

# Cardiac Arrest Detector

ECE 508 Internet of Things  
(Group 5)

Kyle Hanks [khanks@gmu.edu](mailto:khanks@gmu.edu)

Kyle Loyd Guthrie [kguthrie@gmu.edu](mailto:kguthrie@gmu.edu)

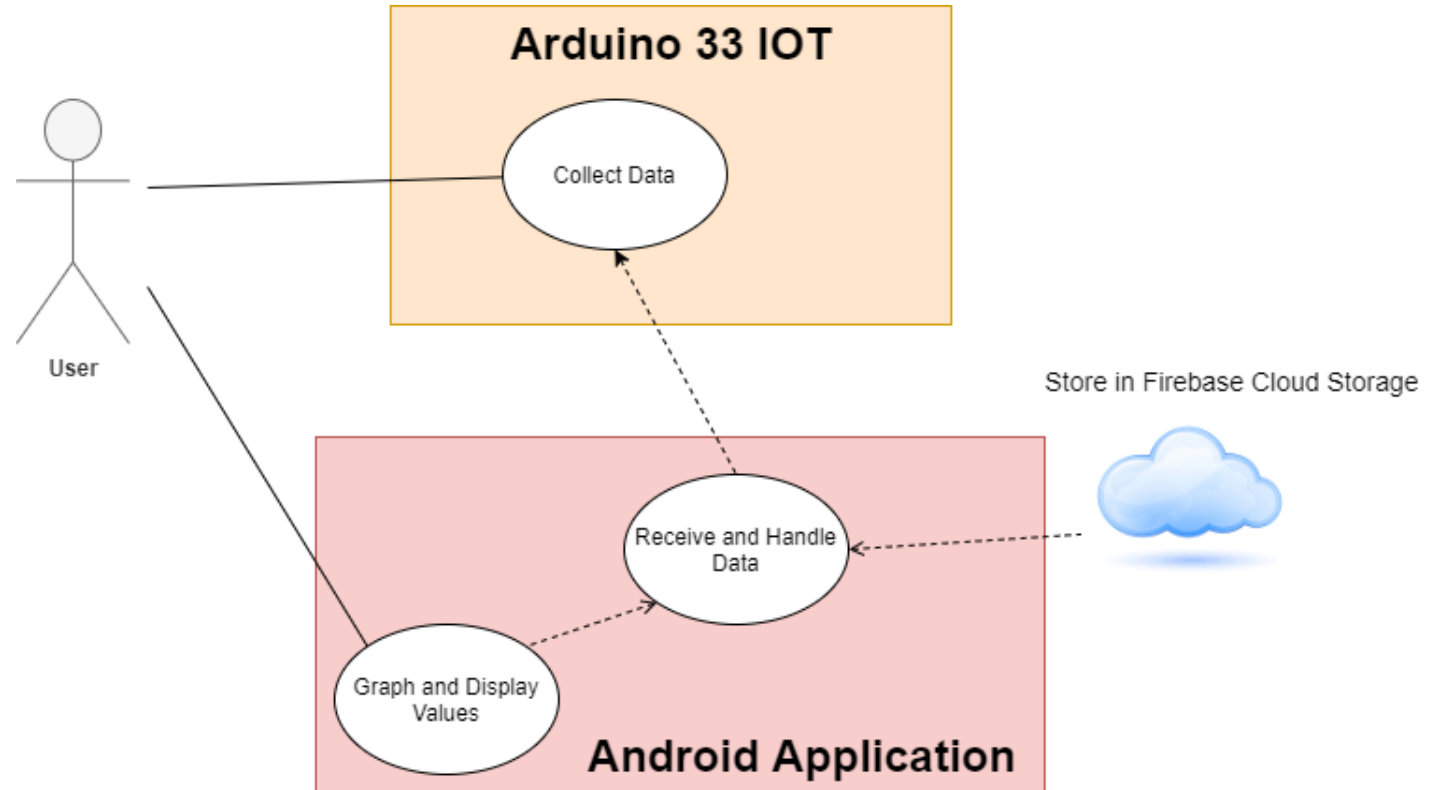
Shamili Mownika Tetali [stetali@gmu.edu](mailto:stetali@gmu.edu)

Sunanda Roy [sroy9@gmu.edu](mailto:sroy9@gmu.edu)

# Project Description


- Our goal was to design an IOT device capable of predicting chances of cardiac arrest in a person
- The Arduino will accept data from a heart rate monitor and a body temperature sensor. It will then send this data over BLE to an Android application that will plot the data and store it in the cloud via Google Firebase, an app development/cloud storage platform.

# Use Case



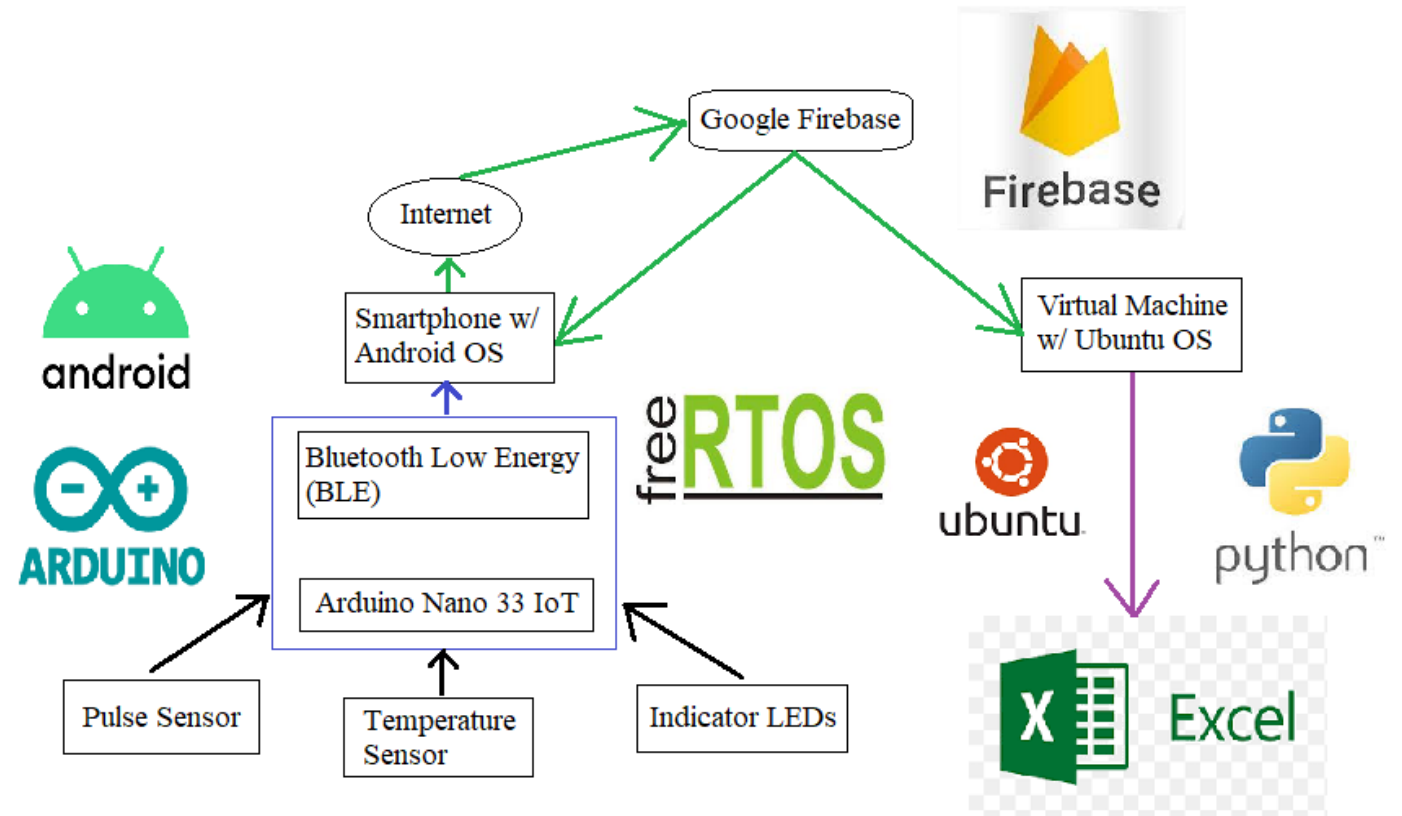


Implementation



Technical Solution and  
IoT System  
Implementation

# Data Flow Diagram



# Technical Solution *Sense*

- The edge IoT device used two sensors: the Tragoods pulse sensor/heart rate monitor and the FTCLock TMP36 temperature sensor.



# Technical Solution *Compute*

- The data from the sensors is read in continuously using a multi-threaded RTOS architecture.
- The data is then converted to proper format to be sent over BLE.
- Sensor readings are converted and rounded off to the nearest integer value before being transmitted as BLE characteristics
- BLE characteristics are only transmitted when there is a change from previous reading

# Technical Solution *Transmit*

- The sensor readings are transmitted as Arduino BLE objects of type *BLEIntCharacteristic* to the Android app.
- The app captures the exported BLE characteristic readings and converts them to Android objects of type *BluetoothGattCharacteristic* for processing



# Technical Solution *Store*

- The Cloud Firestore database provided by Firebase receives real-time data from the Android.
- Due to the asynchronous nature of the Android API (which reads the incoming sensor data over multiple threads), the data are stored to Cloud Firestore storage asynchronously as well.

# Technical Solution *Retrieve*

- The Android app is also capable of retrieving data back from cloud storage once a user-specified number of sensor readings has been captured

# Results

- The Arduino is currently capable of reading the values from both sensors and sending the data to the Android app over BLE
- The Android app can read stored values from the cloud after a round of data collection has been completed.
- In future, this retrieved data can be plotted into a graph on the app's user interface itself for subsequent analysis
- Future work would include further research of IoT sensors to improve accuracy of the data collected.

# RTOS task usage

```
*****
Free Heap: 9280 bytes
Min Heap: 9280 bytes
*****
Task          ABS          %Util
*****
Task Monitor   156          <1%
IDLE           9896176      64%
Task Temperatur 31124        <1%
Task Pulse     5409532      35%
Tmr Svc        22          <1%

*****
Task          State   Prio   Stack   Num    Core
*****
Task Monitor   X       1     136     3
IDLE           R       0     126     4
Task Pulse     B       3     194     1
Task Temperatur B       2     188     2
Tmr Svc        B       2     118     5

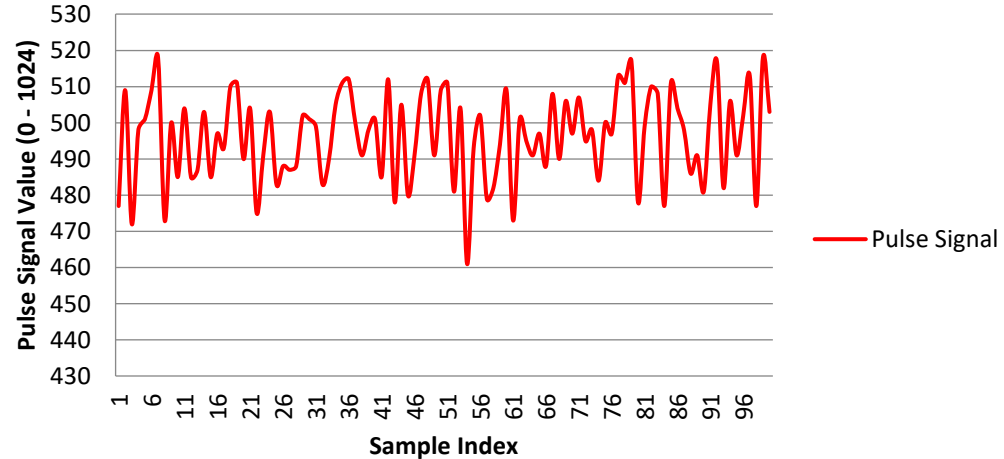
*****
[Stacks Free Bytes Remaining]
Thread Pulse: 194
Thread Temperature: 188
Monitor Stack: 136
*****
```

## Data flow of a sample reading

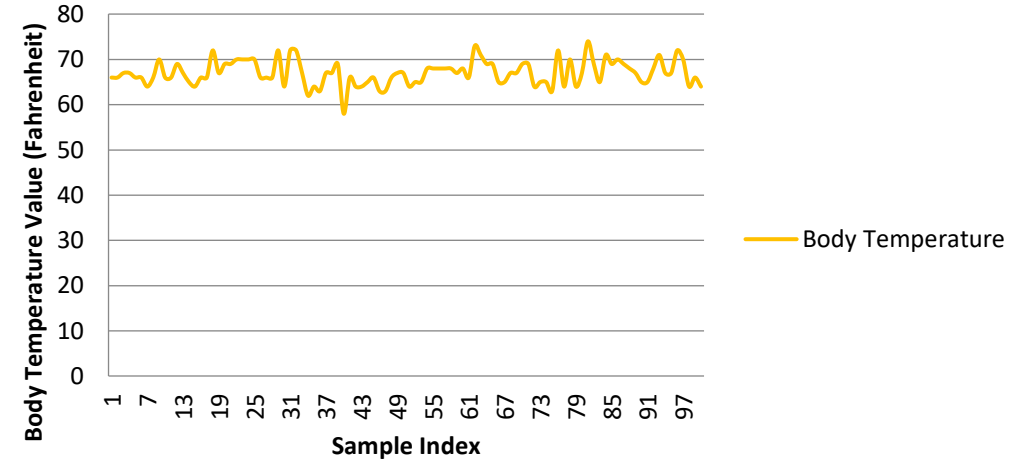
```
1 19:53:54.207 -> BPM 60
2
3 19:53:58.798 -> Body temperature is now: 63
4 19:53:58.798 -> Body temperature updated
5
6 19:54:01.054 -> Heart rate is now: 508
7 19:54:01.054 -> Heart rate updated
8
9 19:54:00.753 29093-29112/com.example.ble_test
I/MainActivity$gattCallback: Debug: Temperature value 1: 63
10 19:54:01.877 29093-29112/com.example.ble_test
I/MainActivity$gattCallback: Debug: Pulse signal value 1: 508
11
12 19:54:02.313 29093-29093/com.example.ble_test
I/MainActivity$gattCallback$1$onCharacteristicRead: Debug:
Temperature DocumentSnapshot added with ID:
7LoQ6bODaz70zewXq6ly
13 19:54:02.455 29093-29093/com.example.ble_test
I/MainActivity$gattCallback$1$onCharacteristicRead: Debug:
Pulse DocumentSnapshot added with ID: 6RwzU86kuvoNmWqtQYxe
14
15 19:54:07.565 29093-29093/com.example.ble_test
D/MainActivity$gattCallback$1$onCharacteristicRead: Debug:
Pulse 6RwzU86kuvoNmWqtQYxe => {pulse signal=508, sample
index=1}
16 19:54:07.572 29093-29093/com.example.ble_test
D/MainActivity$gattCallback$1$onCharacteristicRead: Debug:
Temperature 7LoQ6bODaz70zewXq6ly => {sample index=1, body
temperature=63}
```

# Output waveforms (100 samples)

## Heart Rate Sketch (pulse)



## Heart Rate Sketch (temperature)



# Live Demo

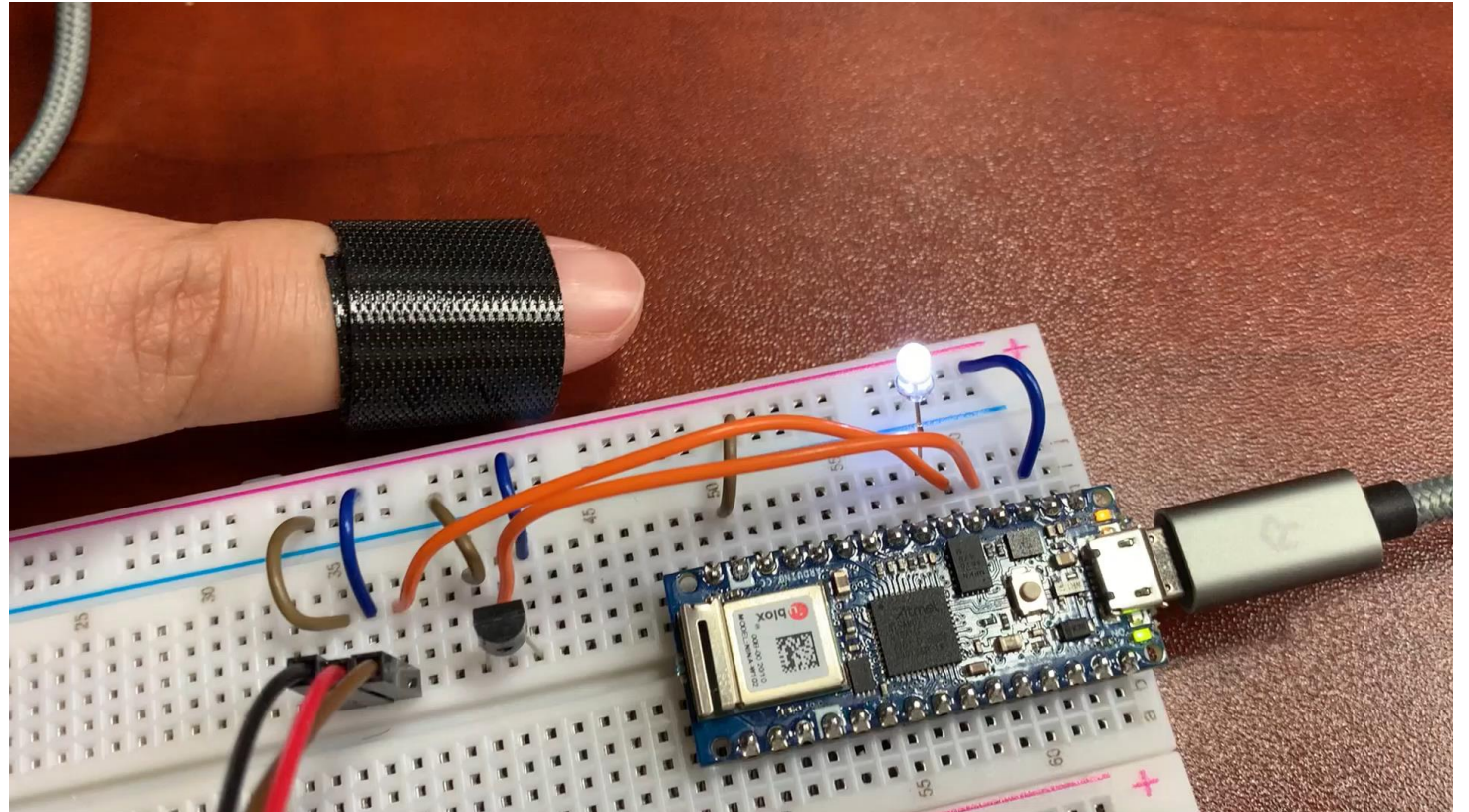
Zoom meeting link:

<https://gmu.zoom.us/j/98442050617?pwd=WHZDcW9BUmNXNm5QejZ2Q1N4c0VxZz09>



# Multi-Threaded Sensor Reading

NOTE: LED\_BUILTIN blinks whenever a temperature reading is taken while the white LED blinks whenever a heartbeat is detected.





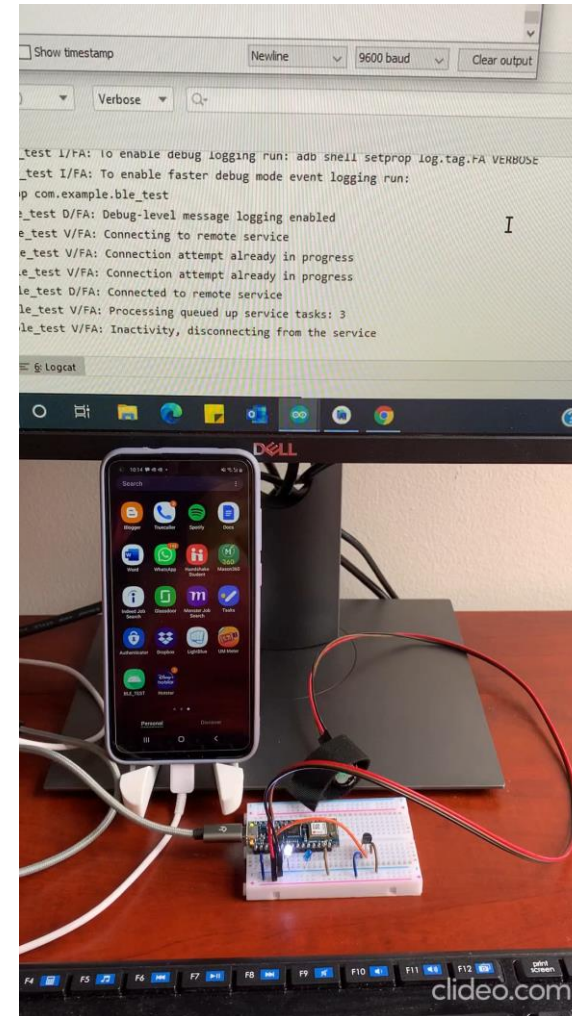
# Incorporating Google Firebase Cloud Storage

## LED coding guide:

LED\_BUILTIN – Temperature  
sensor reading.

WHITE LED (D16) – Pulse  
sensor reading.

BLUE LED (D20) – BLE  
peripheral device (Arduino)  
connected.



# References

1. Pulse Sensor Playground  
[<https://github.com/WorldFamousElectronics/PulseSensorPlayground>]
2. TMP36 Temperature Sensor  
[<https://learn.adafruit.com/tmp36-temperature-sensor>]
3. The Ultimate Guide to Android Bluetooth Low Energy  
[<https://punchthrough.com/android-bleguide/>]
4. Android Developer Guides  
[<https://developer.android.com/guide>]
5. Add Firebase to your Android project  
[<https://firebase.google.com/docs/android/setup>]
6. Cloud Firestore  
[<https://firebase.google.com/docs/firestore>]
7. Python Client for Google Cloud Firestore  
[<https://googleapis.dev/python/firestore/latest/index.html>]