Department of Computer Science and Engineering
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Team: Always Home

Project: Smart Door

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Document Revision History

Revision Number	Revision Date	Description	Rationale
0.1	10/07/2013	Rough Draft	Status Check
0.2	10/26/2013	Preliminary Revision	Peer Review
2.0	11/12/2013	Baseline	Document Release after Gate Review
2.1	01/20/2014	Revision	Adjust Scope Due to Personnel Changes

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1. Product Concept

This section describes the purpose, use and intended user audience for the Smart Door product. The Smart Door is a home doorbell that notifies the homeowner on his smart phone when there is a visitor at the door. Users of the Smart Door will be able to interact with visitors remotely including video monitoring, two way audio and door unlocking functionality.

1.1   Purpose and Use

The Smart Door will allow a homeowner to answer the door remotely. The doorbell will connect the homeowner and guest(s) via a call to the homeowner's smart phone. The homeowner will receive the call, and a snapshot of the guest through a mobile application. The homeowner will see this information, and will be able to decide if he wants to answer or ignore the call. The call will send the homeowner a video feed where he can interact with the guest(s). The mobile application will also allow the homeowner to lock or unlock the door while on and off a call. The mobile application will also receive notifications when the door is opened or closed. The Smart Door web application will store video interactions with guests, and will allow the homeowner to view and download the videos.

1.2   Intended Audience

The target audience for the Smart Door will be homeowners, and renters that would like to know in real time when a visitor is at their door. Business owners and secretaries can also use the Smart Door to interact with visitors in a safe and convenient manner. Absentee owners can use the Smart Door to monitor and interact with people at their remote property.
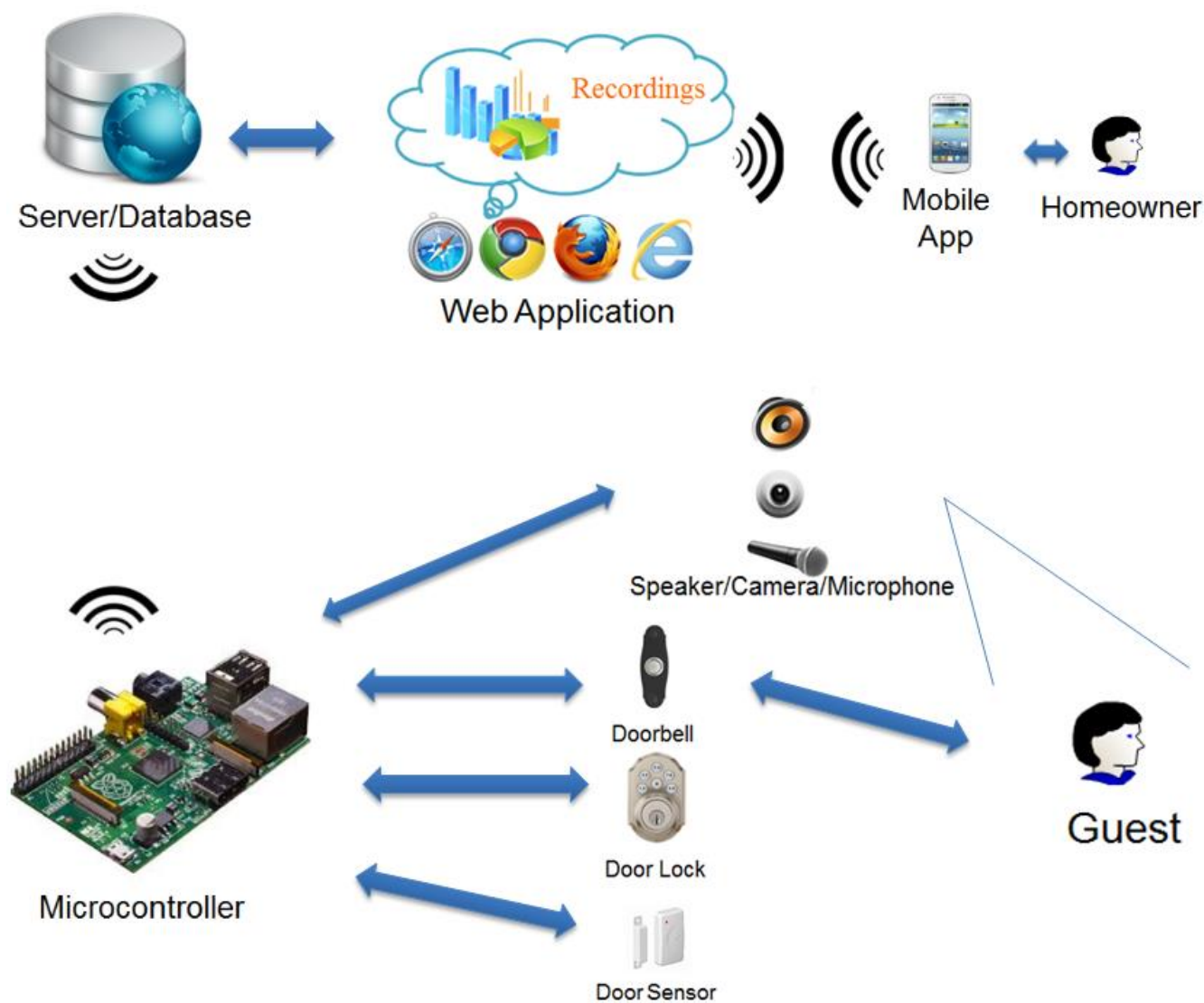
Figure 1: Product Concept

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2. Product Description and Functional Overview

The Smart Door system's primary functionality is to provide an interface to the front door of the user's phone from wherever the user is currently located. Smart Door will include interaction functionality as specified in the remainder of this section.

2.1   Features and Functions

The Smart Door consists of three principle parts/components: the micro controller, the server, and the smart phone. The micro controller will use the doorbell to initiate calls to the homeowner. The micro controller will use the microphone, and camera to send the homeowner an audio and video feed of the guest(s) at their door. The micro controller will use the speaker to transmit the homeowner's audio back to the guest. The micro controller will use an electronic lock to allow the homeowner to lock and unlock the door remotely. The micro controller will use a door sensor to send the homeowner a notification if the door opens or closes. The server will hold a database with user information and video recordings. The server will provide the homeowner a web interface to view, delete, and download videos. The smart phone will use an application to control system functionality.

2.2   External Inputs and Outputs

Name	Type	Description	Use
Door bell	Input	A wireless button to the right of the door.	Visitor presses the doorbell button. The system calls the homeowner.
Mobile application call prompt	Output	A smart phone graphical user interface with two buttons and an image.	The homeowner receives a call through the mobile application with a snap shot of the door. The system allows the homeowner to answer or decline the call.

Mobile application answer call button	Input	A smart phone graphical user interface green button with "Answer" in the middle.	The homeowner pressed the answer call button. The mobile application will start streaming video and audio from the micro controller.
Mobile application call answered	Output	A smart phone graphical user interface with a video stream and three buttons.	The homeowner will see the video stream of the door camera. The homeowner will be able to interact with the guest.
Mobile application ignore call button	Input	A smart phone graphical user interface red button with "Decline" in the middle.	The homeowner pressed the decline call button. The mobile application will stop ringing.
Door sensor	Input	A small magnetic sensor that transmits radio frequencies to the micro controller.	The door opens breaking the magnetic field of the door sensor. The mobile application will display a "door opened" message.
Mobile application open door notification	Output	A smart phone graphical user interface that show the message "Door opened" and a timestamps of the incident.	The homeowner will receive a message that the door was opened. The homeowner could notify the police or neighbors if the homeowner was not expecting the door to be opened. The homeowner could also watch the live feed and see if the intruder is visible.

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Mobile application lock door button	Input	A smart phone graphical user interface button with a closed lock image in the middle	The homeowner presses the lock button and the application will tell the micro controller to push the deadbolt of the electronic lock out securing the door
Mobile application unlock door button	Input	A smart phone graphical user interface button with an open lock image in the middle.	The homeowner presses the unlock button and the application will tell the micro controller to pull the deadbolt of the electronic lock in; unlocking the door.
Electronic lock	Output	An electronic lock that is connected to the micro controller.	The deadbolt is pulled in to the unlocked position. The door is unlocked.
Web application login	Input	A web page with two input fields for the user name and password, and a button to submit the form.	The web page will allow a user to enter a user name and password. The user will gain access to the profile's home screen.
Web application home screen	Output	A web page with two sections door history, and interaction history.	A page with a log of all the interaction with the Smart Door system. The user will be able to see a history of the door's activity.
Web application view video link	Input	A web page with a list of videos ordered by date with a button to download and a button	A link that will direct the user to a page with the video described. The user will be able to watch the video of the interaction.

		to delete.	
Web application video played	Output	A web page with a media player in the middle.	The browsers media player will display the video and allow the user to control volume, screen size, stop the video, play the video and skip to a specific time in the video. The user will be able to see a previous interaction with the Smart Door system.
Web application delete video link	Input	An image link of a trash can.	The link will confirm that the user is sure about deleting the video and delete if confirmed. The user will be able to delete videos that are not important.
Web application video removed from database	Output	A SQL function inside the server.	The video will be permanently deleted from the server. The server will have more memory available.
Web application download video link	Input	An image link inside a web page of an arrow pointing down.	The user presses the download video link. The user will be able to store the video on the computer's hard drive.
Web application video download	Output	A file inside of the user's hard drive.	The user will choose a path in the computer's directory to save the video. The user will have the video for as long as the user wishes.

Table 1: External Input and Outputs

2.3   Product Interfaces

The following screenshots are simply examples to show the functionality that will be available from the various screens in the final version of the Android application.

2.3.1 Mobile Application Interface

Figure 2: Mobile Application Home Screen

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Figure 3: Mobile Application Incoming Call Screen

Figure 4: Mobile Application During Call Screen

2.3.2 Web Application Interface

The following screenshots are simply examples to show the functionality that will be available from the various screens in the final version of the Web based application.
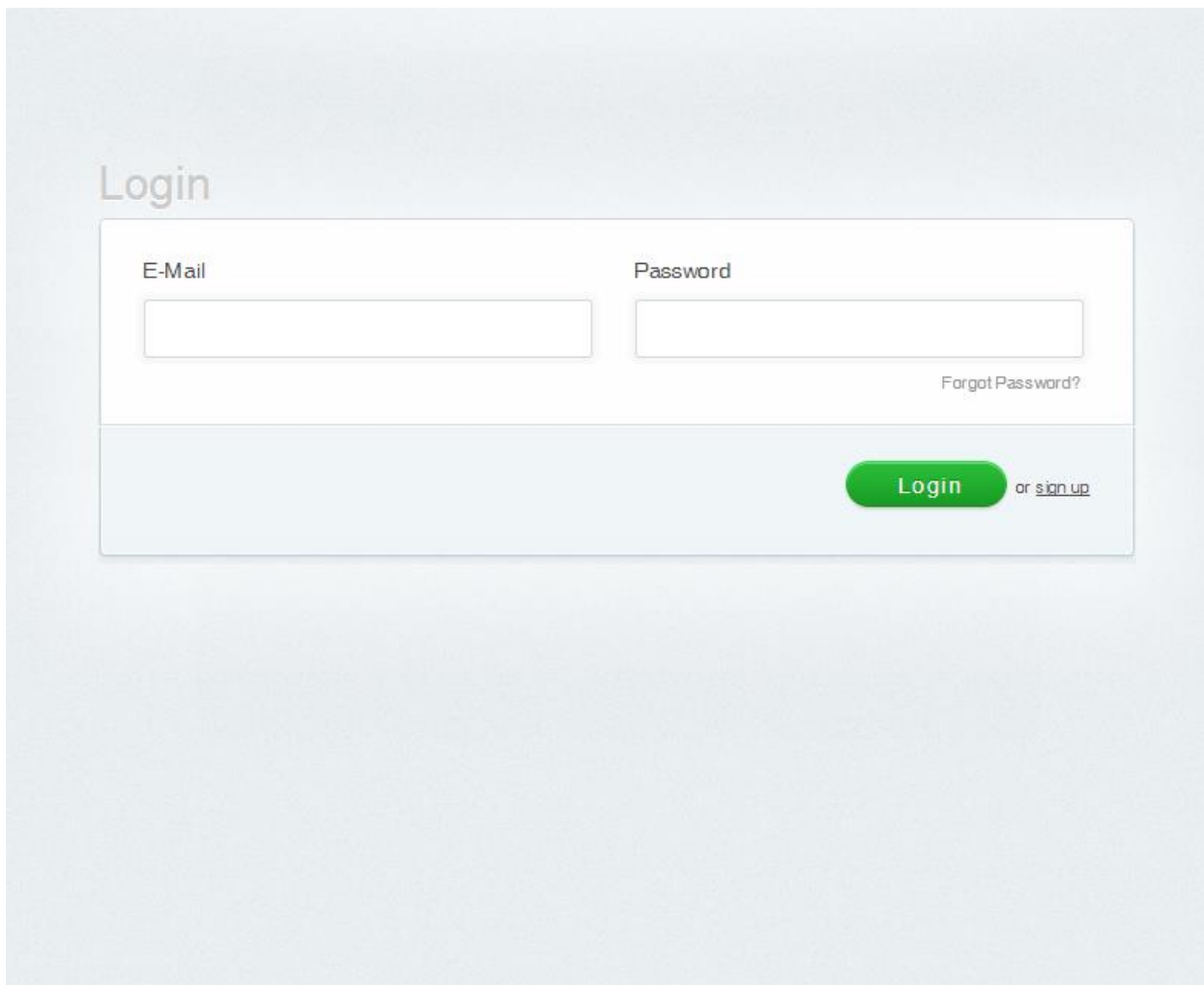
Figure 5: Web Application Login Screen
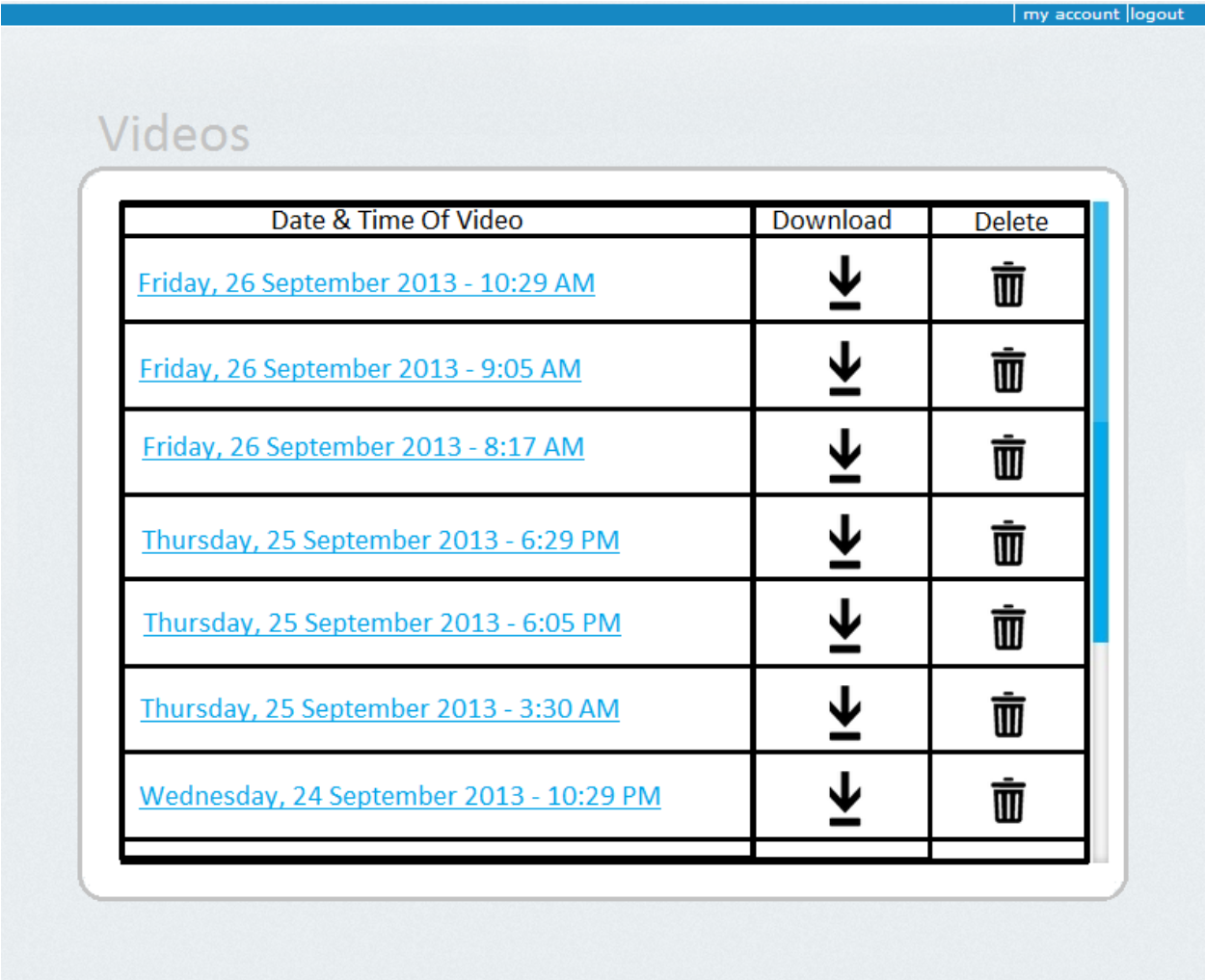
Figure 6: Web Application Home Screen

3. Customer Requirements

The customer requirements for the Smart Door were elicited form multiple classes of stakeholders. Team Always Home interviewed homeowners, home security industry business owners, and second homeowners in order to make sure Smart Door includes all functionality that was important to them. This functionality is formally specified here and also forms the basis for the acceptance criteria in Section nine of this document.

3.1   Smartphone Application Control

3.1.1 Description: The system shall be controlled by a smartphone application installed on the users' smartphone, providing a means for the users to interact with the system.

3.1.2   Source: Sean Jones (Sponsor).

3.1.3   Constraints: Android version 4.2.

3.1.4   Standards: None.

3.1.5   Priority: 1 - Critical.

3.2   Snapshot Of Guests at Door

3.2.1 Description: Photo images shall be taken and stored by the system when doorbell is rung.

3.2.2   Source: Sean Jones (Sponsor).

3.2.3   Constraints: There will be a 1 minute delay between snapshots.

3.2.4   Standards: Photo images will be in PNG format. Minimal resolution is as described in section 5.16.

3.2.5   Priority: 1 - Critical.

3.3   Keep Activities Log

3.3.1 Description: The systems activity log shall differentiate between users when logging all interactions and activities of the system.

3.3.2   Source: Sean Jones (Sponsor).

3.3.3   Constraints: Storage constraint as specified in Requirement 5.8

3.3.4   Standards: None.

3.3.5   Priority: 1 - Critical.

3.4   Emergency Power Supply

3.4.1   Description: The system shall have an emergency power supply.

3.4.2   Source: Sean Jones (Sponsor).

3.4.3   Constraints: None.

3.4.4   Standards: None

3.4.5   Priority: 4 - Low

3.5   Video Monitoring

3.5.1   Description: The system shall allow registered users to monitor activities via live video feed on smart phones.

3.5.2   Source: Sean Jones (Sponsor).

3.5.3   Constraints: Video performance is specified in requirement 5.4.

3.5.4   Standards: None.

3.5.5   Priority: 2 - High.

3.6   System Portability

3.6.1   Description: The system shall be a portable device that the customer can take with them when they move.

3.6.2   Source: Sean Jones (Sponsor).

3.6.3   Constraints: None.

3.6.4   Standards: None.

3.6.5   Priority: 2 - High.

3.7   Smart Phone Pairing

3.7.1   Description: The system shall pair user activity with a particular smartphone to keep logs of who interacts with the system.

3.7.2   Source: Sean Jones (Sponsor).

3.7.3   Constraints: Storage constraint as specified in Requirement 5.8

3.7.4   Standards: None.

3.7.5   Priority: 2 - High.

3.8   Motion Sensor

3.8.1   Description: The system shall have a short-range motion sensor. The motion sensor will take a picture and upload it to the server every time the sensor is triggered.

3.8.2   Source: Sean Jones (Sponsor).

3.8.3   Constraints: 2 feet range sensor.

3.8.4   Standards: None.

3.8.5   Priority: 5 – Future.

3.9   Local Storage

3.9.1   Description: The device shall have an on-board storage device.

3.9.2   Source: Sean Jones (Sponsor).

3.9.3   Constraints: Storage constraint as specified in Requirement 5.8

3.9.4   Standards: None.

3.9.5   Priority: 2 – high.

3.10   Hardware Security

3.10.1 Description: The device shall be enclosed in a secured case.

3.10.2 Source: Sean Jones (Sponsor).

3.10.3 Constraints: None.

3.10.4 Standards: None.

3.10.5 Priority: 2 – High.

3.11   Z-Wave

3.11.1 Description: The system shall be compatible with Z-Wave wireless communications protocol.

3.11.2 Source: Sean Jones (Sponsor).

3.11.3 Constraints: None.

3.11.4 Standards: None.

3.11.5 Priority: 5 – Future.

3.12   Lock/Unlock

3.12.1 Description: The system shall be able to lock and unlock the door remotely.

3.12.2 Source: Sean Jones (Sponsor).

3.12.3 Constraints: None.

3.12.4 Standards: None.

3.12.5 Priority: 5 – Future.

3.13   Open Source

3.13.1 Description: The source code of the system shall be released under an open source license.

3.13.2 Source: Mr. O'Dell.

3.13.3 Constraints: None.

3.13.4 Standards: None.

3.13.5 Priority: 1 – Critical.

3.14   Nonintrusive

3.14.1 Description: The system shall not interfere with normal functionalities and operations of the existing door and doorbell.

3.14.2 Source: Sean Jones (Sponsor).

3.14.3 Constraints: None.

3.14.4 Standards: None.

3.14.5 Priority: 1 - Critical

3.15   Account Setup

3.15.1 Description: The system shall provide account setup capability. The account setup will be responsible for pairing a phone to a particular Smart Door device.

3.15.2 **Source:** Sean Jones (Sponsor).

3.15.3 Constraints: The Smart Door system and smartphone being paired must be connected to the same WIFI network during initial setup.

3.15.4 Standards: None.

3.15.5 Priority: 2 – High

3.16   Video Log Downloads

3.16.1 Description: The system shall allow registered users to download videos from the video log on the website interface.

3.16.2 Source: Sean Jones (Sponsor).

3.16.3 Constraints: The user must have Internet access.

3.16.4 Standards: None.

3.16.5 Priority: 4 – Low

4. Packaging Requirements

This section describes the packaging requirements for the Smart Door. The main concerns for our product when determining packaging were size, portability, and security. These factors drove our requirements and helped to isolate high priority items from the less essential elements. Other high priority factors to consider were power and port access, since without these two items the Smart Door would be inoperative.

4.1   Size

4.1.1 Description: The system shall be enclosed in a box that is no larger than 12x12x4 (576 cubic in). This size will optimize volume while ensuring adequate space is still available for components, connections, and heat dissipation.

4.1.2   Source: Team Always Home

4.1.3   Constraints: None

4.1.4   Standards: None

4.1.5   Priority: 1 – Critical.

4.2   Temperature Control

4.2.1 Description: The enclosure shall provide ventilation for heat removal.

4.2.2   Source: Team Always Home

4.2.3   Constraints: The system will operate within the temperature range described in requirement 5.8.

4.2.4   Standards: None.

4.2.5   Priority: 3 – Moderate.

4.3   Mounting

4.3.1 Description: The product shall provide mounting brackets and screws for secure attachment of the system. The portion of the system containing the camera shall be mounted within 2 feet of the door.

4.3.2   Source: Team Always Home

4.3.3   Constraints: Screws are not provided due to varying material and wall thickness.

4.3.4   Standards: None.

4.3.5   Priority: 1 – Critical.

4.4   Casing

4.4.1   Description: The system shall be enclosed in a case that shall keep its internal components secure.

4.4.2   Source: Team Always Home.

4.4.3   Constraints: None.

4.4.4   Standards: None.

4.4.5   Priority: 2 – High.

4.5   Software Acquisition

4.5.1   Description: The system software shall be available on the Internet. Software for the PC/hardware interface shall be packaged with the product on a CD.

4.5.2   Source: Team Always Home.

4.5.3   Constraints: User will need an android version 4.2 smartphone with Wi-Fi and/or mobile Internet access. The user must have a PC and a CD Drive to configure the device.

4.5.4   Standards: None.

4.5.5   Priority: 1 – Critical.

4.6   Included Components

4.6.1   Description: The product will be delivered to the end-user with the Always Home device, user manual, and mounting hardware.

4.6.2   Source: Team Always Home.

4.6.3 Constraints: None.

4.6.4 Standards: None.

4.6.5 Priority: 2 – High.

4.7   Team Logo

4.7.1 Description: The logo will be visibly displayed on the base of the final product.

4.7.2 Source: Team Always Home.

4.7.3 Constraints: None.

4.7.4 Standards: None.

4.7.5 Priority: 4 – Low.

4.8   System Configuration

4.8.1 Description: The system's camera, doorbell, and microphone shall be collocated in a common enclosure.

4.8.2 Source: The Always Home Team.

4.8.3 Constraints: None.

4.8.4 Standards: None.

4.8.5 Priority: 1 - Critical.

5. Performance Requirements

The performance requirements for the Smart Door system specify how fast and reliably the product is expected to perform. The performance requirements for the Smart Door system include characteristics such as the time it takes to start/stop activities, how long the emergency power supply must last, and maximum time it must take to set up the system.

5.1   System Setup

5.1.1 Description: The system shall be able to be mounted and configured in less than ten minutes by the end user. The user will mount the hardware near the door, and the configuration shall be defined as pairing the user's mobile device with the hardware.

5.1.2   Source: The Always Home Team.

5.1.3   Constraints: The user may require tools to bore holes for the mounting hardware. The user must have a PC and an Android OS for system configuration.

5.1.4   Standards: None.

5.1.5   Priority: 3 - Moderate.

5.2   Notification Time

5.2.1 Description: While the system is operational and connected to the internet, the system shall notify the user of guest activity in less than 30 seconds.

5.2.2   Source: The Always Home Team.

5.2.3   Constraints: Notification time is dependent upon network bandwidth and connectivity.

5.2.4   Standards: None.

5.2.5   Priority: 2 - High.

5.3   Latency

5.3.1 Description: The user shall have an overall user request latency of less than 10 seconds. Overall latency includes the transmission of the user request and system response time.

5.3.2   Source: The Always Home Team.

5.3.3   Constraints: Overall latency is dependent upon network bandwidth and connectivity.

5.3.4   Standards: None.

5.3.5   Priority: 2 - High.

5.4   Response Time

5.4.1 Description: While the system is operating within the Active state, the system shall respond to user requests in less than 7 seconds.

5.4.2   Source: The Always Home Team.

5.4.3   Constraints: Response time will rely on network bandwidth and connectivity.

5.4.4   Standards: None.

5.4.5   Priority: 2 - High.

5.5   Data Transmission - Live Video Feed

5.5.1 Description: The system shall transmit video at 30 frames per second at a minimum resolution specified in requirement 5.16.

5.5.2   Source: The Always Home Team.

5.5.3   Constraints: The network bandwidth must be at least 41Mbps for video transmission.

5.5.4   Standards: NTSC standard for broadcast TV using True Color image representation.

5.5.5   Priority: 2 - High.

5.6   Data Transmission - Audio Transmission

5.6.1 Description: The system shall transmit audio at a minimum of 800 bits per second.

5.6.2   Source: The Always Home Team.

5.6.3   Constraints: The network bandwidth must be at least 800 bps for audio transmission.

5.6.4   Standards: FS-1015 DOD telephony speech encoding standard

5.6.5   Priority: 2 - High.

5.7   Recording Log - Log Availability

5.7.1 Description: The logs shall be updated at least 5 minutes after interaction has ended.

5.7.2   Source: The Always Home Team.

5.7.3   Constraints: Availability will rely on network bandwidth and connectivity.

5.7.4   Standards: None.

5.7.5   Priority: 3 - Moderate.

5.8   Recording Log - Storage Capacity

5.8.1 Description: The system shall provide at least 32GB of storage capacity for videos.

5.8.2   Source: The Always Home Team.

5.8.3   Constraints: None.

5.8.4 Standards: None.

5.8.5   Priority: 3 - Moderate.

5.9   Power - Power Supply

5.9.1Description: The system shall be equipped with a power supply that will take a power source as specified in requirement 5.10 and provide an operating voltage of 1-15V and a current less than 20A.

5.9.2   Source: The Always Home Team.

5.9.3   Constraints: The types of devices chosen to implement our system will drive the specific power requirements.

5.9.4 Standards: None.

5.9.5   Priority: 1 – Critical

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5.10   Power - Power Source

5.10.1 Description: The system shall source 120VAC power from a standard household electrical outlet.

5.10.2 Source: The Always Home Team.

5.10.3 Constraints: Location must have 120VAC electrical outlet.

5.10.4 Standards: National Electric Code (NEC).

5.10.5 Priority: 1 - Critical

5.11   Emergency Backup Battery

5.11.1 Description: The system shall provide an emergency backup battery that allows it to operate for at least eight hours.

5.11.2 Source: The Always Home Team.

5.11.3 Constraints: The amount of power consumption due to system activity may limit operation time.

5.11.4 Standards: None.

5.11.5 Priority: 5 – Future Item

5.12   I/O Ports

5.12.1 Description: The system shall provide the appropriate I/O ports for interacting with components, including, but not limited to: General Purpose I/O ports, USB ports, and TRS phone jacks.

5.12.2 Source: The Always Home Team.

5.12.3 Constraints: Microcontroller will determine the type and number of I/O ports.

5.12.4 Standards: None

5.12.5 Priority: 2 - High.

5.13   Operating Environment

5.13.1 Description: The system shall remain operational within humidity ranges from 0% - 95%, and temperature ranges from -12°C - 70°C.

5.13.2 Source: The Always Home Team.

5.13.3 Constraints: None.

5.13.4 Standards: None.

5.13.5 Priority: 2 – High

5.14   Video/Photo Resolution

5.14.1 Description: The system shall have recording capability for photo and video resolution of at least 352x240 pixels.

5.14.2 Source: The Always Home Team.

5.14.3 Constraints: Transmitted resolution may be limited by external factors such as network bandwidth.

5.14.4 Standards: NTSC standard for television broadcast.

5.14.5 Priority: 2 – High

5.15   System Availability

5.15.1 Description: After initial configuration, the system shall be available at least 95% of the time that it is connected to both working 120VAC electrical power and a working internet connection.

5.15.2 Source: The Always Home Team.

5.15.3 Constraints: The mobile device and system must both have internet access and electrical power.

5.15.4 Standards: None.

5.15.5 Priority: 2 – High

5.16 Notification Limit

5.16.1 Description: The system shall notify the user of doorbell rings a maximum of 3 times in a 2-minute period where rings will be processed every 30 seconds.

5.16.2 Source: The Always Home Team.

5.16.3 Constraints: This requirement will not apply to door open/close notifications.

5.16.4 Standards: None.

5.16.5 Priority: 5 – Future Item

5.17 Initialization Time

5.17.1 Description: Upon device power on, the system shall be initialized after a period no longer than 5 minutes.

5.17.2 Source: The Always Home Team.

5.17.3 Constraints: If a device fails the system will notify the user and report the failed component in the web log.

5.17.4 Standards: None.

5.17.5 Priority: 1 – Critical

5.18 Mounting Height

5.18.1 Description: The system's user manual shall specify that the portion of the system containing the video camera be mounted within a height range of 60 – 66 inches.

5.18.2 Source: The Always Home Team.

5.18.3 Constraints: None

5.18.4 Standards: Anthropometric Reference Data for Children and Adults: United States, 2003–2006, CDC.

5.18.5 Priority: 1 – Critical

5.20 Microphone Sensitivity

5.20.1 Description: The system shall provide a microphone with at least -20db sensitivity to reduce ambient noise processing.

5.20.2 Source: The Always Home Team.

5.20.3 Constraints: Microphone that has a sensitivity of at least -20db and Nominal Sensitivity is -40db based on limits of human hearing.

5.20.4 Standards: None

5.20.5 Priority: 2 – High

6. Safety Requirements

In general an electronic communication system has a low potential to cause physical or financial harm to anyone operating the system. However, there are circumstances where precaution needs to be exercised during installation and operation of the Smart Door system. The following requirements specify the conditions under which the operation of the Smart Door system could cause physical harm to a user of the system.

6.1   Camera Mounting

6.1.1 Description: The camera shall be secured properly to prevent a fall or collision hazard. The camera's mounting base must be properly secured to the door and positioned at the correct height for use.

6.1.2 Source: Always Home

6.1.3 Constraints: Securing material must be strong enough to hold the camera in place

6.1.4 Standards: The correct mounting height is specified in requirement 5.20 Mounting Height.

6.1.5 Priority: 3 – Moderate

6.2   Microphone Mounting

6.2.1 Description: The microphone shall be secured properly to prevent a fall or collision hazard. The microphone's mounting base must be properly secured to a structure and positioned four or more vertical feet off the ground.

6.2.2 Source: Always Home

6.2.3 Constraints: Securing material must be strong enough to hold the microphone in place

6.2.4 Standards: None

6.2.5 Priority: 3 – Moderate

6.3   Camera and Microphone Weather Safety

6.3.1 Description: The camera and microphone shall be installed in a manner that is considered to be weather safe.

6.3.2 Source: Always Home

6.3.3 Constraints: The user's geographical location is capable of producing the required weather conditions at time of installation.

6.3.4 Standards: Weather safe installation behavior is categorized as the following:

Camera and microphone power shall be protected against water penetration to prevent shock hazards upon installation.

Camera and microphone shall be installed during daylight and in fair weather conditions,

Fair weather is defined by NOAA as the following:

("…less than four tenths [of the celestial dome] opaque, no precipitation, no extreme conditions of visibility, wind or temperature, and generally pleasant weather…")

6.3.5 Priority: 1 - Critical

6.4   Receptacles

6.4.1 Description: All electric receptacles shall meet the National Electrical Code for outdoor wiring. The National Electrical Code states:

- Receptacles must be a minimum of 12 inches above grade to keep receptacles out of water and snow accumulations
- Receptacles must user either a ground fault circuit interrupter (GFCI) or GFCI breakers to protect the users of these receptacles

6.4.2 Source: Always Home

6.4.3 Constraints: The home where the Smart door system is to be installed already has acceptable wiring or is capable of being rewired to include an acceptable outdoor receptacle

6.4.4 Standards: National Electrical Code

6.4.5 Priority: 5- Future Item

7. Maintenance and Support Requirements

7.1   Software Updates

7.1.1 Description: Software updates shall be available from the internet.

7.1.2   Source: Team Always Home

7.1.3   Constraints: Time and continued availability of team members will limit how often updates are made.

7.1.4   Standards: None

7.1.5   Priority: 5- Future Item

7.2   User Manual

7.2.1 Description: The system shall provide English instructions on how to use and configure the device. There shall be a troubleshooting guide section for system installer.

7.2.2   Source: Team Always Home

7.2.3   Constraints: Languages known by the user will determine the usefulness of instructions provided in written English.

7.2.4   Standards: None

7.2.5   Priority: 3 – Moderate

7.3   Open Source

7.3.1 Description: All documents and source code shall be made available without financial remuneration. Code shall be commented and include breakpoints to support troubleshooting.

7.3.2   Source: Team Always Home.

7.3.3   Constraints: None.

7.3.4   Standards: None.

7.3.5   Priority: 1 – Critical.

8. Other Requirements

This section describes the requirements that have not been specified in any other section of the SRS. However, this part includes requirements related to customer setup and configuration that are not specified in previous requirement sections. These are necessary for implementing a complete product.

8.1   Web Interface Support

8.1.1 Description: The system shall include a web application that provides the same capabilities for controlling and interacting with the system as the smartphone application.

8.1.2   Source: The Always Home Team.

8.1.3   Constraints: None.

8.1.4   Standards: None.

8.1.5   Priority: 1 - Critical.

8.2   Portable Source Code

8.2.1 Description: The system shall include an iOS application that provides the same capabilities for controlling and interacting with the system as the smartphone application.

8.2.2   Source: The Always Home Team.

8.2.3   Constraints: None.

8.2.4   Standards: None.

8.2.5   Priority: 5 – Future Item.

8.3   Notification Control

8.3.1 Description: The system shall not notify the customer again for at least two minutes if the user chooses to ignore the first notification.

8.3.2   Source: The Always Home Team.

8.3.3   Constraints: Correct system notification behavior is specified in requirement 5.18.

8.3.4   Standards: None.

8.3.5   Priority: 2 - High.

9. Acceptance Criteria

The acceptance criteria for Smart Door are listed below in 9.1 through 9.9. The Smart Door system will be accepted as completed upon demonstrating each qualification as specified below. The sponsor has agreed to verify each criterion by following the included verification procedures.

9.1   Verify that Smart Door wakes and notifies upon connected doorbell being pressed

9.1.1 Requirement(s) addressed:

3.1 Smartphone Application Control
3.2 Snapshots Taken
5.2 Notification Time
5.13 Operating Environment

9.1.2 Verification Procedure: Upon pressing the doorbell the android device shall display a notification and play the selected ring tone within 1 minute of the customer connected to the Smart Door system. The notification shall include a snapshot taken when the doorbell was pressed.

9.2   Verify that Smart Door wakes and logs the status of the connected door upon connected door opening or closing.

9.2.1 Requirement(s) addressed:

3.3 Keep Activities Log
5.7 Recording Log - Log Availability
5.8 Recording Log – Storage Capacity

9.2.2 Verification Procedure: The android device shall display a notification within 1 minute of the door connected to the Smart Door system opening or closing. The notification shall include a snapshot taken when the doorbell was pressed. This log and snapshot shall be available on the server within five minutes in accordance with requirements 5.7 and 5.8.

9.3 Verify live video monitoring capability within the Smart Door android app

9.3.1 Requirement(s) addressed:

3.5 Video Monitoring
5.4 Response Time

9.3.2 Verification Procedure: Upon pressing the "Monitor" button in the android app the application shall display a live video feed from the door.

9.4 Verify one way video communication between door and the Smart Door android app

9.4.1 Requirement(s) addressed:

3.1 Smartphone Application Control
5.4 Response Time
5.7 Recording Log - Log Availability
5.8 Recording Log - Storage Capacity
5.16 Video/Photo Resolution

9.4.2 Verification Procedure: Upon answering a notification from the door the android app shall display a live video feed from the door. Upon completion of the video interaction the video shall be posted in accordance with requirements 5.7 Recording Log - Log Availability and 5.8 Recording Log - Storage Capacity.

9.5 Verify two way audio communication between door and Smart Door android app

9.5.1 Requirement(s) addressed:

5.19 Mounting Height

9.5.2 Verification Procedure: Upon answering a notification within the android app audio from the android app shall be transmitted to and emitted at the door. Additionally, audio from the door shall be transmitted to and emitted at the android app.

9.6   Verify the Smart Door system returns to sleep mode upon completion of interaction

9.6.1 Requirement(s) addressed: None

9.6.2 Verification Procedure: Smart Door will deactivate and return to sleep mode upon the completion of an interaction. Additionally Smart Door will deactivate and return to sleep mode after 30 seconds of inactivity following a press of the doorbell.

9.7   Verify video logging and ability to retrieve videos using the Smart Door web app

9.7.1 Requirement(s) addressed:

3.3 Keep Activities Log
5.7 Recording Log - Log Availability
5.8 Recording Log - Storage Capacity
5.16 Video/Photo Resolution

9.7.2 Verification Procedure: Upon logging into the web interface the user will be presented with a list of previously recorded videos and an interface to download the videos.

9.8   Verify the Smart Door system portability and ease of installation

9.8.1 Requirement(s) addressed:

3.6 System Portability
3.10 Hardware Security
4.6 Included Components
5.1 System Setup

9.8.2 Verification Procedure: This criterion is quite subjective so it will be verified in person by the sponsor. The sponsor will determine whether the product meets their definition of portability.

9.9   Verify the Smart Door system does not interfere with normal operation of door

9.9.1 Requirement(s) addressed:

        3.14 Nonintrusive
        4.1 Size
        4.3 Mounting
        4.4 Casing
        6.1 Camera Mounting

9.9.2 Verification Procedure: The doorbell, locking mechanism and peephole of the door will be tested to ensure that they all still work normally while the Smart Door device is attached to the door and functioning.

9.10   Verify the Smart Door system supports multiple Smartphones

9.10.1 Requirement(s) addressed:

        3.7 Smart Phone Pairing

9.10.2 Verification Procedure: Verify that multiple smartphones can be paired with the prototype via the Smart Door website.

10. Use Cases

The following section contains the stated uses cases for Smart Door. The system's use cases are split into two categories: guest use cases and owner use cases.

10.1 Guest Use Case

These are the use cases that specify how a guest will interact with the Smart Door system. The following use cases encompass the user interaction with the system at the beginning of a call.
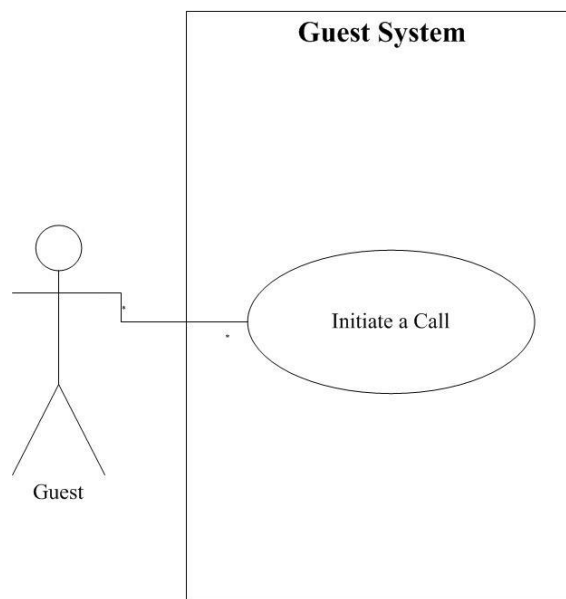
Figure 7: Guest System

10.1.1 Initiates a Call

This use case describes the actions of the guest when they initiate interaction through Smart Door by manually ringing the doorbell.

> **Actor(s):** Guest, Owner

> **System:**   Smart Door

> **TUCBW:** Guest rings the doorbell

> **TUCEW:** Guest receives a response

10.2 Owner Use Cases

These are the use cases involve how an owner will interact with the system. This involves monitoring, viewing recorded videos, unlocking the door.
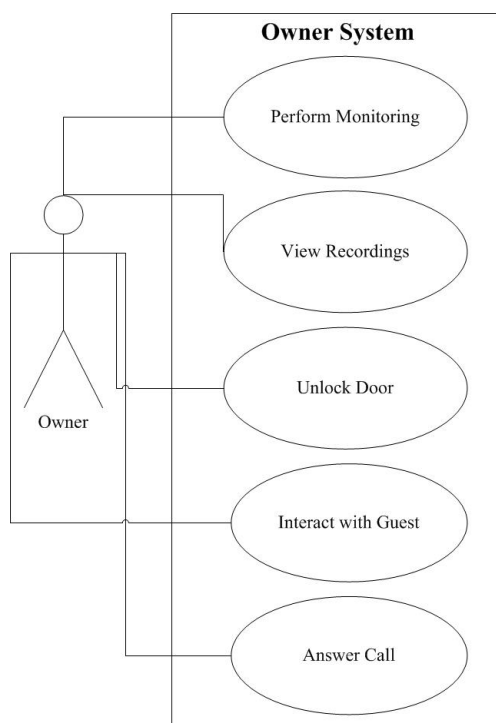
Figure 8: Owner System

10.2.1 Perform Monitoring

This use case describes the actions of the user when they are ready to perform monitoring.

> **Actor(s):** Owner
>
> **System:**   Smart Door
>
> **TUCBW:** Owner clicks the Start Monitoring option.
>
> **TUCEW:** Owner sees a video feed from the camera on the door.

10.2.2 View Recordings

This use case describes the actions of the user when they access their recorded videos.

Actor(s): Owner

System: Smart Door

TUCBW: Owner clicks on View Recording button

TUCEW: Owner sees previously recorded videos

10.2.3 Unlock Door

This use case describes the actions of the owner when they unlock the door via phone.

Actor(s): Owner

System: Smart Door

TUCBW: Owner clicks on Unlock Door button

TUCEW: Owner sees the door is unlocked

10.2.4 Answer Call

This use case describes the actions of the owner when he answers a guest call from the door via phone.

Actor(s): Owner, Guest

System: Smart Door

TUCBW: Owner clicks on Answer or Decline button on the phone

TUCEW: Owner hears guest on the phone.

10.2.5 Interact with the Guest

This use case describes the actions of the owner when he talks to the guest at the door via phone.

>**Actor(s):** Owner, Guest
>
>**System:**   Smart Door
>
>**TUCBW:** Owner talks to guest via phone
>
>**TUCEW:** Owner ends the call

11. Feasibility Assessment

Always Home has conducted extensive analysis of our relative strengths and weaknesses against our project definition. The results of this research are summarized in the following Feasibility assessment. The feasibility assessment outlines the feasibility of completing Smart Door as specified within this system requirements specification. Product scope, necessary research, technical aspects, development cost, development team resources, and proposed schedule will each be analyzed to determine their effect on the overall feasibility of the project. Taken together these analyses will provide a big picture estimate of the overall project feasibility. This analysis is necessarily based on the current knowledge of the team regarding the project and may become outdated as the development effort continues.

11.1 Scope Analysis

The scope of this Smart Door was one of the harder metrics to finalize. There are few similar products on the market so defining the needed functionality for the end user was quite difficult. Based on our understanding of user needs and possible functionality we analyzed a wide range of possible solutions. Our sponsor ICU Security was a wonderful resource in this regard and helped us refine the functionality so that the Smart Door meets unfilled needs while remaining a competitive product in terms of price and ease of use. This added insight helped us to prioritize our requirements and come up with acceptance criteria. Once we ICU Security agreed to the preceding acceptance criteria we analyzed the product concept for gaps between intended functionality and the teams' knowledge base. The areas where we found shortcomings in the skills necessary to meet acceptance criteria are Android video streaming, network communication, and potentially unknown hardware. Thus, our defined scope is all requirements and functionality included in the acceptance criteria.

We have agreed to complete all priority one requirements called out in the acceptance criteria so that our product will be fully functioning in its intended features. In order to do this we have identified research areas, prioritized the requirements and begun studying the areas of development where our expertise has been identified as insufficient. Based on the analysis and research we have completed so far we believe that we can meet all acceptance criteria by the project due date. Further review of this analysis is included below.

11.2 Research

After consultation with our sponsor we have a good understanding of the functional requirements for the system. Our design specifies three main components; an android app, a web server, and the door mounted hardware to fulfill these requirements. We have identified research topics for each of these main components and begun research as described below.

11.2.1 Android development

Since there is limited mobile development experience on our team we have identified mobile interfaces, and video streaming as knowledge deficits. Our system requires interactions between the mobile device, the webserver and the hardware attached to the door. Currently we are aware that this is possible but unaware of how we will be able to implement it. In order to address this deficit, team members have agreed to take an online course from Stanford and reach out to the mobile development club at UTA.

11.2.2 Web Server

Web development is an area where are team has an established knowledge base but the complexity required to meet our product specification is higher than what team members currently have experience developing. We are currently analyzing whether a cloud based storage solution will fulfill our needs or if the project requires a network attached computer to function. Once we have identified the best solution implementation is expected to be straightforward.

11.2.3 Hardware

Hardware is the least specified part of the system at this stage of development. Our team has done an initial examination of microcontrollers and associated hardware that can be used to fulfill the specified functionality of our product. We have narrowed our focus to three ARM based computers, Arduino, Raspberry Pi, and Beaglebone Black. Our near term plan is to obtain one of each and assess their relative applicability to fulfilling our requirements. The only other hardware decision that remains unresolved is how to implement the lock/unlock functionality required by the stakeholders. We are currently in the process of deciding between using a COS electronic lock or developing our own latching system.

11.3   Technical Analysis

Smart Door as it is being developed by Always Home is not a revolutionary design. Smart Door is a novel way of combining and packaging functionality that already exists in the home security marketplace. Seeing as existing products already duplicate much of the functionality that we are planning to develop and we do not plan on building custom hardware the technical aspects of this product should not present any significant barriers to development. The only technical facets that are anticipated to be challenging deal with the modular nature of Smart Door and the disparate domains

these modules operate within. We expect the hardware to web and web to android interfaces to provide the most challenge to the development team. Our strategy for overcoming these challenges is laid out with great detail in section 11.5.2 of this document. Additionally incorporating all of the various components into a self-contained package could provide a challenge. When it comes to the interface challenges we plan on gaining insight from the well-established communities online that consist of hobbyist developers for the chosen platform. In order to assist with the packaging challenges we will ask for advice and technical expertise from our sponsors at ICU Security. These mitigation factors are believed to be sufficient to enable project success.

11.4   Cost Analysis

Team Always Home has a project budget of eight hundred dollars. Normally this would be considered quite inappropriate as a project budget for a development effort. Luckily team Always Home consists of students who will work for free so our only cost is parts and materials. Normally software development environments could also factor into overhead costs but Always Home will be using the open source IDE Eclipse and compatible plugins for all of our software development effort. Furthermore the software we are developing is open source as well. Keeping these factors in mind we anticipate our expenditures to be well within the budget. Considering the costs of hardware we expect total expenditures of around five hundred dollars.

Item	Quantity	Price	Total
Raspberry Pi	1	$35.00	$35.00
Beaglebone Black	1	$45.00	$45.00
Arduino Uno	1	$30.00	$30.00
Camera Module	1	$35-$50	$50.00
USB Soundcard	1	$35.00	$35.00
Microphone	1	$50.00	$50.00
Speaker	1	$50.00	$50.00
USB WIFI Dongle	1	$20.00	$20.00
Wireless Doorbell	1	$50.00	$50.00
Misc Wires	100ft	$0.25/ft	$25.00
Electronic Deadbolt	1	$100.00	$100.00
Enclosure	1	$20.00	$20.00
Mounting Screws	4	$0.10	$0.40
Mounting Bracket	1	$10.00	$10.00
		TOTAL:	**$520.40**

Table 2: Cost Estimate

11.5   Resource Analysis

11.5.1 Resource Overview and Problem Description

Always Home has a diverse talent pool consisting of strong students who each have industry experience. Our most practiced skills include web development, model based development, microcontroller programing and the programming languages C and Java. Major development challenges on the Smart Door project are brought about by the complex interfaces and communication between web components, mobile application, server and hardware components. As will be shown in the following analysis, team Always Home is well suited to these challenges. Beyond these two areas the rest of the project is believed to be relatively straightforward development effort. The remaining functionality specified requires team Always Home to develop an Android Application for interacting with guests using the Smart Door, a database management program for storing and retrieving videos, and the hardware system built from commercial off the shelf (COTS) components. Through the intelligent application of our human capitol, team Always Home will overcome the challenges we face and develop the Smart Door within budgetary and schedule constraints.

11.5.2 Application of Resources to Interfaces

Always Home recognizes that specifying the interfaces between hardware and software is the highest risks identified for our Smart Door. Due to the functionality of Smart Door requiring constant communication across three distinct platforms we are focusing much of our early development effort on this critical area. The two software engineers on team Always Home are utilizing use cases and software modeling techniques to identify and specify the critical interfaces in Smart Door. Additionally the software and hardware leads' primary responsibilities are specifying the interfaces between their respective domains. By defining these interfaces up front we are able to develop the architecture of the system without restricting the solutions space for designing the individual software and hardware components. During the interface design process the web design lead will inform the team of constraints imposed on the system by operating over the internet. This strategy is designed to ensure our interfaces support all required product functionality while adhering to KISS principles and being implementable within our chosen communication channels.

11.5.3 Application of Resources to Communications

Secondary to interfaces our next highest risk area is communication. Smart Door's requirements necessitate streaming many messages that originate within one component through at least two interfaces in order to be interpreted and acted upon by a receiving component. In order for this complex communication to function properly we will need small, well designed messages that are able to be transmitted and acted upon quickly. For team Always Home to achieve this goal our web domain lead

will apply his knowledge and experience to analyzing protocols and designing messages that fit our design principles.

11.5.4 Application of Resources to Component Development

The design of software and hardware components that compromise the PRODUCT while straightforward is not simple. We envision the development of individual software and hardware components to be driven by requirements and constraints imposed on the system during the specification of our interfaces and communication protocols. For this reason we will start those tasks early in the architecture specification process and not solidly define our components until we are confident that the candidate components meet the needs of the entire system. Upon completion of system interface, communication, and architecture specification the team will begin implementation as follows. We anticipate building the web based database application using html and JavaScript since all five members have experience in with these languages including one member who has extensive experience. We plan to develop the Android application in JAVA with the Eclipse IDE using the officially supported Android Development Tools (ADT) Plugin. As with the web based languages all five team members have familiarity with the Eclipse IDE and its associated GIT plugin, this will allow common tools amongst team members and robust source code control. On the hardware side our team has chosen to use a powerful microcontroller such as Arduino, BeagleBone Black or Raspberry Pi due to the intense video processing requirements of our PRODUCT. The extensive capabilities of this type of microcontroller mean that we will not need to develop custom hardware to perform our required functionality. The microcontroller will also be able to serve as the hardware systems brain taking input from and controlling all other hardware components including the microphone, camera, electronic lock, and doorbell.

11.6 Schedule Analysis

The negotiation with ICU over included functionality was focused on making the size and effort of the development meet our strict schedule. The scope described in section 11.1 of this document is what we considered achievable by the Always Home team. The following schedule analysis is designed to help determine if we were correct or if the schedule and features will have to be rebalanced to insure project success. In order to track progress towards our goals we have initiated size, effort and schedule estimation using function point estimation and Jones First Order estimation. During function point estimation we used the method described by the International Function Point users Group (IFPUG) which may vary slightly from previous definitions. Due to the teams unfamiliarity with project estimation we decided to use Constructive Cost Model (COCOMO) techniques for a second unrelated estimate. We hope that by having two unrelated estimates we can generate a more accurate estimate of the effort and schedule or the Smart Door project.

11.6.1 Function Point Estimation

In order to complete the function point analysis we first estimated how our required functionality will translate into Inputs, Outputs, Inquiries, Logical internal files and External logical files. This data is summarized below in Table 2and results in an Unadjusted Function Point count (UFP) of one hundred and sixty seven. This number seems high for the project but that is because we decided to include functionality where the microcontroller interacts with the devices it controls. This may not strictly be part of the software development effort but as a team we thought it was important to include since it is part of the overall system development effort.

Function Point Description	Priority	Points
External Inputs (EI)		
Door – Camera	<Low>	3
Door – Microphone	<Low>	3
Door – Doorbell	<Low>	3
Phone – Touch Screen Interface	<HIGH>	6
Phone – Accept Notification Message	<Medium>	4
Phone – Decline Notification Message	<Medium>	4
Phone – Lock Door Control	<Medium>	4
Phone – Unlock Door Control	<Medium>	4
Web – User Interface	<HIGH>	6
DBM – Register App to particular Hardware	<Medium>	4
Total:		**41**

Function Point Description	Priority	Points
External Outputs (EO)		
Door – Speaker	<Low>	3
Door – Doorbell	<Low>	3
Microcontroller – Generate Notification	<Medium>	4
Microcontroller – Notify Phone	<Medium>	4
DBM – Notify Phone	<Medium>	4
DBM – Video: Live Interaction	<HIGH>	6
DBM – Video: Recorded Videos	<Medium>	4
DBM – Video: One-Way Monitoring	<Medium>	4
Microcontroller – Video pass-through to DBM	<Medium>	4
Phone – Video: Live Interaction	<HIGH>	6
Phone – Video: Recorded Videos	<Medium>	4
Phone – Video: One-Way Monitoring	<Medium>	4

DBM – Audio: Live Interaction	<HIGH>	6
DBM – Audio: Recorded Videos	<Medium>	4
DBM – Audio: One-Way Monitoring	<Medium>	4
Microcontroller – Audio pass-through to DBM	<Medium>	4
Phone – Audio: Live Interaction	<HIGH>	6
Phone – Audio: Recorded Interaction	<Medium>	4
Phone – Audio: One-Way Monitoring	<Medium>	4
Phone – Notification	<Medium>	4
Total:		**86**

External Inquiry (EQ)		
Doorbell – Ring	<Low>	3
Phone – Monitor Camera Output	<HIGH>	6
Phone – Download Recorded Videos	<Medium>	4
Phone – Watch Recorded Videos	<Medium>	4
Web – Download Recorded Videos	<Medium>	4
Web – Watch Recorded Videos	<Medium>	4
Web – Register Account	<HIGH>	6
Phone – Lock Door Action	<HIGH>	6
Phone – Unlock Door Action	<HIGH>	6
Phone – Register Account	<HIGH>	6
Total:		**43**

Internal Logical Files (ILF's)		
Web – User Accounts	<HIGH>	6
Web – Video Files	<Medium>	4
Web – GUI	<Medium>	4
Phone – Saved videos	<Medium>	4
Phone – User Accounts	<HIGH>	6
Phone – GUI	<Medium>	4
Total:		**28**

External Interface Files (EIF's)		
Phone – Network ID	<HIGH>	6
Hardware – IP Address	<HIGH>	6
Total:		**12**

Total Unadjusted Function Point Count (UFP):	**167**

Table 3: Function Point Description

The next step in our function point estimation was to calculate the Value Adjustment Factor (VAF) by assigning the fourteen defined General System Characteristics (GSCs) a Degree of Influence (DI) from zero to five. After obtaining the Total Degree of Influence (TDI) we use the IFPUG Value Adjustment Equation (VAE) to calculate the final VAF. This information is presented in Table 3. As shown in Table 3 the total estimated size for Smart Door is 178.69 function points, this information will be used in the following effort estimation.

General System Characteristics (GSCs)	Degree of Influence (DI)
Data communications	5
Distributed data processing	4
Performance	3
Heavily used configuration	3
Transaction rate	3
On-Line data entry	0
End-user efficiency	3
On-Line update	0
Complex processing	3
Reusability	3
Installation ease	5
Operational ease	5
Multiple sites	3
Facilitate change	2
Total Degree of Influence	**42**

IFPUG Value Adjustment Equation (VAF)
VAF = (42 * 0.01) + 0.65 = 1.07

Function Point (FP) = UFP * VAF
FP = 167 * 1.07 = 178.69

Table 4: GSCs Degrees of Influence

11.6.2 Jones First Order Estimation

Always Home is confident of our capabilities to finish the Smart Door project and want our estimates to reflect that confidence, however in the interest of realistic estimation we will use conservative numbers in order to generate a more useful schedule estimate. For Jones First-Order Estimation we will use the

worst in class column and the Systems Software category. We chose these categories since the Smart Door is comprised of both software and hardware and team Always Home is a newly formed team that is comprised of students. To get the schedule estimate we simply take the number of function points raised to the exponent chosen from Table 8-7 Exponents for computing Schedules from Function Points in Rapid Development by Steve McConnell (J in the formula $S=FP^J$). The above choices of a worst in class systems development team give us an exponent of 0.48. By this method Schedule $= FP^J =$ $178.69^{0.48} = 12.05$, this means that a rough estimate of the time it would take a lone programmer to develop the Smart Door System source code is a little over one year. Since team Always home has five developers and seven months to complete the Smart Door project this initial estimate of twelve person-months is very encouraging. Unfortunately there are a three more factors to consider. Team Always Home is unlikely to work through the Christmas break which means we only have six months. Also, Smart Door system is not limited to writing source code, there is also a hardware development effort and the task of integrating the hardware with the software. Finally it would be unreasonable to assume our five team members can devote forty hours per week to the project.

Keeping all of these factors in mind we will adjust the estimate as follows. The members of always home have committed to working twenty hours per week on the project and we have six calendar months to work on the project, this means that there is an equivalent time budget of fifteen person-months to work on the project. According to the prior estimate of twelve person-months to write source code these factors mean we have three months of effort to sort out hardware and integration issues. Team Always Home will use this for our baseline schedule estimate, as we progress into the project we will recalibrate the estimate each time we reach a development milestone or complete a project deliverable. This recalibration will help us make sure our estimate stays accurate and help us decide if it is necessary to work more hours per week or commit to working over the holiday in order to finish by our calendar deadline next May.

11.6.3 COCOMO II

We decided to use the COCOMO technique as a second estimate since our software engineering team members have some experience using COCOMO. Our intent is to refine our overall estimate by having two separate estimation methodologies that can inform our development effort. For the COCOMO estimate we will use the same function points developed above in section 11.6.1 which gives an unadjusted function point count of one hundred and sixty seven. Since COCOMO uses Source Lines of Code (SLOC) we need to convert the unadjusted function points to SLOC. In order to do this we researched conversion tables online for the languages we plan on using and made an estimated conversion factor of 54.9 SLOC for each UFP for this project. The AHCF gives an overall project size of 9169 SLOC or 9 KLOC. This analysis is summarized below in Table 4.

Always Home Conversion Factor (AHCF)

Language	Conversion Factor	Where Used	Overall Usage
Java	1 FP = 53 SLOC	Android App	50%
C/Assembly	1 FP = 100 SLOC	Microcontroller	20%
HTML/SQL/CSS	1 FP = 28 SLOC	Web Interface	30%
		AHCF:	54.9

Overall Project Size (OPS) = UFP * AHCF

OPS = 167 * 54.9 = 9168.3 SLOC

Table 5: Conversion Factors

The next step of COCOMO is defining the Scale Drivers. We assigned values to each of the scale drivers as is shown below in Table 5.

Scale Factor (SF)

Scale Driver	Assessment	Assessment	Value
Precedentedness	Generally Familiar	High	2.48
Flexibility	Some Relaxation	Nominal	3.04
Significant Risks Eliminated	Little	Very Low	7.07
Team Interaction Process	Largely Cooperative	High	2.19
Process Maturity	Level 4	Very High	1.56
		SF:	16.34

E = B + 0.01 * Σ SF where B = 0.91 (COCOMO II 2000)

E = 0.91 +(0.01 * 16.34) =   1.0734

Table 6: Scale Factors

The scale factors give us E=1.0734 which factors into PM = A * Size ^{E} * (Summation of the Effort Multipliers) where size is equal to the KSLOC in Table 4 and A is a given constant of 2.94 person-months per KSLOC. This equation results in PM = $2.94 * 9.1683^{1.0734} * 0.992941176 = 31.4914$. Team Always Home does not expect to write source code to the level of development expected by the COCOMO model so we calculated the remaining numbers using A = 1.3 which results in PM = 13.9248. The effort Multipliers are illustrated below in Table 6.

60

Effort Multipliers (EM)

Identifier	Name	Ranges	Assessment	Value
Product Factors				
RELY	Required Software Reliability	VL 0.82 - VH 1.26	VL	0.82
DATA	Database Size	L 0.90 - VH 1.28	L	0.90
CPLX	Software Product Complexity	VL 0.73 - EH 1.74	N	1.00
RUSE	Required Reusability	L 0.95 - EH 1.24	L	0.95
DOCU	Documentation Match to Life-Cycle	VL 0.81 - H 1.23	H	1.23
Platform Factors				
TIME	Execution Time Constraint	N 1.00 - EH 1.63	N	1.00
STOR	Main Storage Constraint	N 1.00 - EH 1.46	N	1.00
PVOL	Platform Volatility	L 0.87 - VH 1.30	VL	0.87
Personnel Factors				
ACAP	Analyst Capability	VL 1.42 - VH 0.71	L	1.19
APEX	Applications Experience	VL 1.22 - VH 0.81	L	1.10
PCAP	Programmer Capability	VL 1.34 - VH 0.76	H	0.88
PCON	Personell Continuity	VL 1.29 - VH 0.81	VH	0.81
PLEX	Platform Experience	VL 1.19 - VH 0.85	L	1.09
LTEX	Language and Tool Experience	VL 1.20 - VH 0.84	H	0.91
Project Attributes				
SITE	Multisite Development	VL 1.22 - EH 0.8	XH	0.80
TOOL	Use of Software Tools	VL 1.17 - VH 0.78	H	0.90
SCHED	Required Development Schedule	VL 1.43 - VH 1.00	VL	1.43
			EAF:	16.88

Summation of Effort Multipliers (Σ EM)	
Σ EAF =	0.992941176

Table 7: Effort Multipliers

As is evident from the effort multipliers our team is quite inexperienced, however the relative simplicity of the software will help us overcome our inexperience. The formula to obtain a time estimate form the COCOMO analysis is defined below.

Time to Develop in Calendar Months (TDEV) = [C * (PM$_{NS}$)$^{(D+0.2*(E-B))}$] * SCHED%/100
Where SCHED = 1.43, E = 1.074, PM$_{NS}$ = 28.8236 (Summation of Estimated PM excluding SCHED).
The defined constants are C = 3.67, D = 0.28, B = 0.91.

For the Smart Door project as being developed by Always Home this formula results in TDEV = $[3.67*12.7448^{(0.28+0.2*(1.07-0.91))}]*(143/100)=11.6109$ calendar-months. This calendar-month estimate is based on a one person development team, if we divide the person-months value by two and one half to reflect five people working at half time the new estimate is 8.7 calendar-months. This estimate is slightly higher than the estimate generated by Jones First-Order estimation and indicates that we need to adjust the amount of time spent by each team member or simplify the project since we only have a maximum of seven calendar months to complete the project.

11.7 Conclusion

Based on all of the above data and estimates team Always Home will prepare to work for a full fifteen person-months on the Smart Door system. This work will entail a significant amount of research into cross system communications and a reliance on solid implementation of software engineering methods and CASE tools. During the development period Always Home must refine their effort and schedule estimates in order to adjust the development schedule and effort so as to ensure an on-time delivery of the Smart Door prototype. Our two schedule estimates differ by three calendar months with one finishing six weeks early and the other finishing six weeks late. Although we are new to project estimation these numbers still inform the team that tracking our progress and adhering to the schedule will be critically important to the success of the Smart Door project.

12. Future Items

This section discusses the requirements with a low priority of 5, which marks them for future implementation. The only requirements placed here are those that do not affect the core functionality of our system. Many of these requirements add additional functionality or convenience for our user, but are beyond the scope of an initial prototype. Later versions of this system or developers seeking to add to our system's functionality may want to start here for an idea of extensible functionality.

12.1 Motion Sensor

12.1.1 Requirement Description: The device shall have a short-range motion sensor.

12.1.2 Constraint: Time: The system already includes interaction with sensors for the doorbell, lock, and door open/close. These are essential to our devices functionality. If we add this requirement we would increase the man-hours on a project whose schedule estimates have already put us near/over the completion date.

12.2 Z-Wave

12.2.1 Requirement Description: 3.11 The system shall be compatible with Z-Wave wireless communications protocol.

12.2.2 Constraint: Budget / Design Limitation: Although the Z-wave protocol would allow our device to integrate with current home security configurations, this added convenience comes at a cost. Since Z-Wave is a proprietary technology, all devices interacting with it must implement its standard. This would limit our choice of hardware and increase the costs significantly since we would be forced to purchase our hardware from a commercial vendor. Initial estimates place an up-front purchase cost of all materials at nearly $500, which is more than half of our budget.

12.3 Emergency Backup Battery

12.3.1 Requirement Description: The system shall provide an emergency backup battery that allows it to operate for at least eight hours.

12.3.2 Constraint: Time / Feasibility: Since this is a prototype we found it infeasible to include an emergency backup battery in our design. If the product can work with direct power it will

work with backup power. Additionally, adding an emergency backup system would occur at the end of the project, which may interfere with our deadline.

12.4   Notification Limit

12.4.1 Requirement Description: The system shall notify the user of doorbell rings a maximum of 3 times in a 2-minute period where rings will be processed every 30 seconds. If the user declines the interaction, the system will stop processing rings for a period of 2 minutes. This will not affect the door open/close notifications..

12.4.2 Constraint: Time / Feasibility: This is a convenience feature for the user and does not invalidate the functionality of our system. Since it is for convenience we believe it is infeasible to include with the initial product prototype. It would also be a feature pushed until the end of the project, and might interfere with our deadline.

12.5   Receptacles

12.5.1 Requirement Description: All electric receptacles shall meet the National Electrical Code for outdoor wiring. The National Electrical Code states:

- Receptacles must be a minimum of 12 inches above grade to keep receptacles out of water and snow accumulations
- Receptacles must user either a ground fault circuit interrupter (GFCI) or GFCI breakers to protect the users of these receptacles

12.5.2 Constraint: Feasibility: This is only an issue if we decide to receive power for the system from an outside receptacle. This would likely be an optional feature subject to the household's electrical configuration since requirement 6.3 dictates that the system be installed in a manner that is considered weather-safe.

12.6   Portable Source Code

12.6.1 Requirement Description: The system shall include an iOS application that provides the same capabilities for controlling and interacting with the system as the smartphone application.

12.6.2 Constraint: Time / Skills: One of the weakest areas for the team is mobile application development. If we try to develop for two different mobile OSs in which we have little working knowledge, we would only be compounding our difficulties. This decrease in productivity would increase the amount of time spent negatively impacting our deadline.

12.7 Lock/Unlock

12.7.1 Description: The system shall be able to lock and unlock the door remotely.

12.7.2 Constraints: Time / Skills: The Smart Door team lacks a hardware centric team member after losing one teammate last November. Dues to our relative lack of skills on this area we have decided to defer the Lock/Unlock functionality in order to complete the project within the scheduled timeframe.