Functional Specification

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Assignment Evaluation:

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| **Item** | **Score (0-5)** | **Weight** | **Points** | **Notes** |
| **Assignment-Specific Items** | | | | |
| **Functional Description** |  | x3 |  |  |
| **Theory of Operation** |  | x3 |  |  |
| **Expected Usage Case** |  | x3 |  |  |
| **Design Constraints** |  | x3 |  |  |
| **Writing-Specific Items** | | | | |
| **Spelling and Grammar** |  | x2 |  |  |
| **Formatting and Citations** |  | x1 |  |  |
| **Figures and Graphs** |  | x2 |  |  |
| **Technical Writing Style** |  | x3 |  |  |
| **Total Score** |  | | |  |

5: Excellent 4: Good 3: Acceptable 2: Poor 1: Very Poor 0: Not attempted

General Comments:

*Relevant overall comments about the paper will be included here*

1.0 Functional Description

Track-on-Track is a project that helps users to find their belongings. It gathers the location information through GPS or via cellular network and communicates with the user’s cell phone. When the device is in short range with the user, the user can use the phone app to communicate to the device through Bluetooth to activate a sound alarm on the device to help find it. The battery life, cell signal strength, and its operating mode are displayed on an LCD module alongside push buttons that allow the user to change settings locally.

2.0 Theory of Operation

Track-on-Track will utilize a 2G cell modem to determine and communicate its location with a user via SMS messages. The cell modem will use UART to interface with the microcontroller. To ensure a secure connection between the tracking device and user’s mobile phone, a time-based one-time password (TOTP) algorithm will be implemented to verify the user with the device. For tracking purposes that are within Bluetooth range of the user, the user will be able to use a smartphone application to activate a speaker to locate the device and also use the Bluetooth signal strength to gauge the relative distance to the tracker.

Device status information will be displayed on the device’s onboard LCD. This includes battery level, airplane mode status, Bluetooth status, etc. This will communicate with the microcontroller using the UART protocol. The push buttons on the device will be able to toggle these settings on and off. Through the smartphone application, these settings will also be able to be toggled on and off if the device is within Bluetooth range.

The device will include a rechargeable lithium ion battery that will be charge through a USB connection.

3.0 Expected Usage Case

The tracking device will be carried around in backpacks, luggage, or suitcases, and will have to be designed with travel in mind. The device must be convenient to put in a container, meaning

that it will need to both lightweight, and of a size and shape that fits well in most backpacks. The bag it is in may provide some protection from the elements, but the device will still need to be able to handle both hot and cold environments. In addition, the device will be subject to physical stress from the bag being moved, which could include jostling, jolts, strikes against hard surfaces, and being pressed between two objects.

The device is mobile, and will require a battery to operate, and therefore battery life will have to be taken into consideration. Only one person will be using each individual device. Not much can be directly inferred about the user base, but it is known that they are physically able enough to carry a bag or suitcase. In addition, they will require a smartphone, and thus it can be assumed that they are at least somewhat familiar with technology, and are also literate enough to read and write.

4.0 Design Constraints

The device should have a fairly simple, rectangular boxed design with cutouts for the LCD, speaker grill, and button housings. Branding and the device’s tracking capabilities should be kept inconspicuous to prevent theft tampering in the case that the device is being utilized to recover a stolen bag. The device should be made of a lightweight material and be small enough to easily fit into a backpack, purse, suitcase, or other piece of luggage.

4.1 Computational Constraints

The main computational constraint of out device is the authentication algorithm that the design will use to ensure that only the actual user will be able to request the location of the device. A Time Based One-Time Password Algorithm (TOTP) is currently being considered as the algorithm of choice because the values generated according to the timer will match up even if the connection between the device and the smartphone is spotty, as the values change according to a known time. This design will not require very much memory. The only memory that will be necessary will be save user setting, and to save the ID of the device, and for this either a microcontroller with built in memory or a microcontroller that can interface with memory will be required. Information about location will have to extracted from the data sent to the device from the cell modem, but this on its own is not expected to take much processing power.

4.2 Electronics Constraints

The major components Track-on-Track will utilize are a GSM module, a bluetooth module, an LCD display, pushbuttons, a speaker and a battery. The anticipated interfaces for these components are UART or SPI depending on the hardware chosen. Current pin count estimations include 7 pins for the cell modem, 4 pins for the LCD, 4 pins for the bluetooth module, 3 pins for lights, 1 pin for the speaker, 3 pins for buttons, putting the total estimated pin count at 22 pins. In addition, the project will require a SIM card reader that will enable the device to use the GSM network.

4.3 Thermal/Power Constraints

Our device’s target operating temperature range should be similar to that of a smartphone, which ranges from approximately 32°F to 100°F[[1]](https://support.apple.com/en-us/HT201678). With the use of a rechargeable, lithium-ion battery, we need to take precaution to ensure user safety by making sure the device doesn’t get too hot and doesn’t charge too quickly to compromise the battery. With this in mind, we aim to achieve a battery life up to one week by reducing power consumption as much as possible. The device should be able to complete a charge cycle overnight, so the target time to complete a full charge is eight hours or less.

4.4 Mechanical Constraints

Our main mechanical constraint comes from our device being portable. We want our device to be the size of a larger power bank or a larger phone with a case on it so that it can fit in most people’s backpacks, bags, and purses. Sitting in people’s bags they carry around also means we need to make sure the weight doesn’t cause a significant burden on the person carrying it.

4.5 Economic Constraints

Two competitive devices, TrakDot and the Geogram ONE, are priced at around $80 and $85 so we’d like to set a max price point of $100 with a hope that we can get the price down to be competitive with them. Another one of our competitors, the GeoLink OpenTracker, has a price of 99 Euros (around $120) but their device is more focused on being open to development so it has arduino compatibility and modularity. All the listed prices are for just the devices themselves, but because we and our competitors are using cell towers, the user is expected to pay for a sim card and cell service which could be up to an extra $9-20.

4.6 Other Constraints

The device will have to be able to be turned off for specified periods of time to comply with FAA recommendations that telephony be disabled during takeoff and landing. In addition, this will make it so that the device will conserve more battery during flights, which was a common complaint with other similar devices.

5.0 Sources Cited:

[1] Apple Support. (2018). Keeping iPhone, iPad, and iPod touch within acceptable operating temperatures. [online] Available at: <https://support.apple.com/en-us/HT201678> [Accessed 17 Jan. 2018].

[2] Trakdot Luggage Tracker, Flight Baggage Tracer, Anti-lost Palm-size Locator, Airline Trip Worldwide Travel Tracking Monitor Detector Finder, GSM Chip (Cell Towers), SMS Alert, iOS & Android Compatible: Electronics,” *Amazon.com: Trakdot Luggage Tracker, Flight Baggage Tracer, Anti-lost Palm-size Locator, Airline Trip Worldwide Travel Tracking Monitor Detector Finder, GSM Chip (Cell Towers), SMS Alert, iOS & Android Compatible: Electronics*. [Online]. Available: <https://www.amazon.com/dp/B015ZASEG6>. [Accessed: 17-Jan-2018].

[3] *dsscircuits.com*. Geogram ONE - Open Source Tracking Device [Online]. Available: <http://dsscircuits.com/sale/product/dssc0120>. [Accessed: 17-Jan-2018].

[4] *GEOLINK - Online GPS/GLONASS monitoring, fleet management, assets tracking - 100% white label service*. [Online]. Available: <https://geolink.io/opentracker.php>. [Accessed: 17-Jan-2018].

**Appendix I: Functional Block Diagram**

