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