System Requirements (Revision 1)

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1 - Revision History

Date	Revision Number	Authors	Comments
2014/11/03	Rev 0	Adam Trela Brandon Youmans Samuel Habicht Shawn Simon Taylor Sorgini Zach Lau	Initial creation of Goals
2015/03/02	Rev 1	Adam Trela Brandon Youmans Samuel Habicht Shawn Simon Taylor Sorgini Zach Lau	First revision of Goals based on current progress of the project

Table 1 - Table of Revisions

2 - Purpose

2.1 - Mission Statement

It is estimated that 500,000 Canadians have Alzheimer's disease and within the next 5 years, as many as 50% more Canadians and their families could be faced with caring for patients with Alzheimer's disease or dementia[1]. In addition, there are countless other diseases that can affect both the brain and body, requiring varying degrees of care from caregivers.

Commonly people with Alzheimer's or other similar diseases often get confused and are prone to wandering, this forces their caregivers to pay close attention to their whereabouts. Being monitored all hours of the day can create tension between a caregiver and their patient. This loss of independence may lead to depression.

WiCare provides caregivers an easy, accessible and reliable way to monitor the location of their patients while keeping the technology discrete and operational only when completely necessary. WiCare removes the stigma of aging products by discretely concealing the product in everyday objects or accessories, such as a watch, to allow for a feeling of independence by the user.

2.2 - Goal

WiCare's aims to give comfort to caregivers, ensuring their loved are monitored in a reliable, accurate and discrete manner. WiCare strives to provide a better relationship between patients and caregivers. This technology allows the caregiver to have the peace of mind that their patient is safe, comfortable, and properly cared for, at all times and locations.

[1] Alzheimer Society of Toronto: Alzheimer's Disease & Dementia. (n.d.). Retrieved March 3, 2015, from http://alz.to/

3 - Scope

3.1 Project Overview

This product has been designed specifically for caregivers so that when they leave the presence of their Patient, they can still have a sense of security. Therefore the following high-level requirements must be met:

1. The wearable must be comfortable for the patient to wear
2. The wearable must store and report it's precise location under the following circumstances:
    a. *The Expected Area*: this is an area where the Patient would be expected to be, such as a house or a palliative care facility.
    b. *The Accepted Area:* this is an area that the Caregiver would deem as acceptable for the Patient to be in, such as a city block or park surrounding the Patient's home (*Expected Area*).
    c. *The Undesired Area:* this is the area where the Caregiver would deem unacceptable for the Patient to be in. This area is outside the *Expected* and *Accepted Areas.*
3. The server must be constructed to communicate between the Patient's wearable and the Caregiver's mobile application.
4. The application must be created to allow for ease of use by the Caregiver and if needed, real-time communication.

3.2 High-Level Operation

During normal operation the wearable will function independent of the server, unless an event occurs. These events are as follows:

- New expected zone is uploaded to the wearable by the caregiver.
- Patient leaves the expected area and caregiver requests real time location monitoring.
- Patient re-enters the expected area from the undesired area.
- Patient actuates the emergency button on the wearable.
- Device malfunction (i.e. low power) or removal from patient.

The server will act as an communication layer between the wearable and the Caregiver app. The independence of the wearable and server are paramount to the system's efficiency and robustness, and ensures the patient's sense of independence and the caregiver's peace of mind. The wearable acts as a separate system that provides analysis of the patient's well being and location which will only communicate to the server in the cases highlighted above. This allows for the longest battery life possible and a more reliable, safe, and ethical approach to patient safety.

Below is a high-level diagram which shows the hardware, software, and client application in communication with each other.

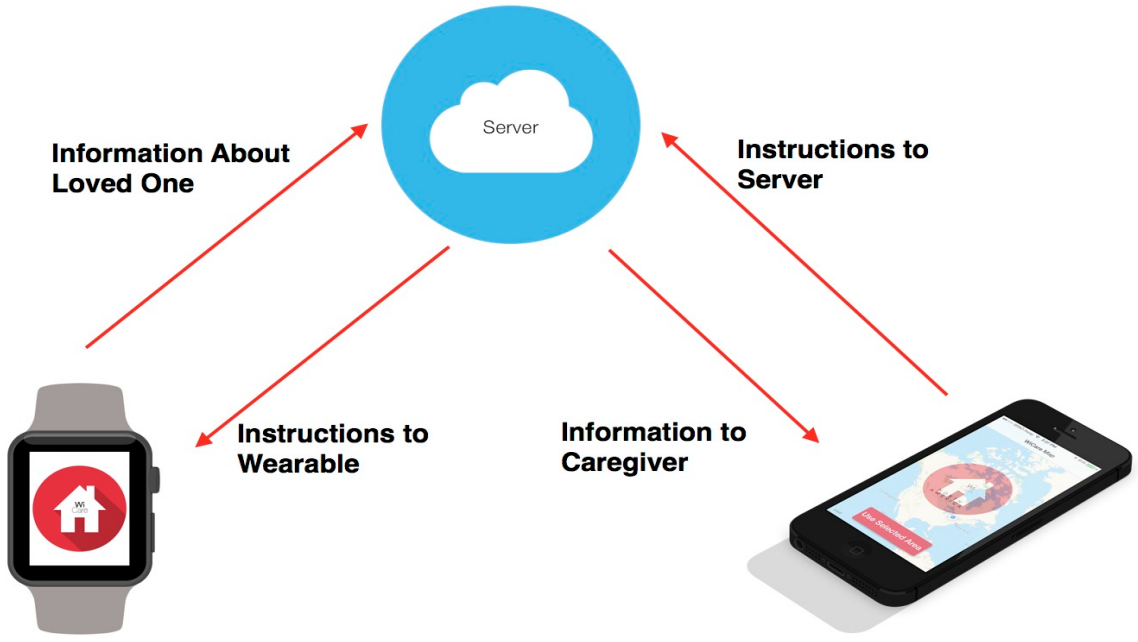

Figure 1 - High-level Diagram

3.3 - Stakeholders

1. **The Patient** - will be the one wearing the device, it must be comfortable, attractive and non-intrusive to their day-to-day activities.
2. **The Caregiver** - will be able to monitor and locate their patient(s) via an iOS app. The caregiver must be satisfied with the level of surveillance that they have of the patient.
3. **The Company** (WiCare) - supplies the service and ability for caregivers to keep track of their patients discreetly and accurately.
4. **The Healthcare Industry** - will be learning from WiCare as an example for future of public health care services and making sure that WiCare complies with all safety and ethics regulations.
5. **The Government** - will use and possibly further fund the development of WiCare's services to be used in federally funded palliative or patient care.

4 - Variables and Diagrams

4.1 - Wearable

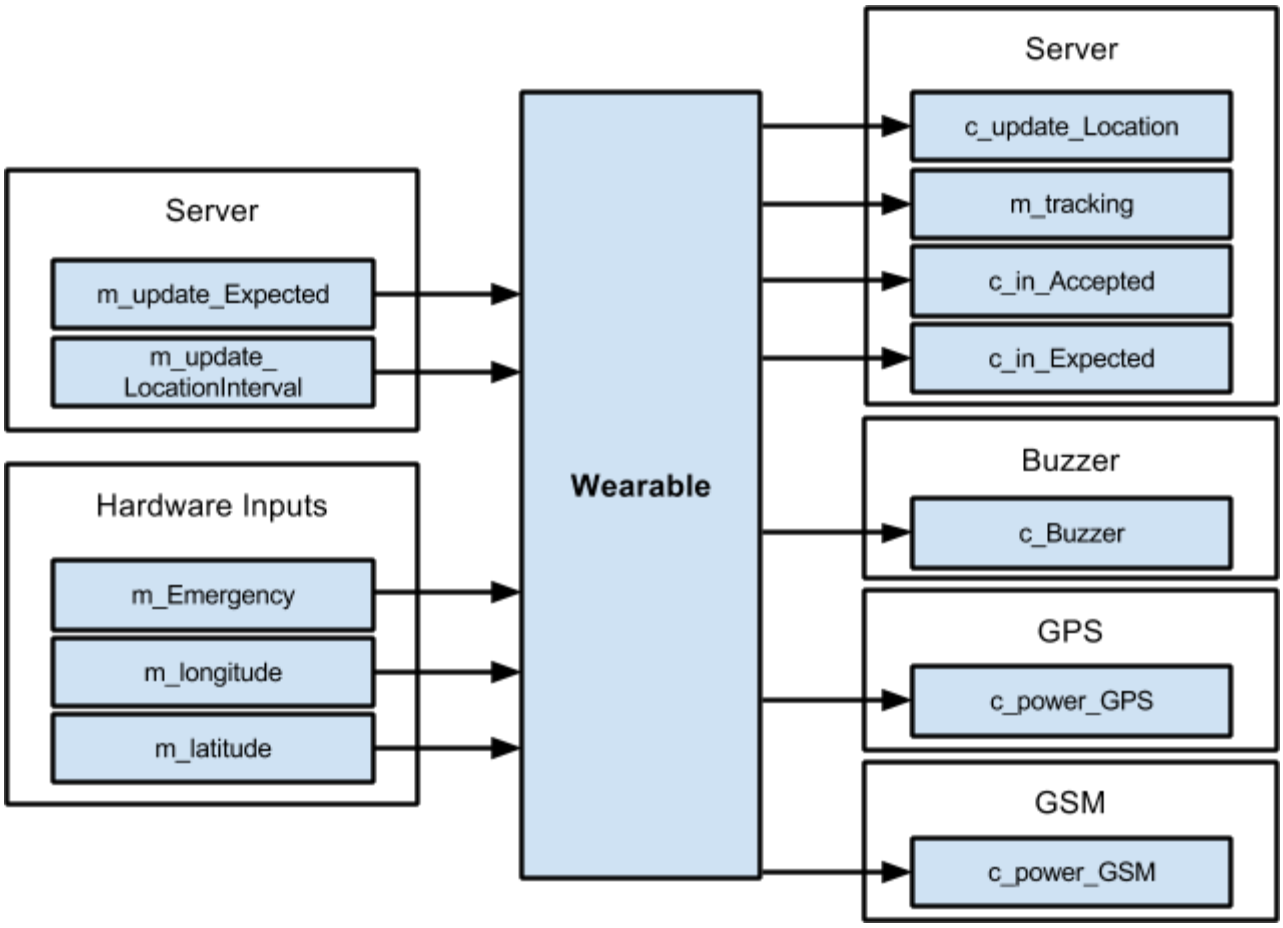

Figure 2 - Wearable Module

Variable	Type	Description	Range	Units
m_latitude	Monitor	Wearable latitude	-90, 90	Degrees
m_longitude	Monitor	Wearable longitude	-180, 180	Degrees
c_in_Expected	Control	Wearable within the expected zone	Binary	-
c_in_Accepted	Control	Wearable within the accepted zone	Binary	-
m_Emergency	Monitor	Emergency button on wearable	Binary	-
m_update_Expected	Monitor	Update wearable expected zone (4 point bounded): Usnnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn[2]	Custom[3]	Degrees
m_update_Location Interval	Monitor	Update the interval at which the wearable checks for location updates: R,x	x = [0, 1440]	Minutes
c_update_Location	Control	Update the wearable's location: Lsnnn.nnnn,snnn.nnnn	Custom[3]	Degrees
m_tracking	Monitor	Enable or disable the tracking of the wearable by the Caregiver. Update position at given interval: E,x	x = [0, 1440]	Minutes
c_update_Data Interval	Control	Update the interval at which the wearable checks for data updates from the Caregiver	0, 10080	Minutes
c_power_GPS	Control	Wearable power signal for GPS module	Binary	-
c_power_GSM	Control	Wearable power signal for GSM module	Binary	-
c_Buzzer	Control	Wearable power signal for audio feedback	Binary	-

Table 2 - Wearable Variable Description

[2] Please see appendix for description of Custom Range

4.2 - Server

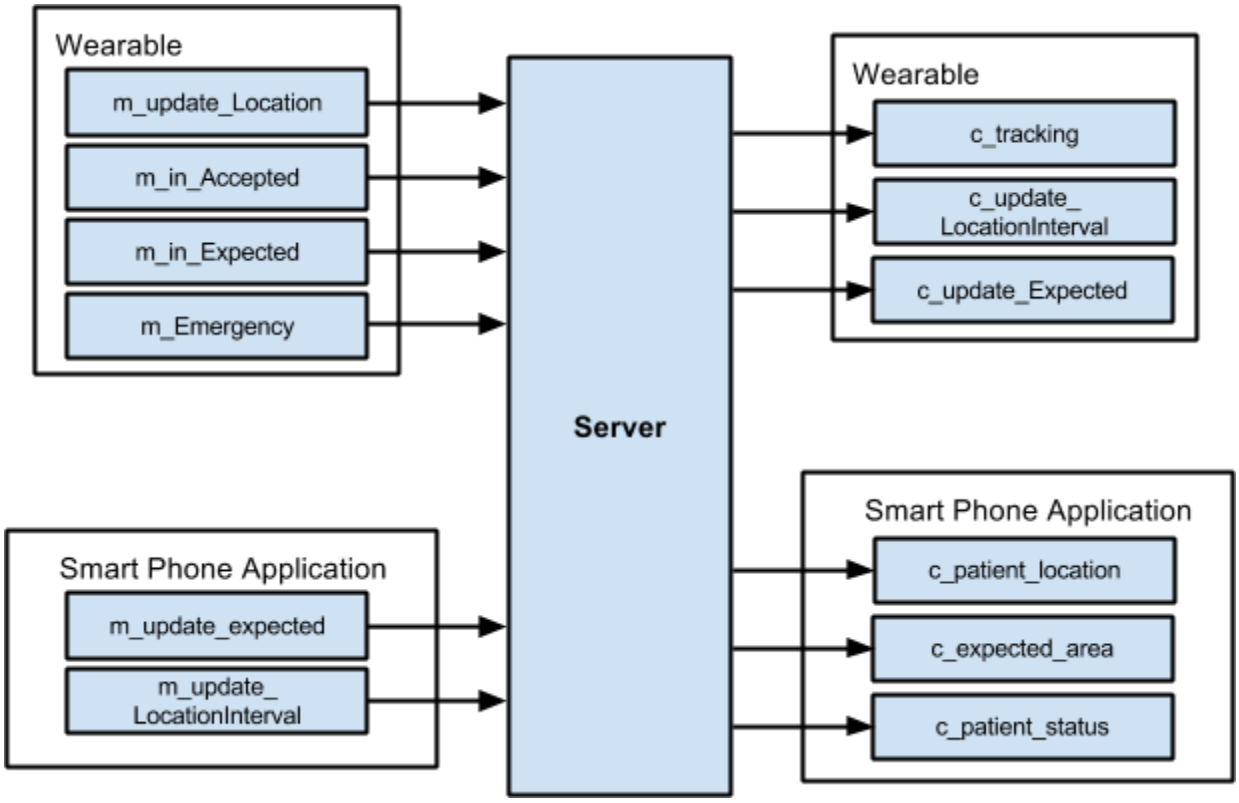

Figure 3 - Server Module

Variable	Type	Description	Range	Units
m_Emergency	Monitor	Emergency button on wearable	Binary	-
m_in_Expected	Monitor	Wearable within the expected zone	Binary	-
m_in_Accepted	Monitor	Wearable within the accepted zone	Binary	-
c_update_Expected	Control	Update wearable expected zone (4 point bounded box): Usnnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn[3]	Custom[3]	Degrees
c_update_Location Interval	Control	Update the interval at which the wearable checks for location updates: R,x	x = [0, 1440]	Minutes
m_update_Location	Monitor	Update the wearable's location: Lsnnn.nnnn,snnn.nnnn	Custom[3]	Degrees
c_tracking	Control	Enable or disable the tracking of the wearable by the Caregiver. Update position at given interval: E,x	x = [0, 1440]	Minutes
c_patient_location	Control	Get location of patient when tracking is enabled on smart phone application. Delivered as tuple of points (latitude, longitude).	Custom[3]	Degrees
c_expected_area	Control	The last known expected area submitted by caretaker to server. Delivered as list of 4 tuples of points (latitude, longitude).	Custom[3]	Degrees
c_patient_status	Control	The current status of the patient regarding whether or not tracking should take place.	Binary	-

Table 3 - Server Variable Description

[3] Please see appendix for description of Custom Range

4.3 - Application

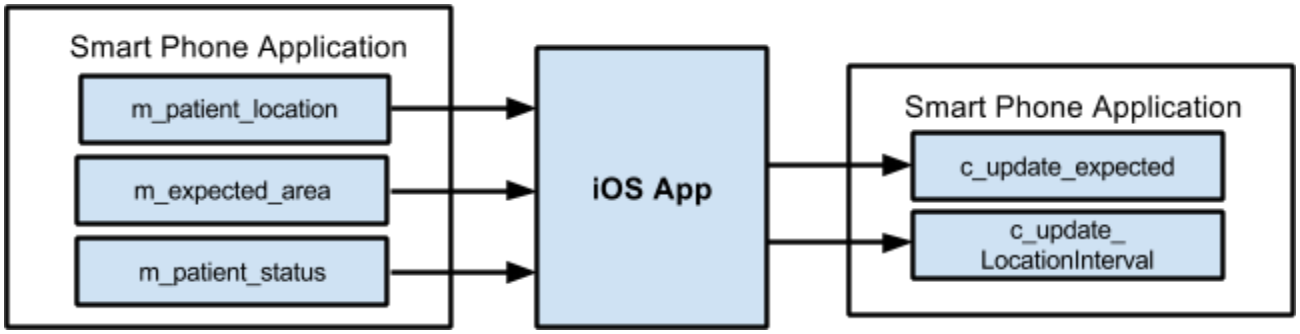

Figure 4 - Application Module

Variable	Type	Description	Range	Units
m_patient_location	Monitor	Get location of patient when tracking is enabled on smart phone application. Delivered as tuple of points (latitude, longitude).	Custom[3]	Degrees
m_expected_area	Monitor	The last known expected area submitted by caretaker to server. Delivered as list of 4 tuples of points (latitude, longitude).	Custom[3]	Degrees
m_patient_status	Monitor	The current status of the patient regarding whether or not tracking should take place.	Binary	-
c_update_Location Interval	Control	Update the interval at which the wearable checks for location updates: R,x	x = [0, 1440]	Minutes
c_update_Expected	Control	Update wearable expected zone on server (4 point bounded): Usnnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn,snnn.nnnn[4]	Custom[3]	Degrees

Table 4 - Application Variable Description

[4] Please see appendix for description of Custom Range

5 - Performance Requirements

1. The wearable must be able to report its location within 5 meters.
2. The wearable must robust and tamper-proof.
3. The wearable's battery life must last for a minimum of 3 months.
4. The device must be able to recover from loss of connection to communication layer.

5.1 - Normal Operation

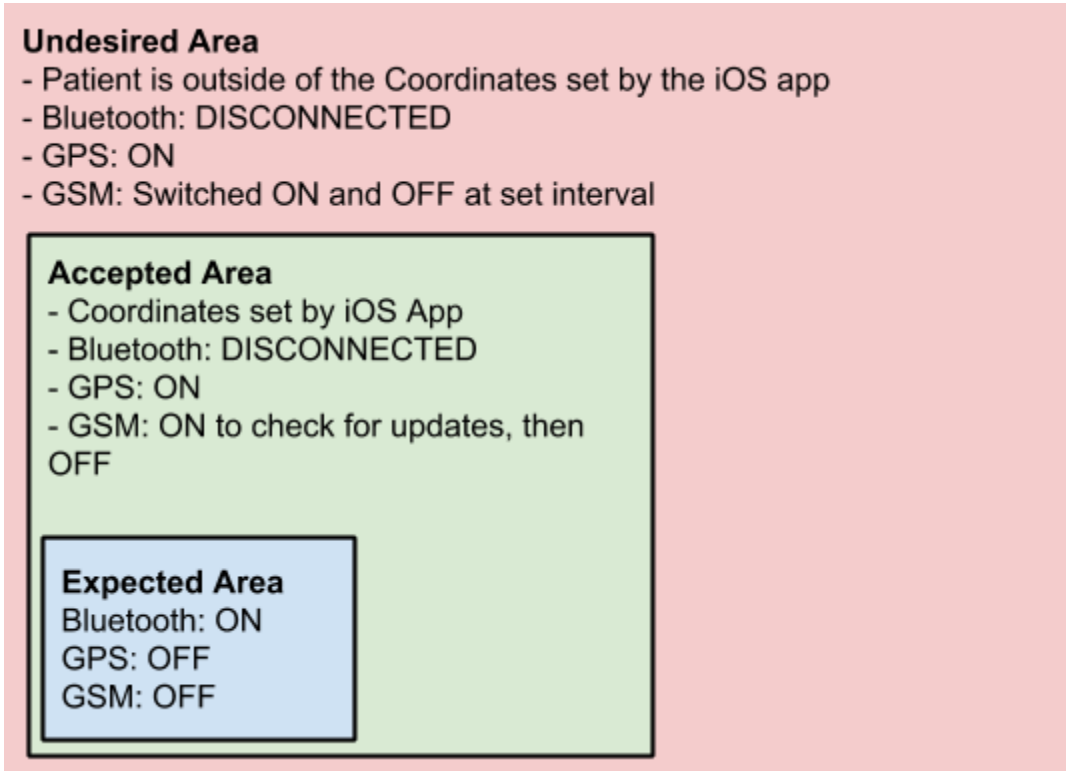

Figure 5 - Undesired, Accepted and Expected Areas

- Patient is within Expected zone:
    - the wearable monitors its whereabouts within the expected zone in proximity to a central bluetooth beacon.

- Patient is within Accepted zone:
    - the wearable will monitor its whereabouts at large intervals using GPS.
    - notifies the caregiver that the Patient is outside the expected area.
    - notifies the caregiver if the patient moves between the accepted and undesired zone.

- Patient is within undesired zone:
    - the wearable will notify the caregiver that the patient has left the accepted zone and report GPS location at more frequent time intervals.
    - update intervals can be customized by the caregiver.

- Battery is low on device
    - when the wearable reaches a defined threshold, a notification will be sent to the caregiver to replenish the battery.

- Patient is with caregiver
    - the wearable will be deactivated if caregiver sends a power-down signal.
    - the wearable will be reactivated if the caregiver sends a power-on signal.

- Patient activates emergency button
    - the wearable will send a message including a GPS location of the patient to the caregiver, indicating that they are in need of assistance.

5.2 Undesired Event Handling

- Wearable is unable to determine current location
    - The application will report its last known location to the caregiver, indicating its inability to specify its whereabouts.

- Wearable malfunctions, non-responsive
    - The server will request periodic tests of the wearable's functionality. Upon failure, a message will be sent to the caregiver recommending action.

6 - Nonfunctional Requirements

6.1 - Wearable

1) *Must be comfortable* - The design of the wearable must be non-intrusive and non-restrictive to the patient's movement.

2) *Must be stylish* - Through clever design the device should not be distinguishable as a tracking unit.

3) *Must be encrypted* - The data that is being sent must be encrypted and secure such that only the caregiver and allowed parties can know where their patient is, this is to ensure privacy as well as safety concerns for high profile patients.

4) *Must have quick response times* - If the patient falls or their heart rate increases past a certain threshold, the wearable must send a signal to the server as soon as possible.

6.2 - Server

1) *Timely response* - when the wearable sends a signal to the server, the server should respond as soon as possible (10ms max).

2) *Must have sufficient patient storage memory and history* - If a caregiver would like to see the history of their patient at any given time, it should be accessible to them, if not, the caregiver should be notified of a certain window of time that is accessible to them.

6.3 - App

1) *Easy to use* - interface must be simple enough so that the caregiver is not confused when they first start using that app. They must be able to set up a safe-zone on the initial boot up and be simple to use from there on in.

2) *Must remember designated safe zone as well as edit safezone* - once the safe-zone is set up, this should not be forgotten or need to be re-entered all the time.

3) *Must be compatible with all iOS versions* - the app must work with whatever device the caregiver has, and it must work all of the time.

7 - Appendix

7.1 - Hardware State Diagrams

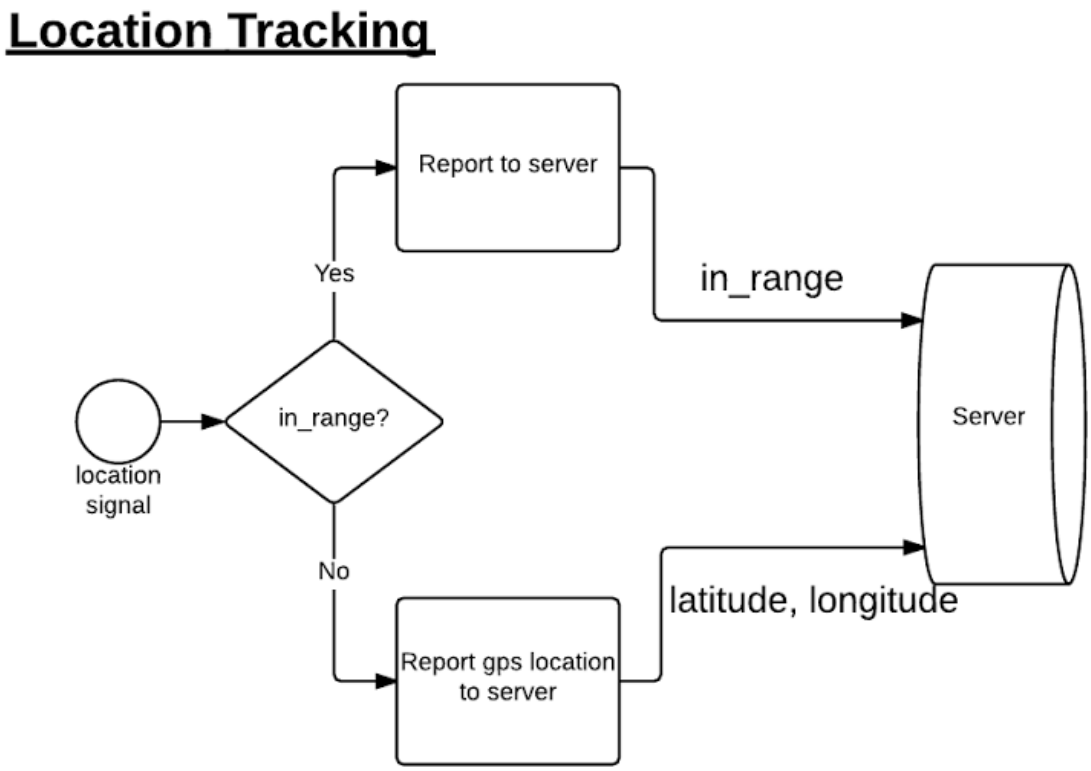

Figure 5 - Hardware State Diagram of Location Tracking

7.2 Server State Diagram

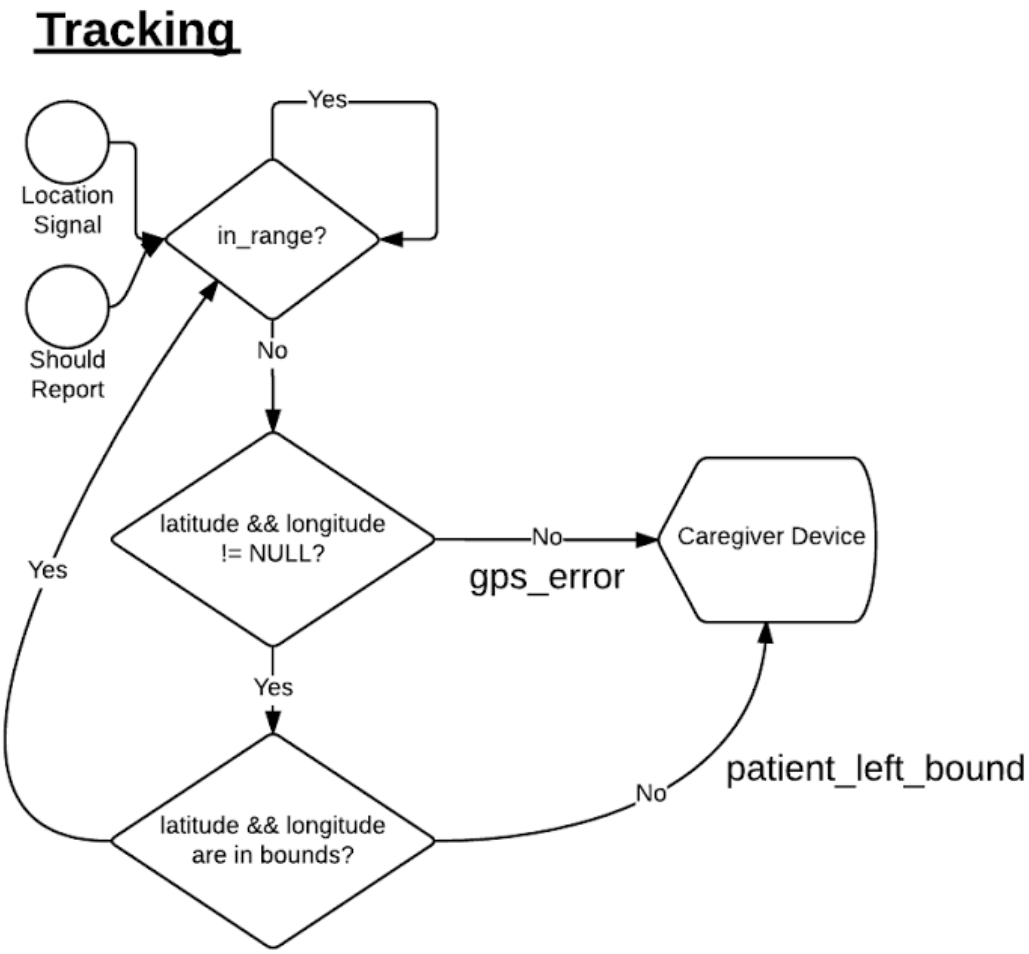

Figure 6 - Location Tracking State Diagram with regards to the Server

7.3 Application State Diagram

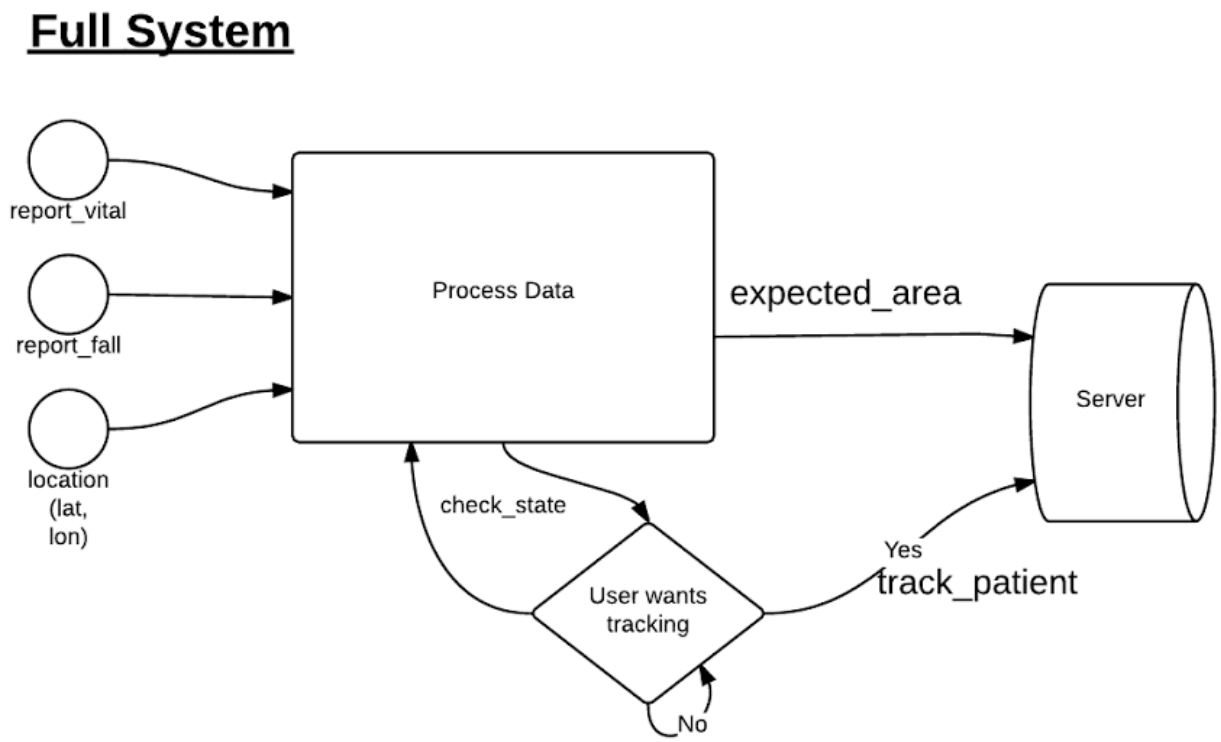

Figure 7 - Mobile Application Full System State Diagram

8 - Appendix

For our project communication of GPS coordinates accurately is very important. We have established a very strict set of rules regarding communicating coordinates between the modules in our project. More specifically the communication between:

1. GSM and Server module
2. GSM module and microcontroller
3. microcontroller and GPS module

The use and format of GPS coordinates is explained in great detail in a document assembled by the NAAS[1]. This document is summarized in sufficient detail (for our purposes) in a post on stackoverflow[2].

Using the standards above, coupled with the specific output produced by our hardware - all GPS coordinates will appear in the format "*x,y*" $x \in [-90,90]$ $y \in [-180,180]$. Where *x* and *y* are of the format *Snnn.nnnn. S* specifies the sign, *n* specifies a single digit. All *n* must appear in the coordinate, explicitly we require zero padding. An example coordinate follows for reference.
EXAMPLE:
-089.7650,+130.0001

9 - Citations

Alzheimer Society of Toronto: Alzheimer's Disease & Dementia. (n.d.). Retrieved March 3, 2015, from http://alz.to/

stackoverflow: maximum length of latitude and longitude Retrieved March 4, 2015 from http://stackoverflow.com/questions/15965166/what-is-the-maximum-length-of-latitude-and-longitude

NAACS explanation of GPS coordinate formatting: Retrieved March 4, from http://www.naacs.org/documents/GPSCoordinates.pdf