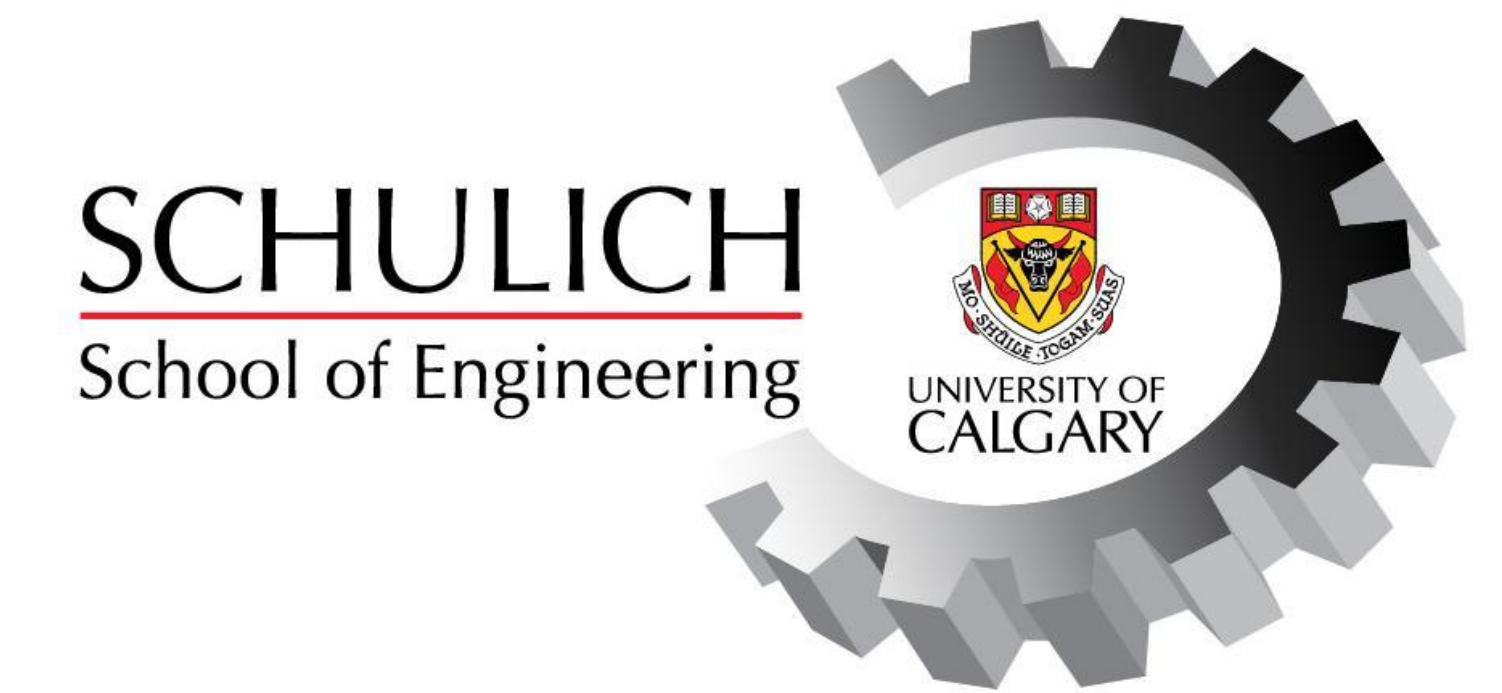


# Sensory Monitor System

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## The Problem

It is currently estimated that anywhere from 5-16% of the general population suffers with sensory processing challenges [1]. Sensory processing challenges can be triggered by excessive or extreme lack of input to the senses. Caretakers of these sensitive individuals may include teachers with a classroom full of students, busy parents keeping the household functioning, or support workers providing respite care. Recipients of care and caretakers alike often struggle with recognizing potential triggers of sensory overload in the environment of the recipient. This makes it difficult to anticipate or prevent sensory overload from occurring.

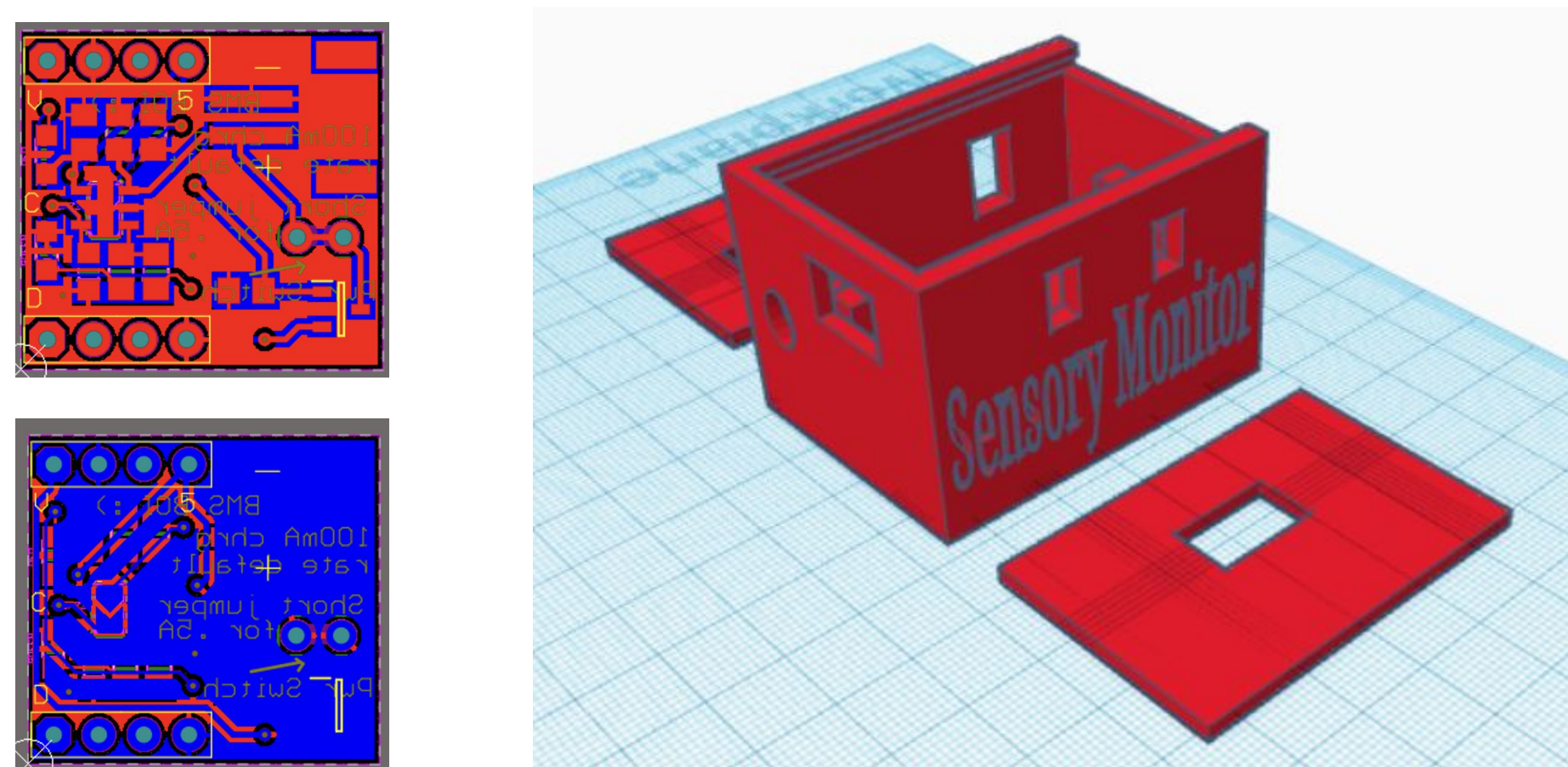
## The Solution

The sensory monitor device collects and processes data from recipient's current environment and sends the data over BLE to a Connect IQ app on a Garmin watch worn by a caretaker. The watch displays the recipient's current environmental data and notifies the caretaker of warnings. These warnings include sound exceeding a high threshold, temperature exceeding a high or low threshold, and losing connection for any reason. During this process the watch will also record the data in a custom Garmin activity. Caretakers can adjust and disable the notification thresholds to modify the system for the recipient's unique sensitivities. Caretakers can also view historical data using Garmin Connect.

### Hardware

#### Components

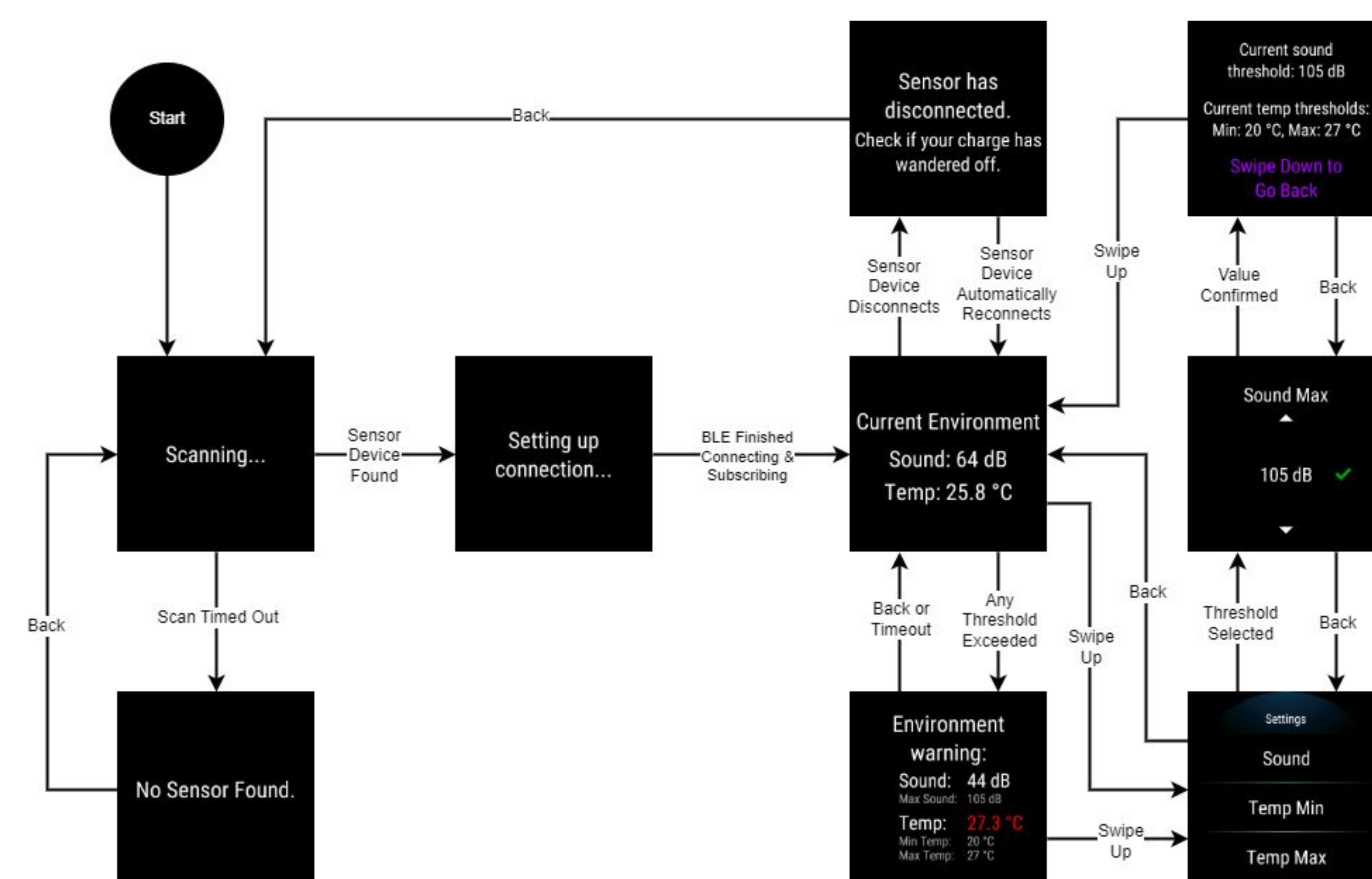
- Garmin Venu 2 Smartwatch for the caretaker
- Sensory Monitor Device for the recipient
  - Arduino Nano BLE 33 Sense Rev2
  - Lithium ion battery capable of powering the device for 56 hours while actively streaming BLE data
  - Custom BMS PCB with load switching MOSFET for simultaneous battery charging while powering or reprogramming the device
  - Custom 3D printed enclosure to secure all components together, designed for optimal functionality and space usage



### Software

#### Components

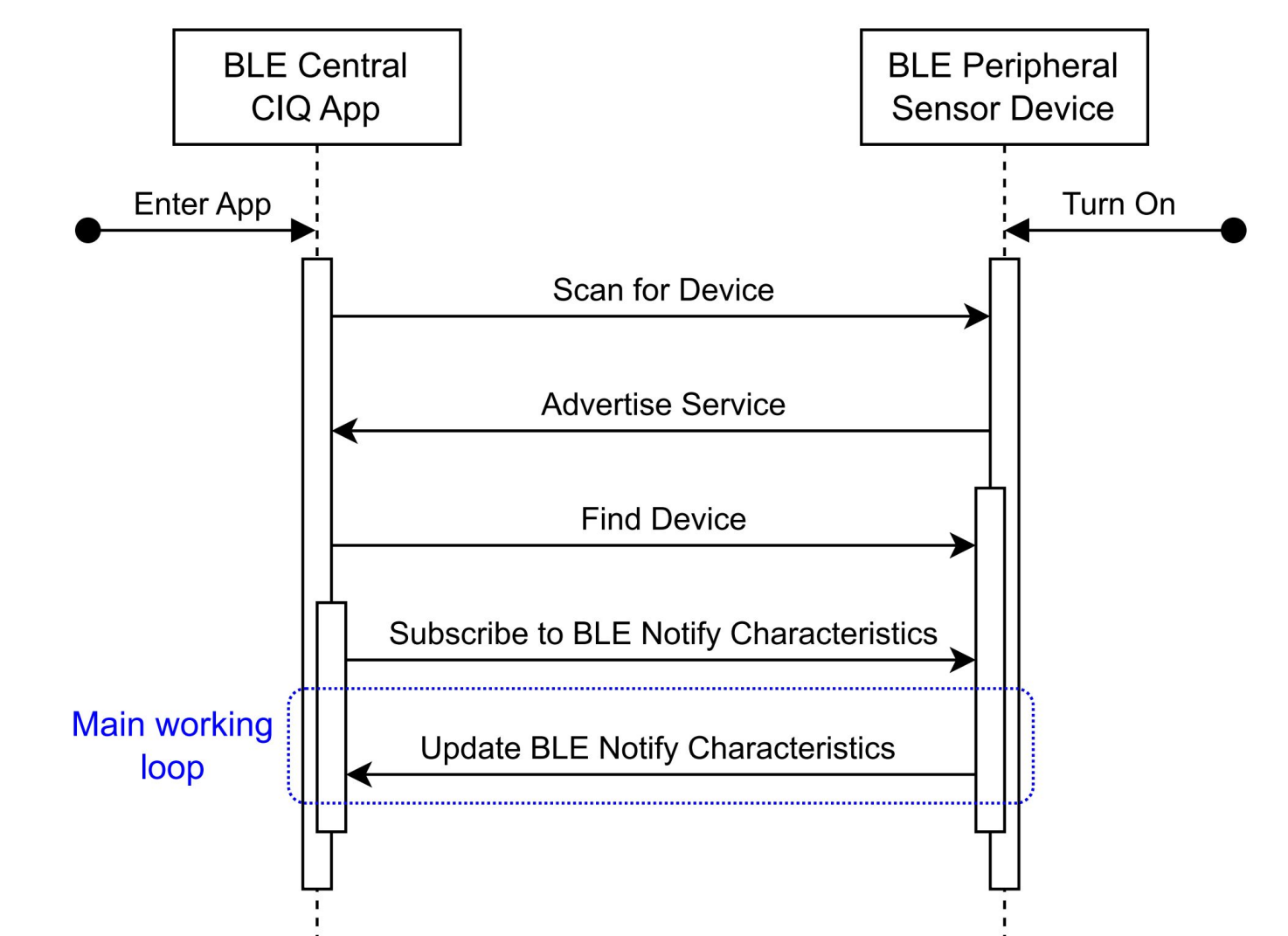
- Garmin CIQ Application
  - Connect to device BLE service and subscribe to notify characteristics
  - Display recipient's current environment data
  - Record recipient's environment data over time in a custom Garmin activity
  - Produce visual and vibration notifications when appropriate
  - Allow modification of notification thresholds
- Embedded Software
  - Advertise BLE service with notify characteristics
  - Collect and update temperature data
  - Collect, process, and update sound data
  - Sample sound data from microphone at a frequency of 16kHz
  - Send data to watch at a rate of 2Hz



### Communication

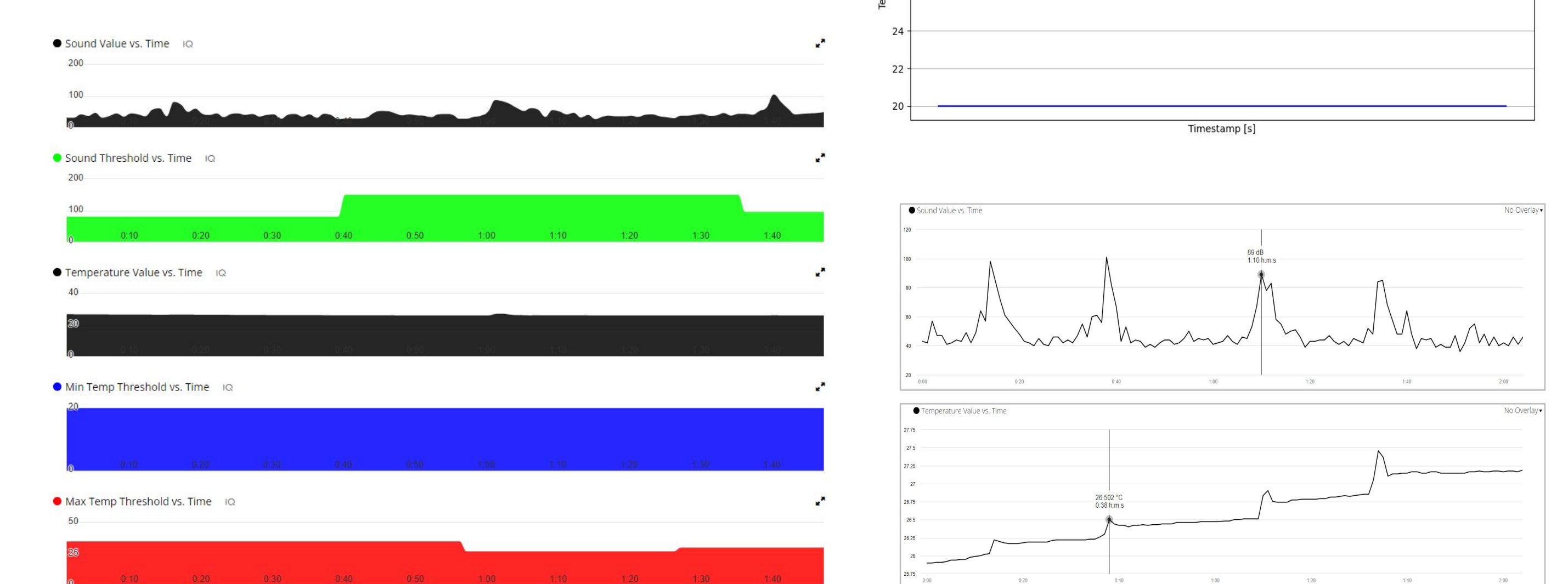
#### Bluetooth Low Energy

- Custom BLE profile:
  - Temperature Characteristic
  - Sound Characteristic
- Watch acting as central and device acting as peripheral in our system
- Notify type characteristics chosen to allow watch subscription to characteristic updates without enforcing acknowledgement



#### Garmin Connect

- Beta application uploaded to Connect IQ store
- Custom activity starts when BLE setup is complete and stops when app is exited
- Activity available to view the next time the watch is synced



### Glossary

- BLE - Bluetooth Low Energy
- BMS - Battery Management System
- PCB - Printed Circuit board
- CIQ - Garmin Connect IQ
- Recipient - Individual with sensory overload challenges receiving care
- Caretaker - Individual providing care to the recipient

### References

[1] National Library of Medicine, "Identification of Sensory Processing and Integration Symptom Clusters: A Preliminary Study", <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5733937>, [March 15, 2023]