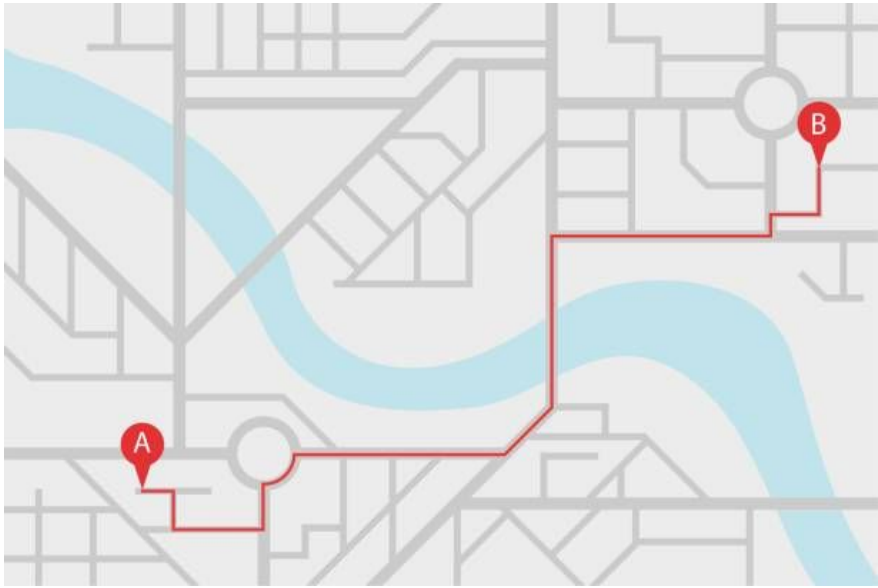
Old Use Case

- a wearable camera system that detects:
  - Walks signs, when they are on and off
  - A person's alignment with the crosswalk when they're crossing the street
- Gives auditory feedback to:
  - Indicate whether it is safe to cross (walk sign is on)
  - Give person directions if they are misaligned with, or off the crosswalk

ECE Areas: **Software Systems, Signals and Systems**

New Use Case

- User is a visually impaired person
- Wants to go from point A to point B
- Ideally, only wants routes with “blind-friendly” crosswalks
  - Crosswalks with audio cues which signal when it is safe to cross
  - Text-to-speech, beeping, etc.
- Aid the visually impaired person in learning a new area



Use-case Requirements

- Update user frequently so they are informed about where they are going
  - Every **15s** if next action is far away (ie. turn or crosswalk approaching)
  - Every **5s** if next action is near
  - Feedback should be concise and include relevant information (ie. turn left on Forbes Ave. in 100m)
- Identification of user location within **1 meter** of actual location
- Battery life of **16 hrs**
  - Can sustain roughly a whole day of use

Use-case Requirements

- Reliability; user should be confident in directions/information given
  - should give a valid route from point A to point B **100%** of the time
  - Should notify user **100%** of the time when they attempt to cross “blind-unfriendly” crosswalk
    - We will identify user as attempting to cross crosswalk if they are <10m away from crosswalk
- Latency: should return response (ie. directions) **<1s** after coordinates of user is given
- Weight: **<1kg**

Solutions Approach

- Product: wearable device which gives user route from point A to point B
  - Route will only contain “blind-friendly” crosswalks
  - If user deviates from route, notify user if they attempt to cross “blind-unfriendly” crosswalk
  - If user deviates from route, reroute them based on direction they are currently walking in
- Front-end:
  - Combination of internal measurement unit and GPS locator
    - I2C Serial Communication
  - Audio feedback via wired earbuds
    - 3.5mm audio jack
  - Wireless communication to Maps API
    - Via cellular data network card
    - I2C Serial Communication

Solutions Approach

- Backend:
  - Will keep a database of “blind-unfriendly” intersections
  - Find possible routes from A to B, and filter after for blind-friendly routes
  - Find coordinates of next intersection/crosswalk to turn at, calculate distance between user current location
  - Give feedback to frontend to direct to user
  - Use Google Maps and Overpass API to assist with route planning and intersection mapping

Components

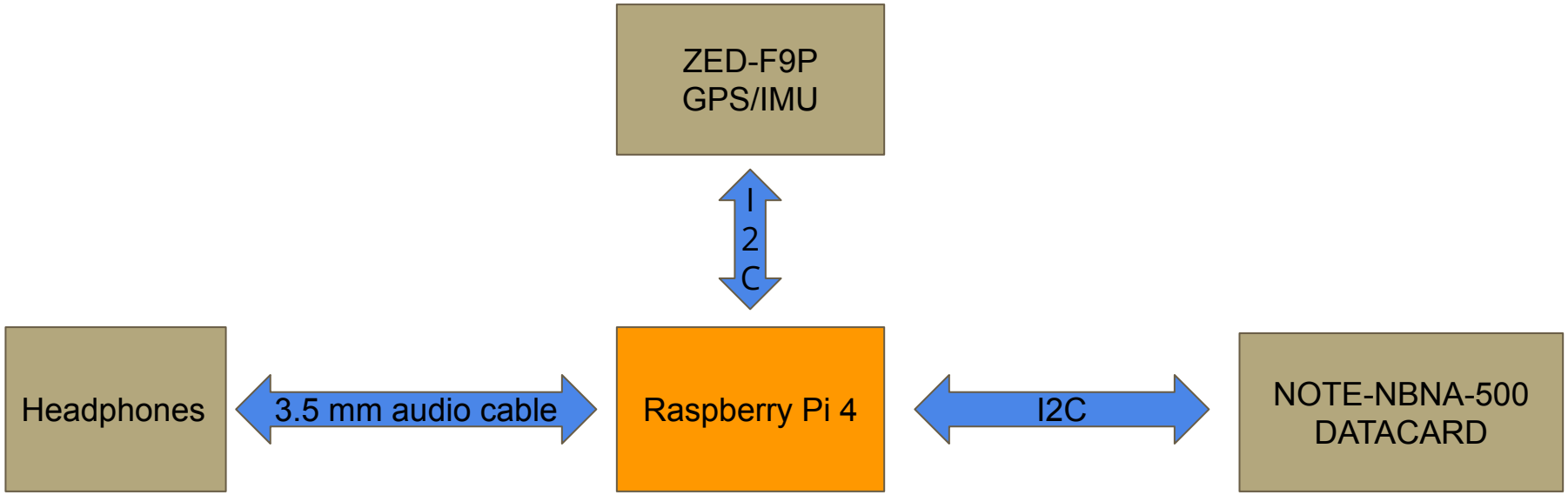
Hardware:

- Raspberry Pi 4
- NOTE-NBNA-500 Cellular Data Card
- SparkFun GPS-RTK2 Board - ZED-F9P GPS/IMU
- GNSS/GPS antenna
- Cellular antenna

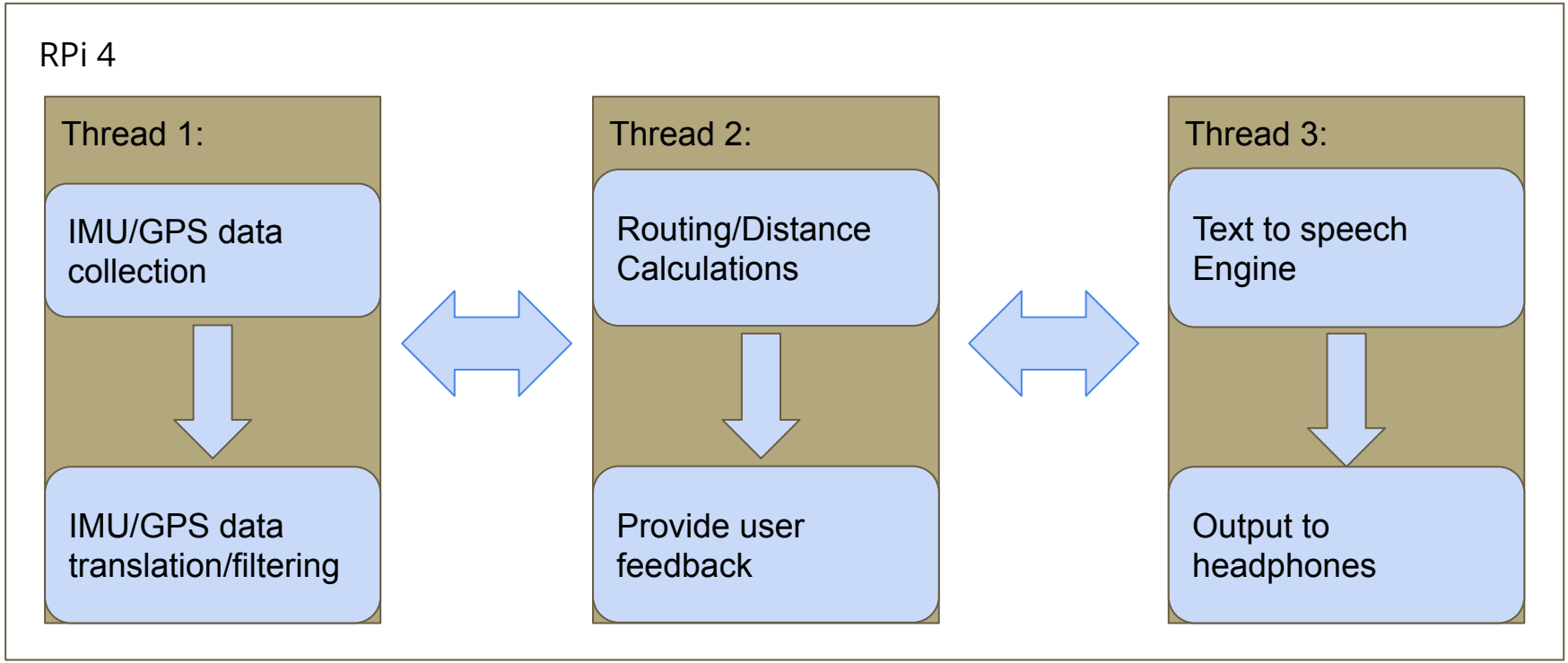
Software:

- Gather GPS/IMU data
- Communicate with cellular data card
- Pyttsx3 text-to-speech engine library
- Audio output control
- Google Maps, Overpass APIs

Hardware Block Diagram



Software Block Diagram



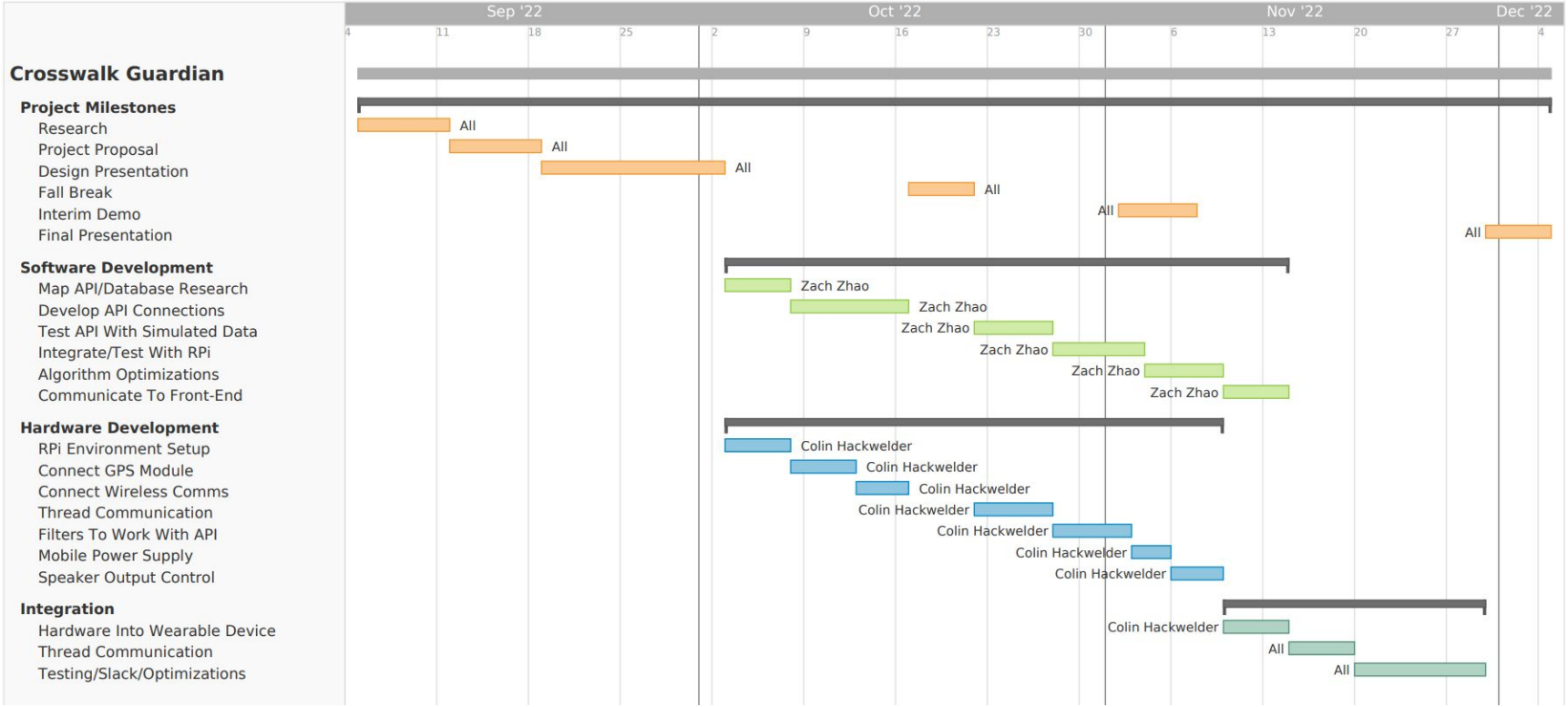
Testing, Verification, Metrics

Requirements	Testing	Metrics
Battery Life	Run continuously without charging	Measure how long it takes before RPi dies
Unfriendly crosswalk detection	Stand at various distances <10m away from unfriendly crosswalk	What percentage of the time does system detect unfriendly crosswalk
Latency	Give custom coordinates	Measure time that it takes for system to provide feedback
User experience	Walk a full route planned by system	Determine if system can provide accurate and safe route/directions

Technical Challenges

- Location accuracy
  - Lose GPS signal for a long time
- Latency
  - Bounded by API response time
- Power/weight
  - Minimize power consumption
  - Should not be uncomfortable to wear
- How to detect if user has deviated from route
  - Increased distance from upcoming checkpoint does not necessarily equal deviation from route

Schedule


Sep '22
Oct '22
Nov '22
Dec '22
4
11
18
25
2
9
16
23
30
6
13
20
27
4
Crosswalk Guardian
Project Milestones
Research
Project Proposal
Design Presentation
Fall Break
Interim Demo
Final Presentation
Software Development
Map API/Database Research
Develop API Connections
Test API With Simulated Data
Integrate/Test With RPi
Algorithm Optimizations
Communicate To Front-End
Hardware Development
RPi Environment Setup
Connect GPS Module
Connect Wireless Comms
Thread Communication
Filters To Work With API
Mobile Power Supply
Speaker Output Control
Integration
Hardware Into Wearable Device
Thread Communication
Testing/Slack/Optimizations
All
All
All
All
All
All
Zach Zhao
Zach Zhao
Zach Zhao
Zach Zhao
Zach Zhao
Zach Zhao
Colin Hackwelder
Colin Hackwelder
Colin Hackwelder
Colin Hackwelder
Colin Hackwelder
Colin Hackwelder
Colin Hackwelder
Colin Hackwelder
All
All