Neha Tarakad

Aidan Wagner

Jason Ledon

Tamal Mukherjee (FAC) 4:13 PM
Fire alarm in Roberts... which way do I go ?

Problem: Fire and smoke alarms may tell occupants that they need to leave the building, but will not direct them away from the fires toward an exit.

Fire Escape

Team B8

Use Case

- Existing solutions
  - Evacuation maps in key areas
  - Typically based on finding closest exit, despite potential hazards
- ECE Areas
  - Software, Hardware/Circuits

- Our take
  - **Distributed node system** will output an **optimal path** based on smoke and temperature readings at different locations
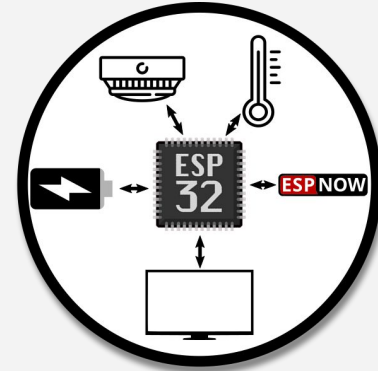 - Occupants **guided** step by step out of building

Wean Hall
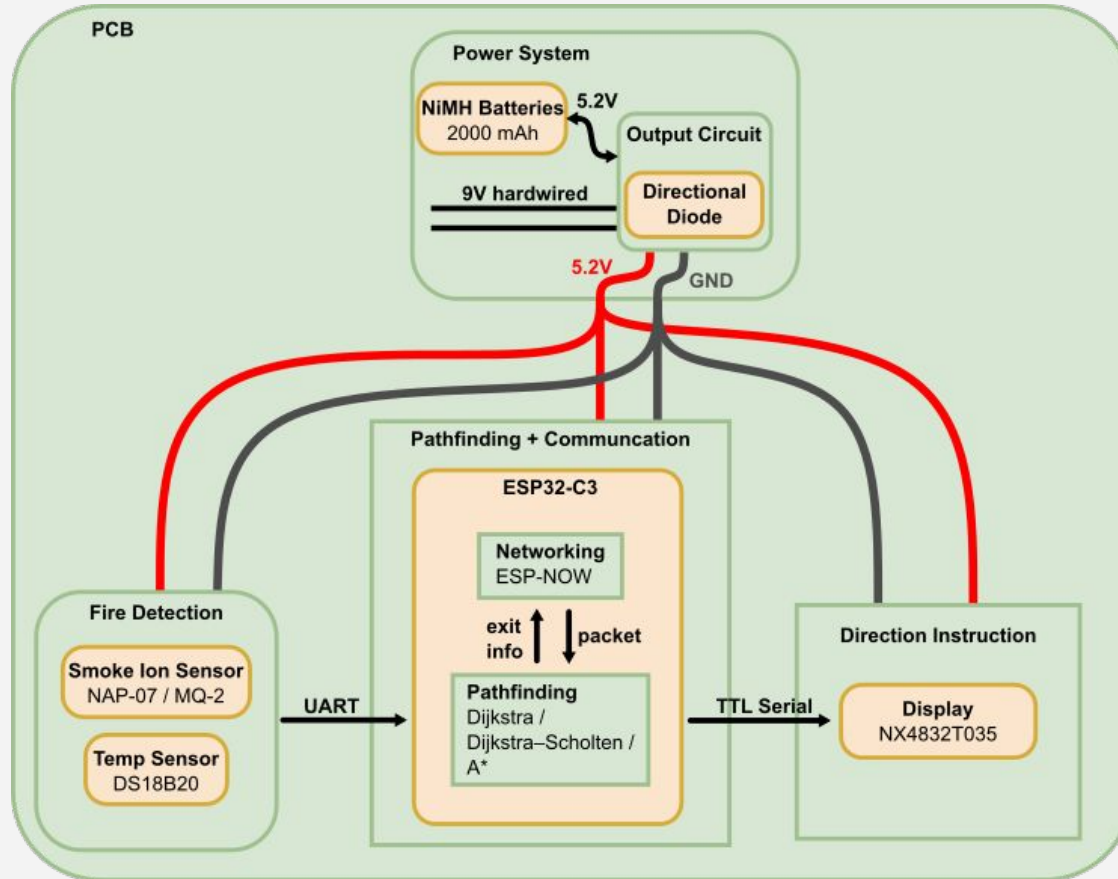Floor 5
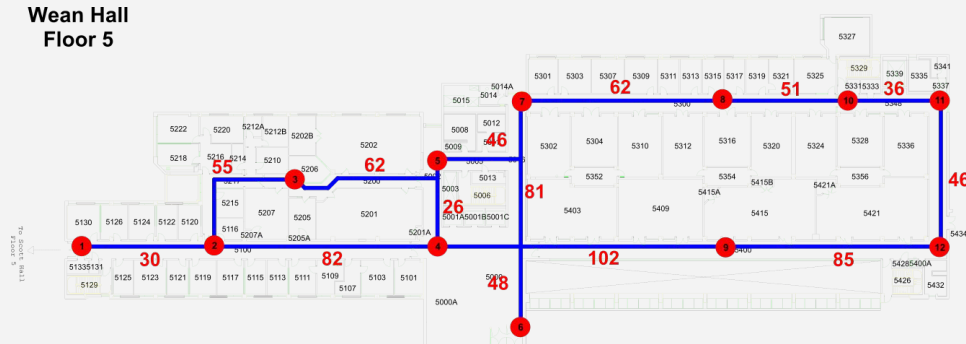
Requirements

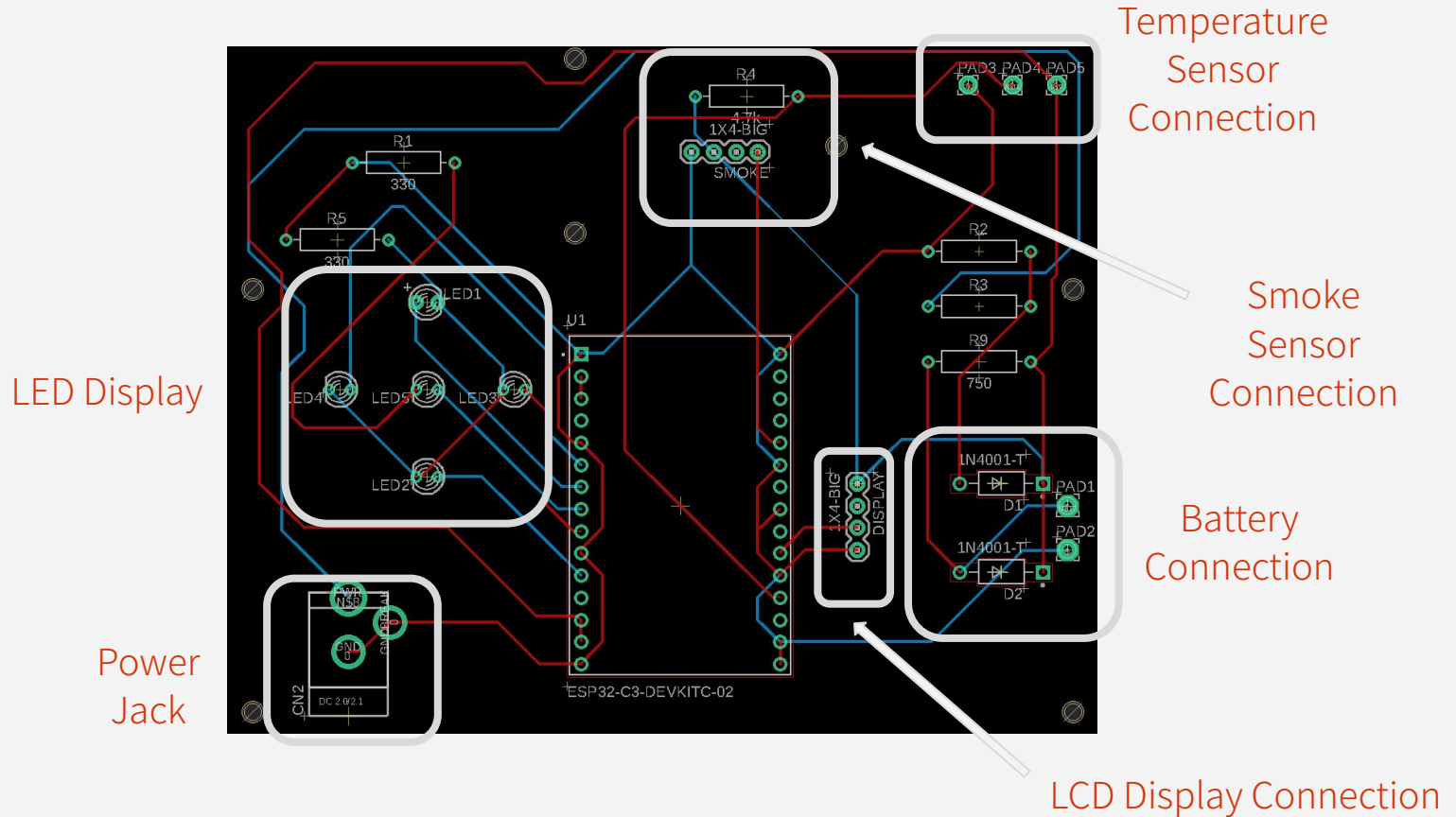| Use-Case Requirements	Technical Requirements
Directions shown in **<100s** after fire detection	Alert upload time + Pathfinding time + download time + time to display directions **< 100s**
Idle mode for **>24hrs** and Active mode for **>5min** on battery power	Idle mode requirement is the dominating factor, needing a capacity of **~1750 mAh**
Battery is recharged when power is on	Once power is restored, diode biases flip resulting in current charging the battery at **6.6mA** (Assuming NiMH 2000mAh battery)
95% of fires are detected	Smoke and Temperature sensor threshold values are exceeded **95%** of the time when exposed to flames
Planned paths are optimal and correct	Pathfinding software is tested and analyzed to prevent **all** bugs and memory leaks

Solution Approach

- Single node structure
  - Each node periodically **monitors temperature** and **smoke levels**
  - When readings reach a specific threshold, a **signal indicating fire** is sent out to other nodes
  - Pulse in and out of **Active Mode** to preserve battery
  - Contain **backup batteries** in case of power outage
- System of nodes
  - Nodes cycle between **modem sleep** and **active mode** for communication
  - When one node detects a fire, all other nodes plan the **shortest, safest route** out of the building
  - Directions are displayed on nodes to guide users to the exit

System Specification / Block Diagram

Complete Solution (Node Structure)

Temperature Sensor Connection

Smoke Sensor Connection

LED Display

Battery Connection

Power Jack

LCD Display Connection

Complete Solution (Node Structure)

- **ESP32**
  - Nodes will communicate over **ESP-NOW**
- Sensors
  - **Temperature** and **smoke** sensors for fire detection
- LED/LCD
  - **LED**s provide **relative direction**
  - **LCD**s provide **in-depth information** on optimal path out of building
- Backup battery (in the event of power outage)
  - **Blocking diode** prevents battery from leaking into power supply
  - Resistor to **prevent overcharging**
- Power jack
  - **9V barrel jack** input into PCB
  - Voltage divider to **step 9V down** to ESP operating voltage

Completed Solution (Communication)

Pros

- Unlimited range on network

- Peer-to-peer network

- Longer range
- Built-in to ESPs
- No additional modules or code
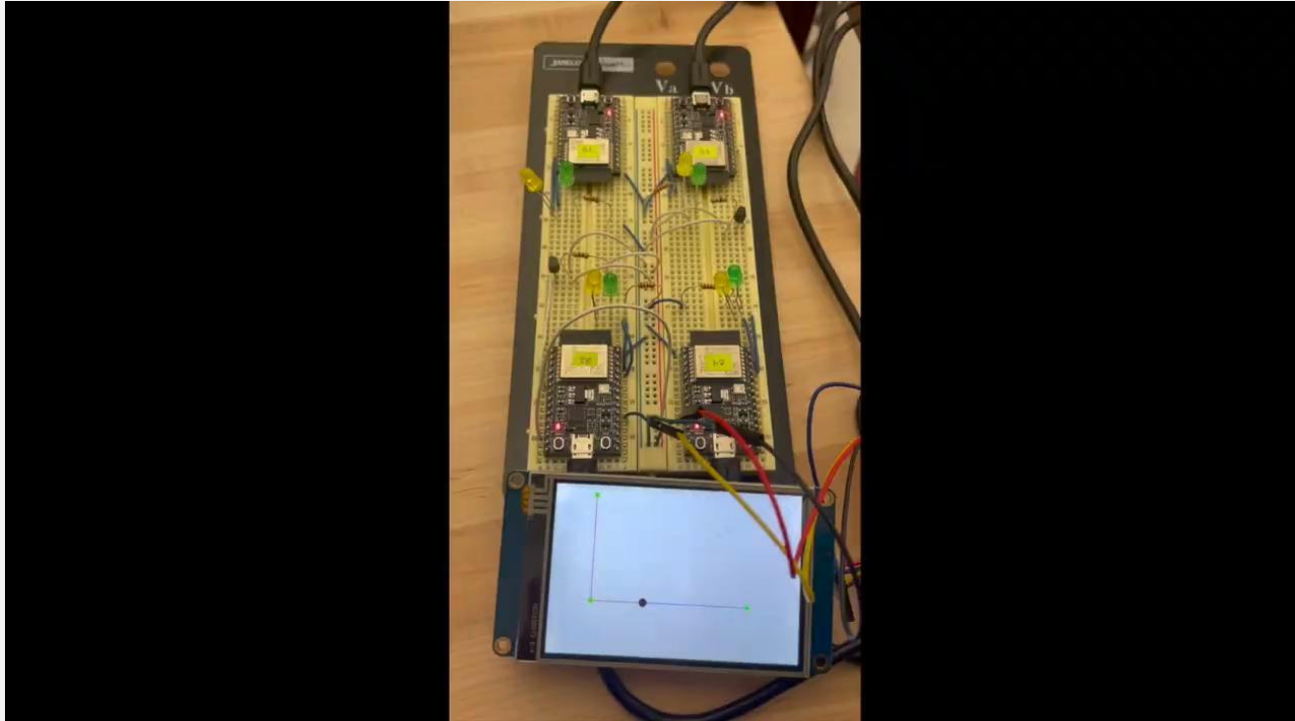- Peer-to-peer network

Cons

- Centralized node system
- Restricted broadcasting capabilities

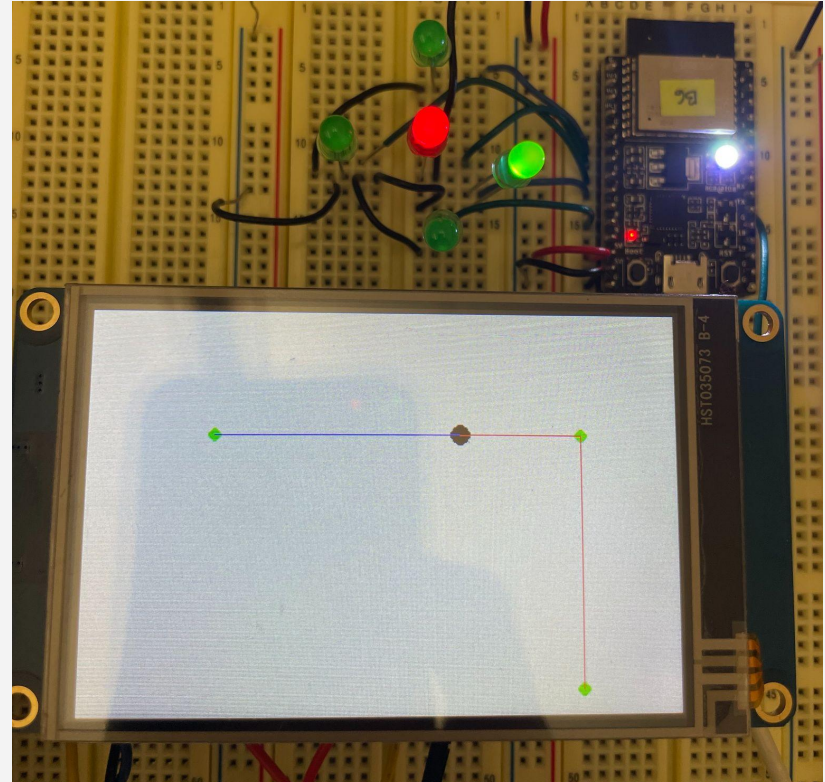- Additional board (pins, power, header files, cost)

- Compatibility with boards from other manufacturers

Complete Solution (Pathfinding)

Complete Solution (Directions/Display)

- LEDs
  - 5 LEDs to direct occupants
    - Left, Right, Up, Down
  - Middle LED is **always on**
- LCD Display
  - **Entire floor plan** is shown on 4.2 inch display
  - **Current location is highlighted**
 - Shortest, safest path to exit is highlighted

Trade-offs

| .15mm Trace	.3mm Trace
- Fits in tighter spaces - Cheaper	- Can handle more current (Up to 1A) - We use ~.7A - Safer at higher temperatures
Build MQ-2 Circuit	**Order MQ-2 With Circuit**
- No need to mount another board - No need to wait for shipping	- No ordering individual components (Cheaper) - Much less time assembling
PCB fabrication in lab	**Order PCB through JLC**
- No need to wait for shipping - Quickly make changes if necessary	- More efficient and accurate - More precise manufacturing method

Performance Metrics

Measuring Functionality	Passing Test Output	Our Output
Ability to detect fire	Fire detected when temperature is above 135 degrees F	0 failed detections from ambient temperature to threshold
Path Finding	Correct and optimal paths to exits from each node	100% correct output path based on unit tests on randomly generated graphs
Display directions on LED	LEDs on node match command given (ie correct NSEW arrow)	Directions are correctly displayed on all of our test cases
Generate path on LCD	Description/Graphic displayed matches program	Directions are correctly displayed on all of our test cases (after 3 second settle period)
Communication between nodes	Information transmitted is displayed correctly on receiving node	0 dropped packets within 200ft hallway ~125ft around corners
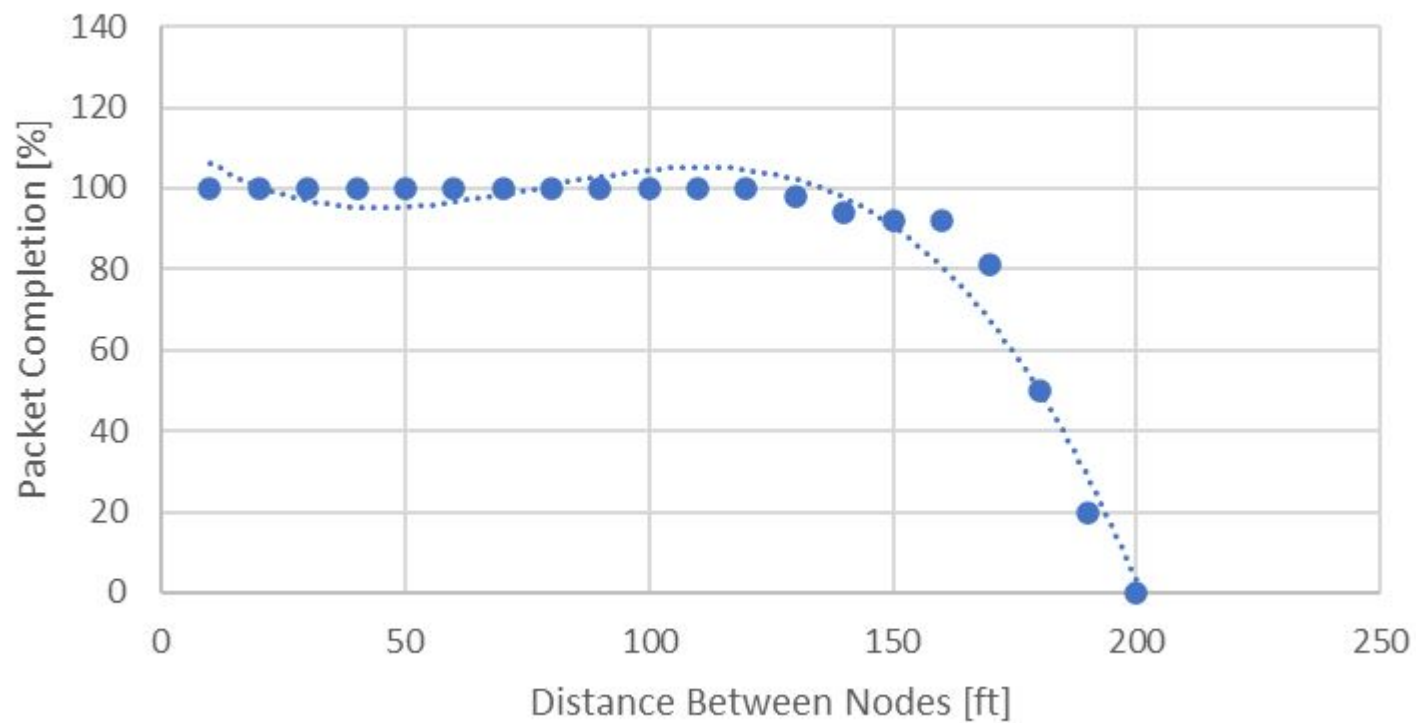
Project Management/Gantt Chart
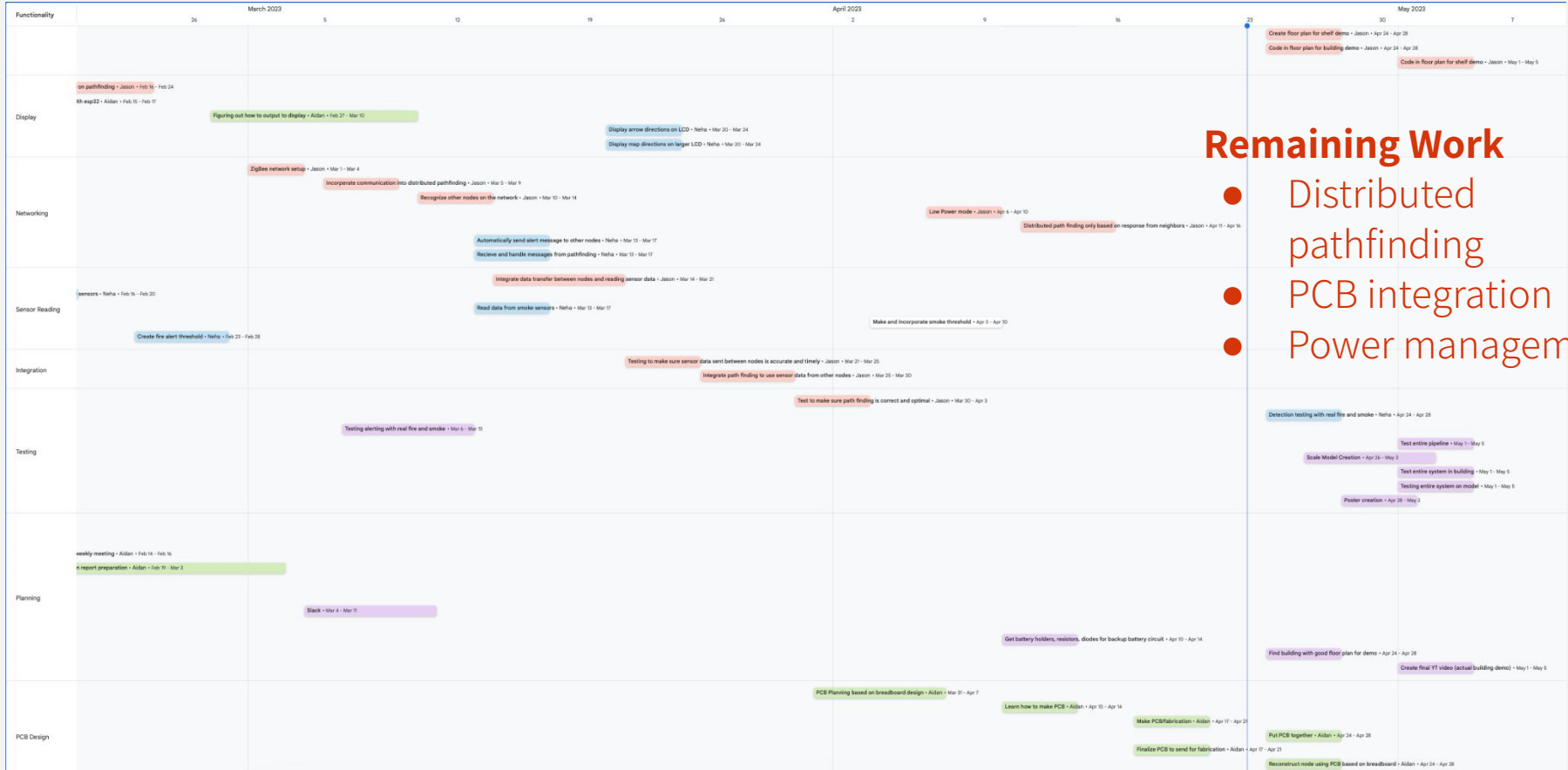
Remaining Work
- Distributed pathfinding
- PCB integration
- Power management

Conclusion

- Public Safety
    - We believe that our design provides a solution to a problem unsolved by current fire alarm systems
    - By informing occupants of real-time exit strategies, we are giving users the chance to avoid fires while they exit the building