# Senior Design Project Review

Temperature Sensors for Veterans

sdmay23-07

# Introduction

- Client: Adaptive Adventures
- Mentors: BAE Systems and Dr. Gaffar
- Users: Individuals suffering loss of sensation to body appendages
- Goal of Project: Provide users with the ability to monitor their body temperature and receive alerts

# Hardware Implementation Architecture

Temperature sensing circuit

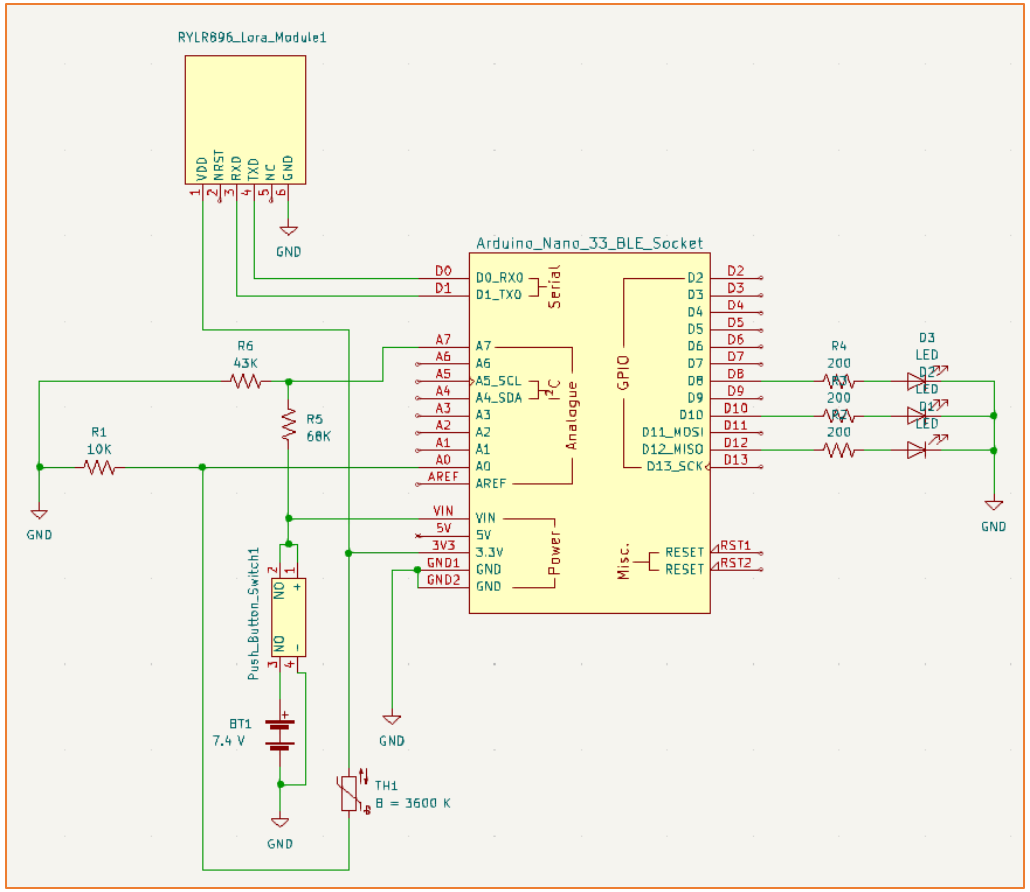
Bluetooth communication for short range data transmission and receival

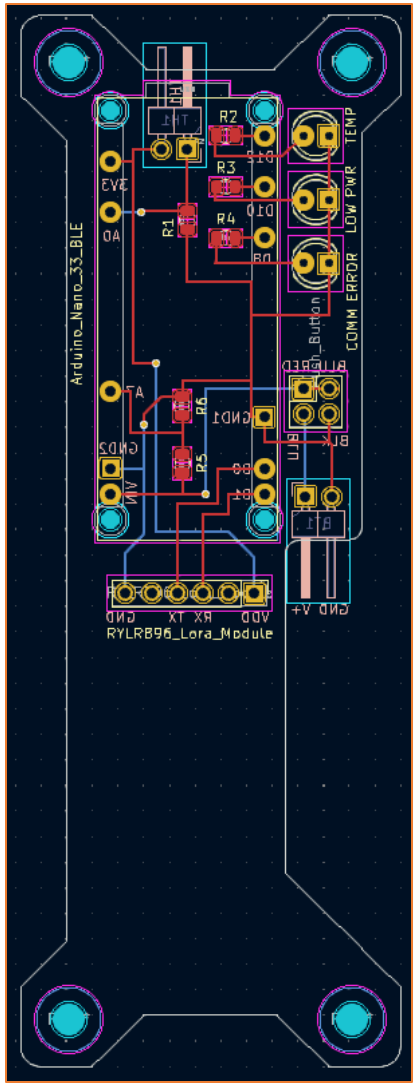
Radio frequency module for long range communication

Push button power control, battery charging circuit, 7.4V power supply

3 LEDs to alert for low battery level, temperature range exceeded, and loss of connection

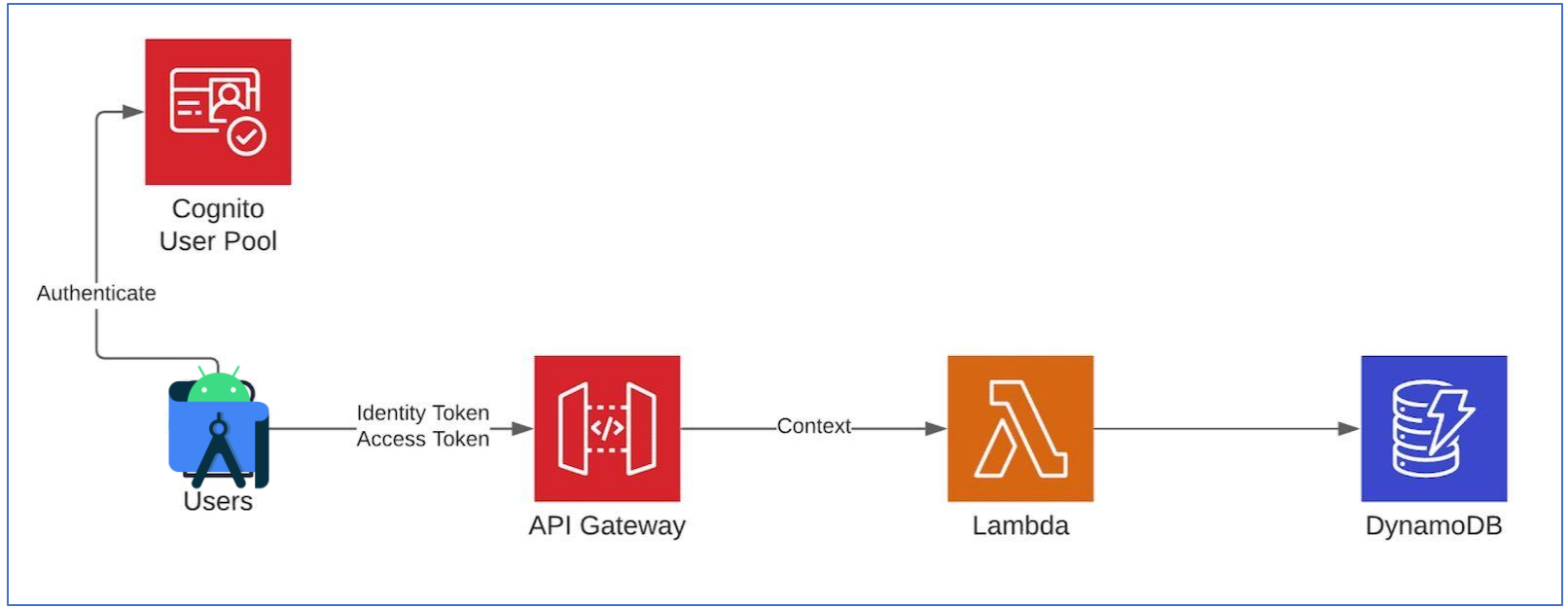
# Hardware Implementation Architecture Schematic



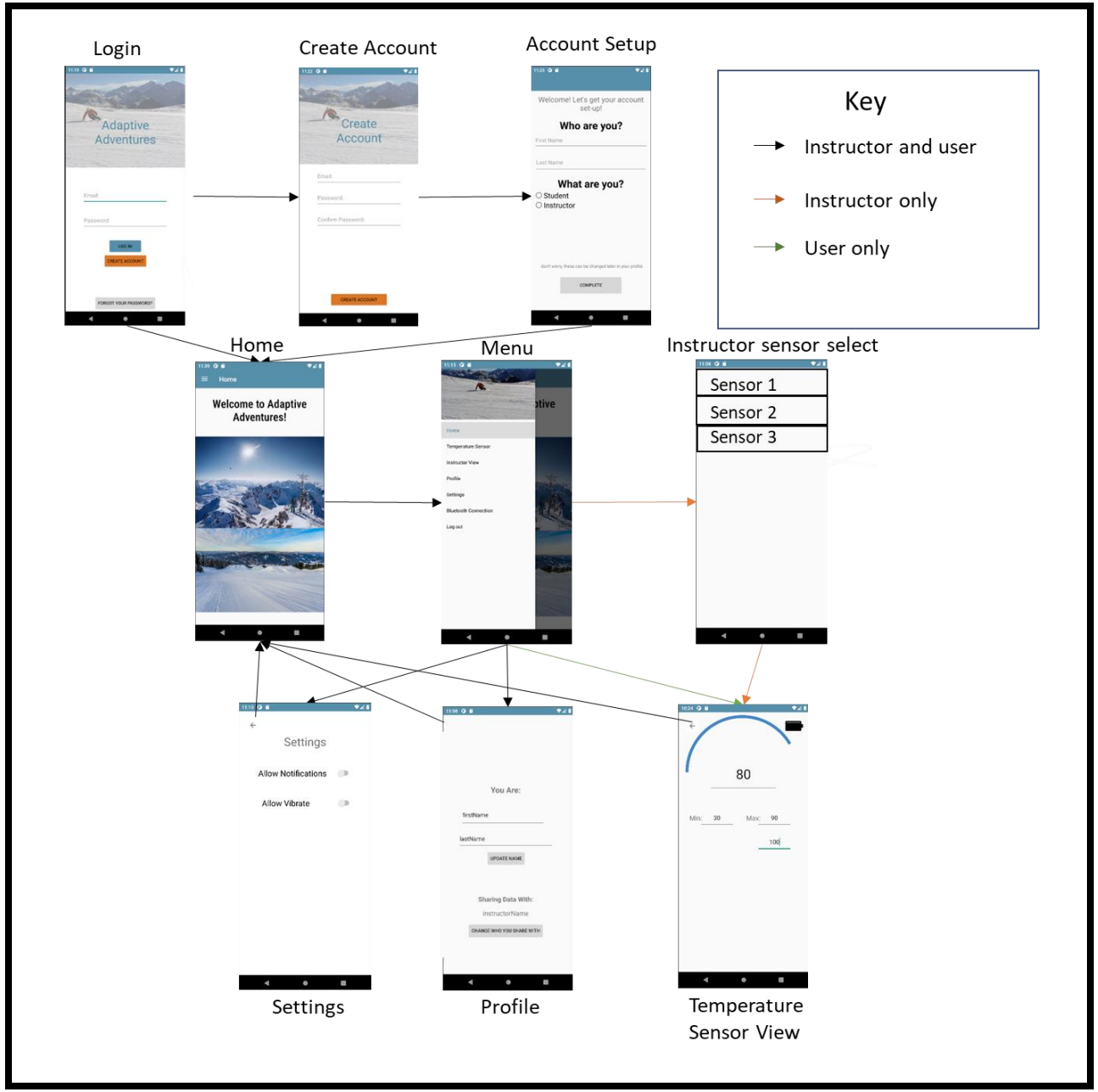



# Software Backend Architecture

**Backend**:
Users' login/identification through Cognito, data flows bi-directionally through API gateway, Lambda, and DynamoDB.



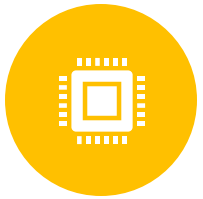
# Software Frontend Architecture



# Key Contributions

**Michael:** Integrated power control and battery management system

Caleb: Implemented temperature sensing, designed schematic/PCB



Max: Developed radio frequency communication for data communication between transmitter and receiver

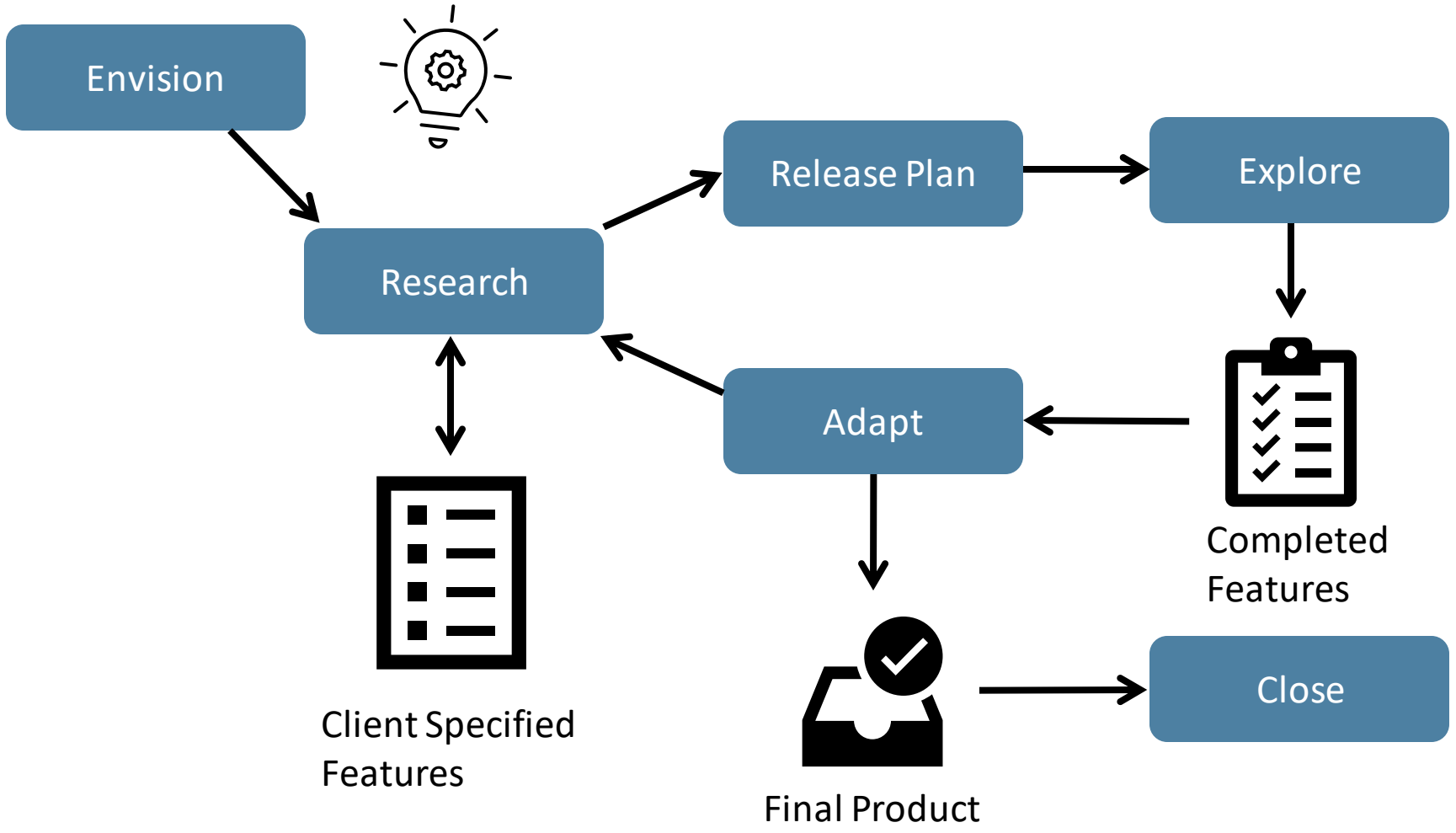
Jared: Developed hardware BLE connection

George: Developed software BLE connection code

Jamie: Integrated backend structures for phone application (databases, login features)

Bridget: Integrated frontend structures for application

# Work Accomplishments



# Hardware Challenges and Solutions

- Lead times of materials
  - Researching necessary hardware and placing orders well in advance
- Secondary alert system
  - Explaining difficulties to the Users and coming to an agreement on alerts – Visual and Vibratory
- Arduino code having to be in a continuous loop
  - Having a counter variable that allows certain actions such as sending data via BLE and RF to only happen at specific time intervals
- Difficulties calibrating and determining accuracy of temperature sensing element
  - Calibrated in controlled temperatures using precision cooker (±1°F) and a digital thermometer
  - Implemented Steinhard-Hart equation to optimize temperature readings
- Loss of RF communication (LoRa just sends out data – it does not check if there is something available to receive the data)
  - Made it so that each RF module is both a transmitter and receiver
  - Each device sends back a confirmation message
- Battery charging circuit
  - Purchased battery pack with built-in charger

# Software Challenges and Solutions

- Outdated resources and documentation
  - Read new documentation if available, review old if not. Find new resources/libraries to utilize.
- Temperature status bar freezing after exceeding high-alert
  - Find corrupted reference in xml and delete.
- Settings page crashing upon opening from menu
  - Find settings page is not set as an activity when it should be.
- Sensor page crashing upon long use period
  - Determine that handler is doing too much within the thread.
  - Initialize handler within onCreate().
- Bluetooth and the rest of the app would not run together
  - Hopefully we get an answer
- Databases unable to be queried directly
  - Act through API Gateway/Lambda, directly code transitions.

# Design Evolution

- Rechargeable, non-removable batteries
- Battery level monitoring
- NEMA-4X enclosure
- Removal of device-based auditory alerts
- Application design, menu page format

# Future work

- Hardware
  - Optimize size of device
  - Heart rate, blood oxygen level, core body temperature measuring
  - LCD visualization of body measurements
  - Optimize alerting systems
  - Improve survivability
  - Design supervisory RF hub

# Future work

- Software
  - Download historical data
  - Add profile pictures
  - Predictive Algorithm
  - Expanding to different platforms
  - Update images to client provided images
  - Develop integration with smart watches

# Conclusion

**Summary:**

**The last two semesters provided our team the opportunity to develop and integrate our skills and knowledge gained throughout our time at Iowa State to visualize and create a wearable temperature sensing device paired with a phone application to better the lives of individuals suffering from loss of circulation or sensation.**

**Lessons Learned:**

- **"If I had an hour to solve a problem, I would spend 55 minutes thinking about the problem and 5 minutes thinking about solutions" - Albert Einstein**
- **Simplicity does not mean inadequacy**
- **Plan for problems**
- **Recognize accomplishments**
- **Communication is vital**

**Plan of action:**

- **Provide for future development**
- **Utilize lessons in future opportunities**

# Any Questions?

# Existing Technology Considerations


- Doesn't measure extremities
- $275+tax


- Only feasible for wrist temperature measurement

# Total Cost of Device

- Enclosure:$14.15
- PCB manufacturing: $5
- Temperature sensor: $5
- LEDs: Free
- Push button:$6
- Miscellaneous supplies:$35
- Radio frequency module: $20
- Arduino Nano 33 BLE: $40
- Battery Supply: $19
- Adhesive Patch: $0.71

- Total: $150

# Shortcomings

- Better schedule management
- Better overall communication
- Additional spare parts
- Team members in different locations