SIS THEORY OF OPERATION AND INSTALLATION GUIDE

Bob Glicksman, Jim Schrempp

Date: 11/17/2015

NOTICE: Use of this document is subject to the terms of use described in the document "Terms_of_Use_License_and_Disclaimer" that is included in this release package. This document can also be found at:

https://github.com/SISProject/SISDocs/blob/master/Terms_of_Use_License_and_Disclaimer.pdf

Contents

1. INTRODUCTION.

This document provides an overview of the Standalone Intelligent Sensor System (SIS). A thorough understanding of the information presented herein is necessary in order to properly install and use the SIS. This document also contains information about how to install an SIS system in a home.

SIS provides a low cost solution that allows family members and caregivers to monitor the daily living activities of an elderly or impaired person living alone at home. **SIS is not a health or emergency monitoring system**. There are plenty of systems already on the market to perform these types of functions. Rather, SIS is intended to help family members and caregivers monitor how a person living alone at home is performing the routine activities of daily living. Further information about the concept and purpose of SIS can be found in:

https://github.com/SISProject/SISOverview/blob/master/SIS_Concept_Nov_2015.pdf

2. SIS OVERVIEW.

2.1. SIS Architecture.

SIS uses inexpensive *passive*, *wireless* sensors to monitor a person's activities when at home. The design of SIS is based upon the principle that routine activities of daily living are performed in different rooms or areas of the home. For example:

- Bedroom: sleeping and dressing.
- Bathroom: personal hygiene.
- Kitchen: food preparation.
- Dining Room: food consumption.
- Living/Family Room: recreation and socialization.

The following figure shows the architecture of SIS.

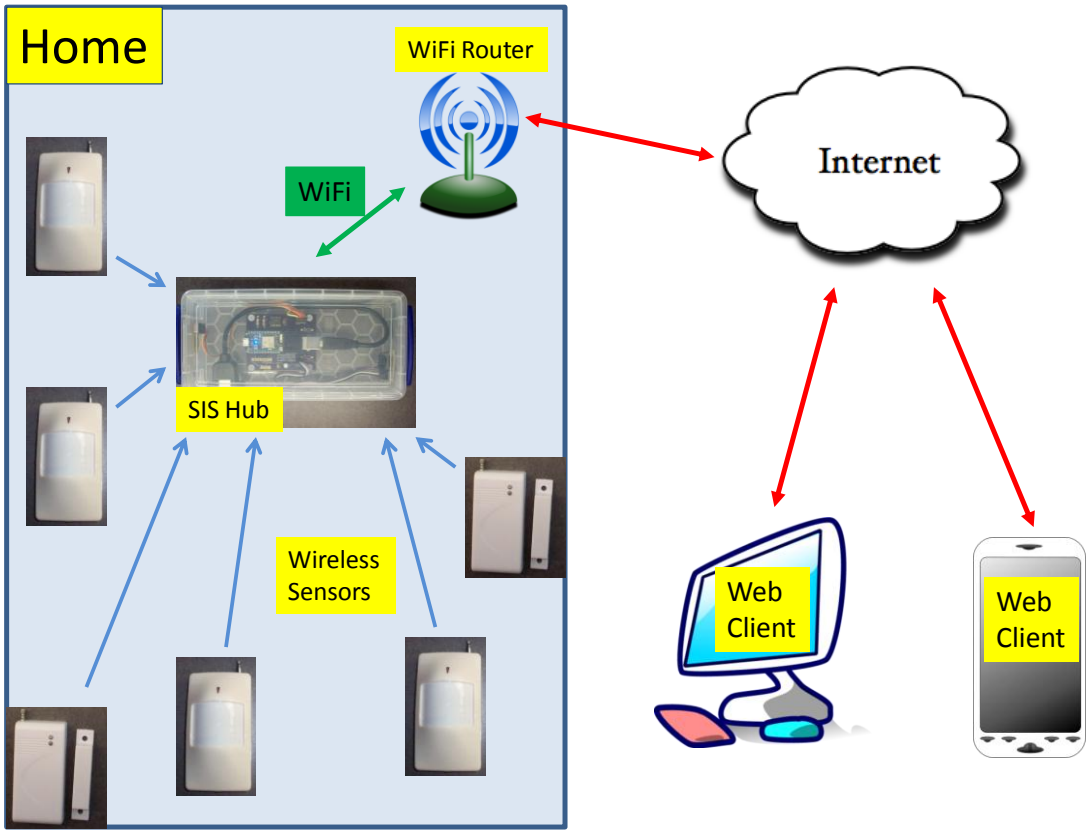

Figure 1. SIS Architecture.

Referring to figure 1: each home to be monitored requires one SIS Hub. The SIS Hub receives signals from various low cost wireless sensors placed around the home. The SIS Hub processes and interprets signals from the wireless sensors in order to create a time stamped log of meaningful *events* and *inferences* about the person's activities. Family members and caregivers can monitor a person's activities by reading out the log remotely, securely over the Internet, via a web-based client. The client is implemented as a web page using Javascript so that it can be run on any device that supports a web browser. Privacy is protected via encrypted communication over the Internet as well as the requirement to log in to a free "cloud" account in order to gain access to the SIS Hub log data.

SIS is designed to operate with no recurring costs. However, a WiFi connection to the Internet is necessary. If a WiFi connection to the Internet does not already exist in the home of the person being monitored, then it must be provided and paid for by the resident or family.

2.2.SIS Hub.

One SIS Hub is required for the home of the person being monitored. The SIS Hub must be assembled from purchased parts. Assembly requires basic through hole soldering skills. Instructions for assembling the SIS Hub can be found at:

https://github.com/SISProject/SISDocs/blob/master/SIS_Hub_PCB_Assembly_Instructions.pdf

The SIS Hub electronics may optionally be mounted in a rugged plastic box. Only simple hand tools are required for this construction. Instructions for this can be found at:

https://github.com/SISProject/SISDocs/blob/master/SIS_Hub_Packaging_Assembly_Instructions.pdf

Before the SIS Hub can be used, a free "cloud" account must be created at *particle.io* and this account must be used to upload operating software ("SIS Firmware") to the Hub over the Internet. Complete instructions for establishing this account, connecting the Hub to the Internet and capturing it into this account, and uploading the firmware into the Hub can be found at:

https://github.com/SISProject/SISDocs/blob/master/SIS_Firmware_Installation.pdf

The "cloud" account at *particple.io* will thereafter be used to access the SIS Hub from anywhere, over the Internet, via a web based client. The web based client source code can be obtained from:

https://github.com/SISProject/SISSoftware/website

An instance of this website is available for you to use at:

http://www.shrimpware.com/SIS/SIS_Client

Please note that all access to the SIS data is from the web browser to the *particle.io* cloud. The site hosting the web pages (e.g. shrimpware.com) does not participate in this communication.

Instructions for using the SIS Client to configure an SIS installation are contained in section 5 of this document.

2.3.SIS Sensors.

SIS utilizes low cost, battery operated, low power, wireless sensors operating in either the 315 MHz or 433.92 MHz RF bands. These bands are internationally recognized for low power, unlicensed use. The SIS Hub contains two receivers, one for each band, so that sensors can be mixed and matched between these two bands within one SIS installation.

In addition to the RF frequencies, wireless sensors compatible with SIS must operate using On/OFF keying (also called "OOK", "ASK", or "AM" modulation) and use protocols compatible

with PT2262 or EV1527 chip sets. A list of known compatible sensors is included in this section, but many more can be found on sites like EBay and Amazon.com.

Each sensor you purchase comes with a pre-set 32 bit "trip code". When the sensor is tripped this code is broadcast for a few seconds. While this trip code is not guaranteed to be unique to each sensor, as a practical matter the code *can* be used to identify a specific sensor from all other sensors.

PIR sensors: Proximity infrared (PIR) motion sensors are the most common types of sensors used within SIS. A typical sensor of this type is: *315 MHz PIR sensor for "My 99 Zone" alarm system*. This sensor can be purchased from E-Bay, typically for less than $10:

http://www.ebay.com/itm/221068187723

Figure 2 shows the sensor and what comes in the box:

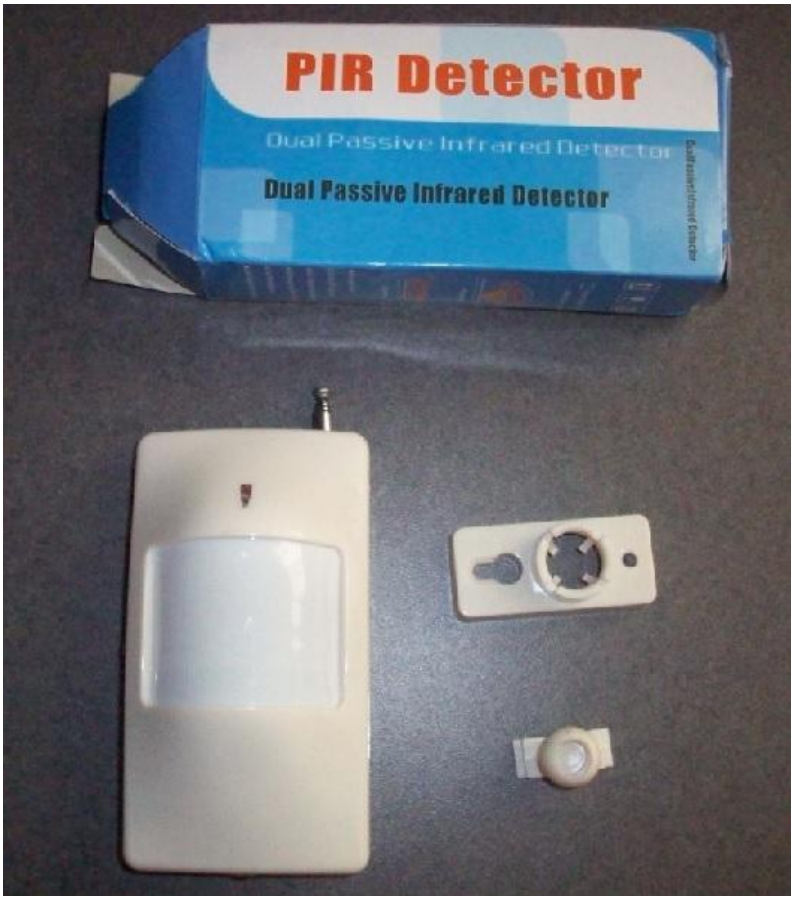

Figure 2. Typical PIR Sensor.

PIR motion sensors are used inside of each room or area of the house where a person would normally perform some activity of daily living, such as sleeping, bathing, or eating. SIS is

preconfigured to support up to 12 PIR sensors for activity sensing and up to 4 additional "misc" sensors (any type) per installation.

Door Sensors: Magnetic separation sensors are primarily used within SIS to detect opening of exterior doors through which a person will enter or exit the house. They may also be used on windows, cabinets or drawers to provide extra information about what the resident is doing. A typical sensor of this type is: *315 MHz magnetic door/window sensor for "My 99 Zone" alarm system*. Purchased from E-Bay:

http://www.ebay.com/itm/370629635675

Figure 3 shows the sensor and what comes in the box:

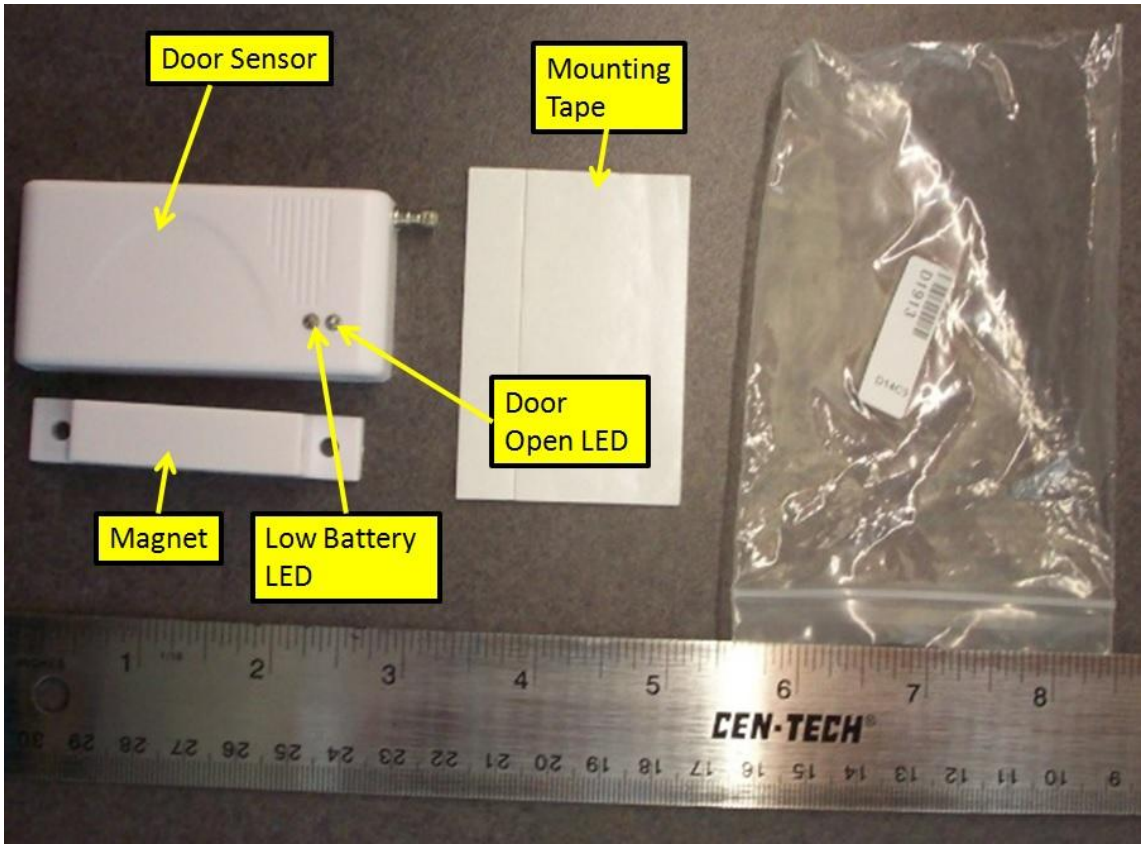

Figure 3. Typical Magnetic Separation Sensor.

SIS is preconfigured to accept up to 4 exterior door sensors and up to 4 additional "misc" sensors (any type) per installation.

Misc. and Alarm/Alert Sensors. PIR motion sensors and Exterior Door sensors have special meaning within SIS. This is discussed further in "SIS Theory of Operation", below. In addition to these special meaning sensors, SIS supports up to 3 "misc" sensors of any type whose sensor trips are simply logged but not further interpreted by the SIS software. SIS also supports up to

one additional "alarm/alert" sensor which is a general purpose sensor of any type. The Alarm/Alert sensor is handled as an additional "misc" sensor but also publishes each sensor trip to the "cloud" so that it can be used e.g. to send an SMS text message to a registered user phone when it is tripped. Note that the Alarm/Alert sensor is NOT intended as an emergency notification – the notification service is not sufficiently reliable for this purpose.

Misc and Alarm/Alert sensors may be of any type that is compatible with SIS. This includes PIR and magnetic separation sensors described above. Other types of sensors that might be useful include:

Water level sensor: This sensor has a float that can detect if the water level reaches a certain point (e.g. in a toilet tank, indicating a flush). An example is: *433 MHz "Wireless Leak Detector" sensor for "my own GSM/PSTN alarm" system*. Purchased from E-Bay:

http://www.ebay.com/itm/111049996563

Vibration sensor: This sensor can detect vibration due to a window breaking or perhaps sitting down in a chair. An example is:

http://www.ebay.com/itm/Wireless-Vibration-Break-Breakage-Glass-Sensor-Detector-433MHz-For-Alarm-System-/371225342804?

Keyfob Button: Various 1, 2 and 4 button keyfobs are available that are compatible with SIS. These sensors generate a compatible signal when a button on the keyfob is pressed, making them good candidates for Alarm/Alert types of sensors. Typical of these keyfobs are:

One button: http://www.adafruit.com/product/1392

Two button: http://www.adafruit.com/product/1391

Four button: http://www.adafruit.com/products/1095

Note that when purchasing one of the keyfobs, you do not need to purchase the corresponding receiver module. The SIS Hub is the receiver.

3. SIS THEORY OF OPERATION.

The SIS Hub software ("firmware") receives and decodes signals from the 315 and 433.92 MHz receivers. The Hub software decodes, validates and processes sensor trip information according to how the sensor is registered within SIS. This process is described below. The Hub software works with the SIS Client app to register sensors for use within SIS, to store and maintain sensor registration and other configuration information, and to maintain a log of *sensor trips*, *events*, and *inferences*.

All entries in the SIS log are time stamped and sequenced to provide a meaningful readout by the SIS Client app. The SIS on-device log contains (up to) the most recent 100 entries since the SIS Hub was last reset. The SIS log contains the basic information upon which a family member or caregiver can evaluate the person living alone for how and when they are performing their routine activities of daily living. To this end, the log contains filtered and processed information that helps to make the log readable and understandable.

The SIS on-device log is stored in volatile memory. This means that if the SIS Hub is reset or if the power fails, the internal log information will be lost. The log should therefore be read out at least daily. If the log is reset, the sequence numbers of log entries are reset back starting from zero, and the time that power last was restored is displayed on the SIS Client app. Log entries are also published to the cloud as they are stored in the Hub and provision may be made, via an external cloud service (such as IFTTT.com), to record these entries in a more robust location, e.g. a Google spreadsheet in the cloud. See the User Manual for details:

https://github.com/SISProject/SISDocs/blob/master/SIS_User_Manual.pdf

Note, however, that this cloud recording process is, itself, neither robust nor timely. Entries into a Google Docs spreadsheet may be significantly delayed or even skipped, given the uncontrollable nature of WiFi and Internet communication. Still, a cloud based log, such as a Google Docs spreadsheet is a good compromise between robustness to power failures and ease of implementation.

In order to understand how the SIS Hub software operates on wireless sensor data, it is important to define four terms: *registration*, *sensor trips*, *events*, and *inferences*.

Registration: All sensors that are installed in a home and are to be used within SIS must be *registered*. The SIS Client app provides an easy way to register sensors and associate these sensors with locations or functions within the home. The registration process also defines how a registered sensor trip is processed and interpreted within the SIS software. *Unregistered sensors are ignored by SIS*. This prevents SIS from responding to other sensors that may be close by (e.g. possessed by a neighbor) or just noise in the environment. Registration information is stored in non-volatile memory (EEPROM) on the SIS Hub. The Hub will remember sensor registration information even if the power is removed and subsequently re-applied.

Sensor trips: As mentioned above, the SIS has two radio receivers (315 and 433.92 MHz) that are constantly listening to the environment. The SIS software (firmware in the SIS Hub) responds to signals provided by these receivers. The software tries to decode and validate the signals according to PT2262 and EV1527 protocols. If a valid trip code is received, SIS then "filters" the code so that it cannot be received again for 5 seconds. This is necessary because the sensors generate their "trip code" over and over (perhaps 50 or 60 times) for several seconds in response to the sensor being tripped. Finally, SIS compares a valid and filtered trip code with its list of registered sensor trip codes to see if the code came from a registered sensor. *Only if all of*

these conditions are met is the received sensor code determined to be a "sensor trip" for the SIS to log.

SIS processing of *sensor trips* depends upon how the sensor was *registered* within SIS:

Motion Sensor in a Room: If the *sensor trip* code came from one of the (up to) 12 registered room motion sensors, the sensor trip is not logged by itself, but is recorded and marked for further processing as a possible *event* and to draw possible *inferences* from.

Exterior Door Sensor: If the *sensor trip* code came from one of the (up to) 4 registered exterior door sensors, the sensor trip is not logged by itself, but is logged as an *event* and recorded and marked for further processing to draw possible *inferences* from.

Misc Sensor: If the *sensor trip* code came from one of the (up to) 3 registered "misc." sensors, the *sensor trip* is immediately time stamped and logged. No further processing is applied to "misc" *sensor trips*.

Alarm/Alert Sensor: If the *sensor trip* code came from the one possible registered Alarm/Alert sensor, the *sensor trip* is immediately time stamped and logged. Furthermore, notification of the sensor trip is published to the *particle.io* cloud, from where it may be processed by an external service (e.g. IFTTT.com) to provide a user with an alert notification, such as an SMS text message to a mobile phone. See the User Manual for details:

https://github.com/SISProject/SISDocs/blob/master/SIS_User_Manual.pdf

No further processing is applied to Alarm/Alert *sensor trips*.

Events: *Events* are *sensor trips* that have been further processed by the SIS Hub software before they are logged. The reason for processing these *sensor trips* further is to make the log entries more meaningful and relevant to understanding what a person living alone is doing, and when they are doing it. Sensors that are *registered* as interior motion sensors and sensors that are *registered* as external door sensors are subject to this further processing as follows:

Motion Sensor in a Room: Only the first trip of a particular motion sensor in a room is logged as an *event*. Once a particular motion sensor has been logged, it is "locked out" and will not be logged again until an "unlock" event occurs. "Unlock" events occur when either an exterior door sensor or another room's motion sensor is tripped. This means that room motion sensor log entries record the time stamped movement of a person around the house (from room to room). This filtering greatly reduces the number of log entries associated with the motion sensors. The aim here is to record when a person moves from one room in the house to another room in the house, and thereby moves from performing one activity (e.g. personal hygiene) to another activity (e.g. eating).

Exterior Door Sensor: Each trip of an exterior door sensor is logged but this *event* is also recorded for further processing. When an exterior door trip is sensed, the lockout on the previous motion sensor is removed so that a subsequent trigger of that motion sensor will also be recorded. For example, assume that there is a back door (with an exterior door sensor) in the dining room, along with a room motion sensor in the dining room. When a person first enters the dining room from another room in the house, the PIR sensor trip will cause the *event* of entering the dining room to be logged and the dining room sensor will be locked out. As the person continues to move around in the dining room the sensor will continue to trip, but no further dining room events will be logged. If the person then opens the back door, this *event* will be logged and the dining room sensor will be unlocked. If the person then re-enters the back door, they will again trip the back door sensor (logged *event*) and will then trip the dining room PIR sensor (another logged *event*). The timed sequence of these logged *events* will tell the story of:

- When the person entered the dining room, and how long they stayed there until the back door was opened.
- When the back door was first opened (assumed exiting the house – room first and then door) and when the back door was again opened (how long the person was out of the house).
- When the person re-entered the house (because the door sensor tripped and then the PIR tripped afterward).

Inferences: *Inferences* are additional log entries that are drawn from a timed pattern of room motion sensor trips and/or exterior door sensor trips. SIS computes and logs four types of *inferences*:

- "Person is home". Initially (upon SIS Hub reset), SIS does not know if a person is at home or not. However, if an exterior door sensor trip occurs followed by a room motion sensor trip within 10 minutes, then it can be assumed that the person came into the house via the door and a "Person is home" *inference* is logged.

- "Person is away". Conversely, if an exterior door sensor trip happens and no interior motions sensors are tripped within 10 minutes, it is assumed that the person has left the house and a "Person is away" *inference* is logged.

- "No motion detected". If no room motion sensor or exterior door sensor is tripped when the person is assumed to be home for a period of one hour, a "No motion detected" *inference* is logged.

It should be noted that the motion sensors are made for burglar alarms and their sensitivity can vary greatly from unit to unit and also can vary greatly with small adjustments in placement. A person may fall asleep in the bedroom or in an easy chair in the living room and may or may not trip the room sensor while they are asleep. In addition to sensor

inadequacies, people vary greatly in how much they move while asleep, and motion varies with the stage of sleep as well. The "No motion detected" *inference* may be helpful in determining if a person is asleep or active within a room, but extreme care should be exercised in trying to read too much into this *inference*.

- "Multiple persons detected". **SIS log entries can only be used well if there is one and only one person in the home**. If another person comes to visit or to work in the house, then the log could fill up with extraneous data. SIS sensors do not provide any reliable way of knowing how many people are in the house at any given time. The SIS cannot accurately report on the activity of more than one person in the home.

  The SIS software attempts to detect if multiple persons are present by making this *inference* if any two room motion sensors are tripped within 2 seconds of each other. This will work only if the room motion sensors do not have overlapping fields of view, are placed only in rooms/areas of the house where meaningful activities take place, and are not placed in transit areas such as hallways and staircases. The "Multiple persons detected" *inference* is not only logged, but it also locks out all other room motion sensor events from logging. This lockout persists until one of the exterior door sensors is tripped. At this point, it is assumed that the additional person/people have left the house, and the lockout is removed. However, a subsequent trip of two room motion sensors within 2 seconds of each other will again apply the lockout (and again log the *inference*).

4. SIS INSTALLATION GUIDE.

4.1.Installation Planning Overview.

You should be thoroughly familiar with the SIS Theory of Operation (above) before you begin planning your deployment. Careful thought should be given to what information you want to see in the SIS log. Generally speaking, you want *events* in the log to correspond to the resident's daily living activities that you wish to keep tabs on. This requires a mapping of these activities to rooms or locations within the home. Sometimes, there are several rooms that an activity may take place in; e.g. recreation and socialization can take place in the living room, family room or even the dining room. We suggest making a list of the activities that you want to monitor and review the layout of the home to assess which rooms/locations these activities may take place in. Note that a change in the resident's mood might change their activities; e.g. they may read in the living room or bedroom when they are peaceful and happy but watch TV in the family room if they become sad or depressed. It is likely that detection of these sorts of mood changes is what has prompted you to install and SIS to begin with.

4.2. PIR Motion Sensor Installation.

A motion sensor should be placed in each room or location where a person will spend time doing something. You will want to place a motion sensor in each room or location that represents an

activity that you want to monitor. However, if the resident moves to a room or location that has no sensor in it, SIS will not record this in the log, and the log will falsely indicate that the person is still in the room where the last sensor trip happened. Therefore, a PIR motion sensor should probably be installed in any room or location where the resident is likely to linger, regardless of whether the activity associated with that room is of interest. This is because the room that the resident left before entering this new location may represent an important activity (e.g. sleeping) and you may want to assess how long they were performing this activity of interest.

Do not place motion sensors in any room, location or area of the house that is used strictly for transit. These locations include stairways, hallways, corridors, and walk-thru closets (unless the resident dresses in the closet and this activity is of interest). Note that SIS is NOT an emergency system and is NOT intended to sense to respond to falls or other such emergencies.

When placing motion sensors in a room or other location, it is very important to ensure the following:

- The field of view of the sensor covers the room or location sufficiently so that the resident is certain to trigger it if they enter and linger in the room. The PIR motion sensors that we have evaluated have little LEDs that light up when the sensor is tripped, so it is easy to assess sensor coverage in a room.

- The field of view of the sensor must not spill outside of the room or location and into a transit area. If it does, the sensor may trip (and an *event* logged) on a transit. Even more importantly, such transit sensor trips may trigger the "multiple persons" *inference* and lock out further logging of *events*. When placing PIR sensors in a room, it is best to mount them in a corner, up high, on the wall where the entry door is, or on an intersecting wall, so that the PIR field of view can be aimed inside the room and not spill outside the doorway.

- Some homes contain open "great rooms" where one open space may serve several functions (e.g. dining and recreation). In such instances, it may not be possible to aim multiple PIRs with non-overlapping fields of view inside the great room to distinguish between these multiple possible activities. In this instance, a single PIR sensor should be used to cover the great room, and perhaps a "misc" sensor positioned to give further information (e.g. a vibration sensor on an easy chair used for TV viewing in the great room). This way, the log can reflect that e.g. the resident has entered the great room but has not sat in the TV viewing easy chair (so perhaps is in the dining part of the great room).

4.3.Exterior Door Separation Sensor Installation and Planning.

Generally speaking, there should be one separation sensor placed on each exterior door of the home. SIS cannot monitor activities outside of the home, so it is important to know when a person has left the home and when they have re-entered the home.

A possible exception to this rule is an exterior door that leads to an enclosed patio or yard with no exit from the property from that patio or yard. In this case, opening the exterior patio door may not imply that the person has left the house; only that they are out in the patio. You should carefully consider what you want logged when deciding on whether to place a separation sensor on such a door, and if you do place a separation sensor on a patio door, whether to *register* it as an "exterior door sensor" or as a "misc." sensor. Please review the SIS Theory of Operation to understand the differences between these types of registrations in SIS' processing of sensor data.

4.4.Other Sensor Installation and Planning.

You can pretty much place sensors that are registered as "misc." or "Alarm/Alert" anywhere and of any type that you want. Placement of these sensors is not critical because SIS only logs *sensor trips* for these and does not process them for *events* or *inferences*. The intent of "misc." sensors is to add some information to the log that may be of interest but is not provided by PIR motion sensors and exterior door separation sensors. An example of this might be a vibration sensor on an easy chair or a water level sensor inside a toilet tank (to log flushes of the toilet).

4.5.Wireless Range Considerations and Mitigation.

SIS sensors operate wirelessly, at low power, and thus have limited range. Sensor trip transmissions can be received several hundred feet away in open air, but the range is much more limited inside a house. It is very difficult to predict the range of a sensor in a general home environment, as the range is affected by walls, interior wiring and plumbing within walls, cabinets and closets and what is in them, etc. Generally speaking, our testing has shown that SIS sensors can communicate with the Hub over distances of 50 – 100 feet, both horizontally and vertically. This adequately covers most homes, both single and multiple story.

Since SIS sensors communicate wirelessly with the SIS Hub, the latter will work best if it is located in some central location within the home. The Hub should be located somewhere where there is AC power but is otherwise not obstructed by walls, closets, plumbing or wiring, etc. Note, however, that the SIS Hub must also communicate wirelessly (via WiFi) with the home's Internet router or WiFi access point.

SIS has been designed for low cost. As such, the sensors are very inexpensive. The SIS sensors only transmit codes; they have no receiver capability. They operate on simple protocols that do not support mesh networking or repeaters. It is therefore essential that the sensors can communicate directly with the Hub. If making this happen requires that the Hub be located outside of range of the home's WiFi router or access point, then consideration should be given to

either moving the latter or extending the WiFi range via access points or other commercially available WiFi range extenders.

The WiFi module on the *particle.io* Photon used in the SIS hub has provision for adding a u.FL antenna to it. We have not tested this capability to see if the WiFi range can be meaningfully extended with such an external antenna. Additional details can be found at:

https://docs.particle.io/datasheets/photon-datasheet/

Most SIS-compatible sensors have a telescoping antenna. Our testing has shown that extending the antenna may improve the transmission range of the sensor, but the added range is usually marginal. The 315 MHz and 433.92 MHz receivers in the SIS Hub have provision to solder in a ¼ wave antenna wire, and sometimes come with such an antenna wire installed and coiled up. Our testing has shown that the addition of a coiled wire antenna does not extend the range very much. We have not tested a straight up ¼ wave antenna wire for range extension.

The SIS Hub builder should be aware that we have found receivers for sale that look very similar to the ones in our parts list, but we found these receivers have a more limited range. The sensors we recommend have a small metal can on them.

4.6. Wireless Sensor Battery Life Considerations.

The SIS sensors are wireless and battery operated. This makes them very easy to install. The sensor is simply taped or screwed into a wall or door jam.

The sensors that we have purchased and tested usually come with batteries installed. You may need to remove a paper insulator between the battery and its electrical contact that the manufacturer has placed there to keep the battery fresh. Sometimes the sensors we have received had old or leaking batteries in them. Batteries for the sensors listed in this document are:

- PIR motions sensor: ordinary 9 volt "transistor" battery.
- Door, water level and vibration sensors: 23A battery (12 volts).
- Keyfob: 2 ea 2016 lithium coin cell batteries.

Sensor battery life is primarily determined by how many times the sensor is tripped. Each time the sensor is tripped, it transmits a signal for several seconds and these transmissions are, by far, the largest drain on the batteries. As the batteries are drained, the wireless range of the sensors may be degraded. It is therefore important to test the sensors periodically and to replace the batteries when they are getting weak. Our testing has shown that PIR motion sensor batteries may need to be replaced every 6 months or so and other sensor batteries can last at least one year. Keyfob battery life will, of course, be highly dependent upon how often the keyfob button is pushed.

None of the sensors that we have tested with SIS have any provision to transmit a battery low indication. Therefore, SIS has no way to know (no way to report) when a sensor battery may need replacement. Some of the sensors have a battery low LED on them, but our testing has shown these indications to be unreliable. It is best simply to replace the batteries often to ensure that the sensors always have the maximum sensitivity and range.

Obviously, battery replacement should be considered when placing sensors in the home. The sensors should be as accessible as possible, given the other placement considerations noted above.

5. CONFIGURING YOUR SIS USING THE SIS CLIENT APP.

This SIS Client app is used to register your sensors once they have been installed and tested by tripping them and observing the sensor's trip LED. This section provides an overview of the registration process. Detailed information about using the SIS Client app can be found in the User Manual:

https://github.com/SISProject/SISDocs/blob/master/SIS_User_Manual.pdf

Figure 4, below, is a snapshot of the SIS Client app screen after the user has logged in and selected their hub device from the dropdown list. Note that the SIS Client screen presentation varies with the size and orientation of the user's screen or browser window; therefore, your screen may look a little bit different than figure 4.

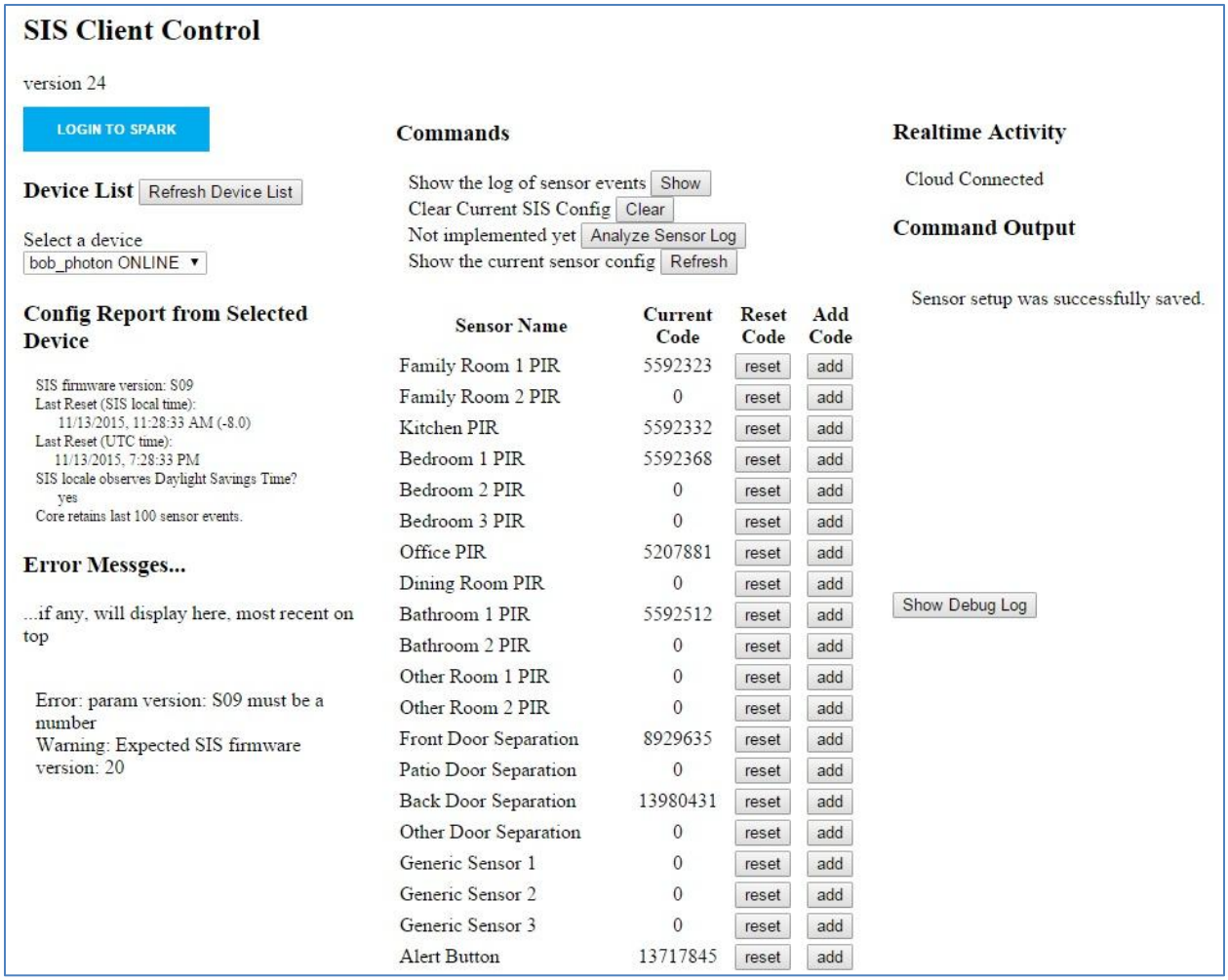

Figure 4. SIS Client App Screen.

Referring to figure 4: there are four buttons shown under "Commands" in the center of the screen:

- "Show the log of sensor events" **Show**: selecting **Show** reads out the log from the SIS Hub and displays the log entries under "Command Output" on the right side of the screen.

- "Clear Current SIS Config" **Clear**: selecting **Clear** clears out all sensor registration information from the SUS Hub. This means that all possible sensors are unregistered. You should only use **Clear** when moving the SIS Hub to a different house with a completely different set of sensors to register.

- "Show the current sensor config" **Refresh**: selecting **Refresh** will display the trip codes for all currently registered sensors by the room that they are registered, in the sensor registration table below the **Commands**.

Below **Commands** is a table that displays the current sensor registration for the SIS Hub. The Current Code column contains the currently registered trip code for each sensor by location. A code of "0" means that there is no sensor registered for that location. In order to register a new sensor for that location, the current code should be "0". If it is not "0", click the **reset** button for that location first. A "?" means that the Client has not yet retrieved the sensor configuration for that sensor. A "--" means that the Client is currently working to update the sensor registered for that location.

To register a sensor for a location, first click the **add** button for that location. You will get a pop up dialog box indicating that you need to trip the sensor for the new location. After tripping the sensor, click the button "New Sensor Was Tripped". At this point, the pop up dialog box will disappear and the sensor trip code for the sensor just tripped will be shown in the sensor registration table (after a second or so Internet delay).

Any particular sensor trip code can only be registered for one location. If you try to add a sensor that is already configured for another location you will get an error message when you click the "New Sensor Was Tripped" button. There are typically two causes of this error. You, or someone else, might have tripped a different sensor that is already configured in the SIS. In this case, just try to add your new sensor again. The second cause is that you are moving a sensor from one location to another. In this case you must first reset the previous sensor location so that the SIS will unregister the sensor trip code. Then you can add the sensor to the new location

In order to register all sensors in the house, go to each location with your WiFi laptop, tablet or smartphone running the SIS Client app and repeat this process until all sensors are registered. If you wish to test the sensor registration, move from location to location and trip each sensor (as verified by the sensor's trip LED). At any time, you can select the "Show the log of sensor events" **Show** button and observe the time stamped log under the **Command Output** column of the SIS Client app display. Thereafter, every new sensor trip will be processed by SIS according to the description in the "Theory of Operation" section, above.

Note: The SIS Client app stores the registration information into non-volatile storage (EEPROM) every time that you **reset** or **add** a new sensor. EEPROM has a limited life (about 100,000 write cycles), which is much more than sufficient for any intended use of SIS. Just be sure not to overuse this capability to avoid wearing out the EEPROM chip on the SIS Hub.

After registering sensors, you may wish to clear out the SIS Hub's log, as the log will contain extraneous information from the registration process. You can do this in one of two ways:

- Press the RESET button on the Photon module within the SIS Hub
- Unplug the SIS Hub from AC power, wait 10 seconds and plug it back in.

After resetting or repowering the SIS Hub, wait until it completes its setup cycle (the Photon begins to breathe cyan and the D7 LED then flashes 6 times). The log should be cleared out.

Note, however, that sensors will trip as you exit the premises. You might want to make note of the last sequence number in the log after you exit the premises. All subsequent log entries will then be due to activities of the resident of the house.
