**Independent System Components:**

Random Coordinate Generation: Due to known issues with the GPS module, we were approved to instead generate our own coordinates as a substitute. This component is comprised of 2 functions, one for generating latitudes and one for longitudes. Both functions return their randomly generated values when they are called. Coordinates are limited to a radius around a center point. Both the radius and the center point are configurable, and are accepted as arguments to the functions.

Anti Tamper Device: Purpose of this component is to issue an alert when the device is removed without authorization. In terms of hardware, it is composed of a lead stretching from a 3.3v power source to a GPIO set to input. This lead will span across the strap of the device and remain connected during normal operation. The software component is comprised of a single function which detects whether or not the lead is connected. If the GPIO value is high (there is voltage being inputted) then then it can be determined that the lead is connected. If the GPIO value is low (no voltage inputted), then it can be determined that the lead has been disconnected. The function will then return true if the lead is connected and false if it is not.

**Dependant System Components:**

Feedback: Feedback is mainly comprised of the LED indication system. The LEDs serve to provide information on the status of the device, including its position and whether or not it has been tampered with. Under normal operation, the Green Led Will blink. If the user is approaching the boundaries, the red led will blink. If the user has crossed the boundaries, both LEDs will flash. If the tamper detection has been triggered, both LEDs will flash indefinitely. This component accepts input from both the anti tamper component and the random coordinate generator (if the GPS module is working, then it would accept input from that instead). Hardware wise, this component is comprised of a Red and a Green LED, both connected to its own GPIO set to output. Software wise, it processes the inputs and determines the correct feedback to be issued. The LED feedbacks are controlled by 2 functions. The first flashes both LEDs, and the second blinks either one. Both use a series of commands to turn on and off the respective GPIOs, with varying delay between them.

Logging: The logging component serves the purpose of keeping track of where the device has been and its status. It accepts input from coordinate generation, LED feedback, and the anti tamper device. The log is created with one main function. This function accepts four arguments: name of the log file, current longitude, current latitude, and a comment. It will append a single entry to the log file every time it is called. The function first prepares information by calculating the current date and time using the ctime library and calculating distance (between the input coordinates and the centre of the boundaries). The function then appends the time, coordinates, distance, and comments to a new entry in the log file. The comment is used to record the status of the device at the time of logging. For example, if the device is out of bounds, the comment will read “WARNING, OUT OF BOUNDARY”.

Statistic Calculations: Statistics are created with a single function with accepts input from the logging component. The function accepts 2 arguments: the name of the log file, and the name of the statistics file being outputted. The function prepares to calculate information by first parsing the coordinates from the log file into a latitude array and longitude array respectively. This process can be seen in more detail within the state machine diagram. Once the information is parsed, the function then calculates the minimum, maximum, average, and median of both longitude and latitude. It also calculates the average distance from the center of the boundaries. These statistics are calculated by calling a selection of other functions dedicated to calculating each stat. Once calculated, the stats are then written to the statistics document. Note that statistics are calculated after every new entry in the log file, and that old statistics are written over. Therefore, there will always be one set of statistics which are calculated using the latest log file.

**Logging Infrastructure**

Logs entries were created through calling the logging function. Each entry included a time stamp (date and time), the current coordinates, the distance from the center of the boundary, and a comment. The comment indicates the current status of the device (whether its in bounds, out of bounds, disconnected). The timestamp is written on one line and the rest is written on the next line. Entries are separated by a single line. The entries are written to an external log file named “log.txt”.