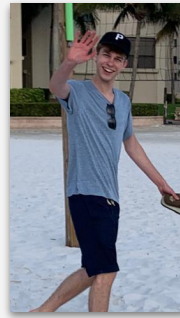**Neha Tarakad**

Aidan Wagner

Jason Ledon

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 **~1750mAh**
Battery is recharged when power is on	Once power is restored, diode biases flip resulting in current charging the battery at **5.8mA** (Assuming NiMH 1750mAh 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 will periodically be monitoring temperature and smoke status
- When readings reach a specific threshold, a signal indicating fire is send out to other nodes
- Pulse in and out of Active Mode to preserve battery

- Communication is performed through **ZigBee custom network** to avoid WiFi outage issues, but can use **WiFi as alternative**
- Nodes are connected to main power, but have a **backup battery** in case of outages
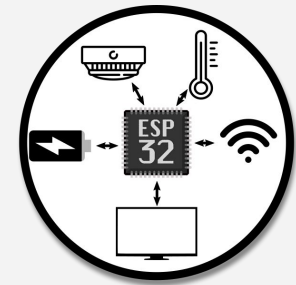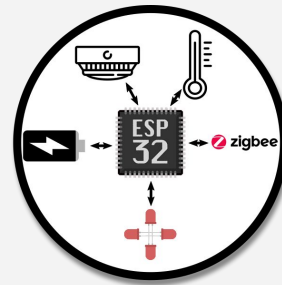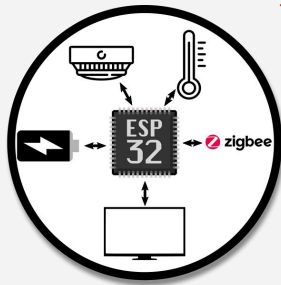
Solution Approach (System of Nodes)

- Nodes will 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
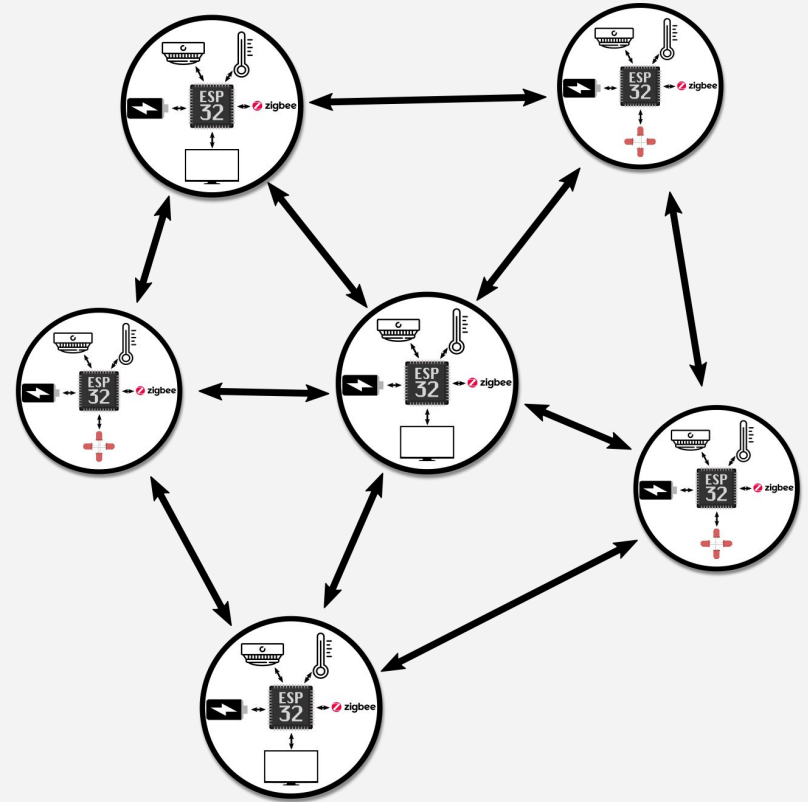
System Specification / Block Diagram
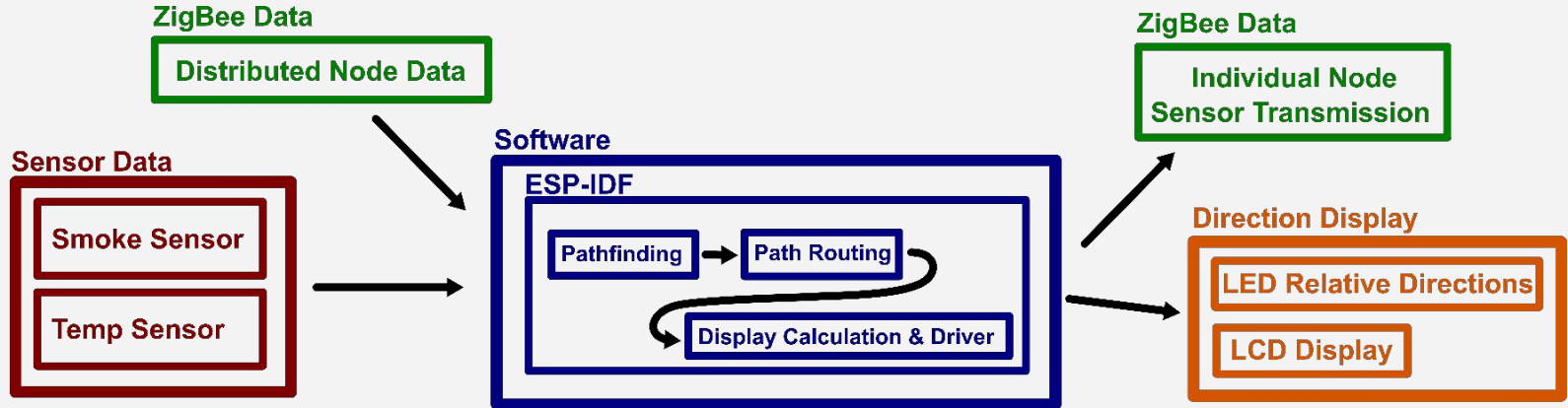
Implementation Plan (Hardware)

- **ESP32**
  - Nodes will communicate over ZigBee / WiFi
- Sensors
  - **Temperature** and **smoke** sensors
- LED/LCD
  - **LED**s provide **relative direction**
  - **LCD**s provide **in-depth information** on optimal path out of building
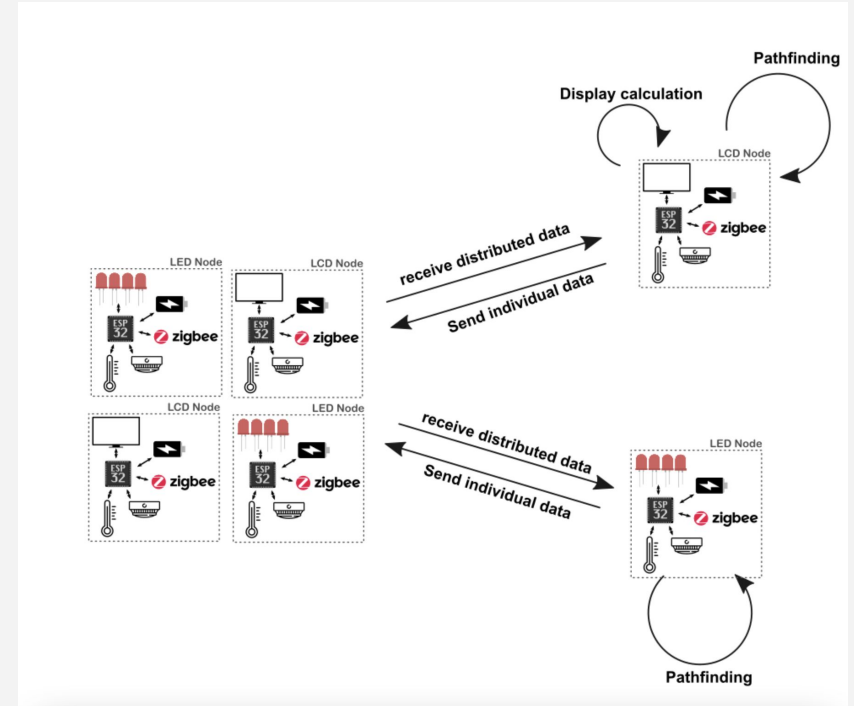
Implementation Plan (Circuit Level)

- **PCB** designed to connect sensors, batteries, and displays to ESP32
- Backup battery circuit
  - **Blocking diode** prevents battery from leaking into power supply
  - Battery supplies power if power supply is unavailable
  - Resistor to **prevent overcharging**

https://www.allaboutcircuits.com/projects/battery-backup-power-supplies/
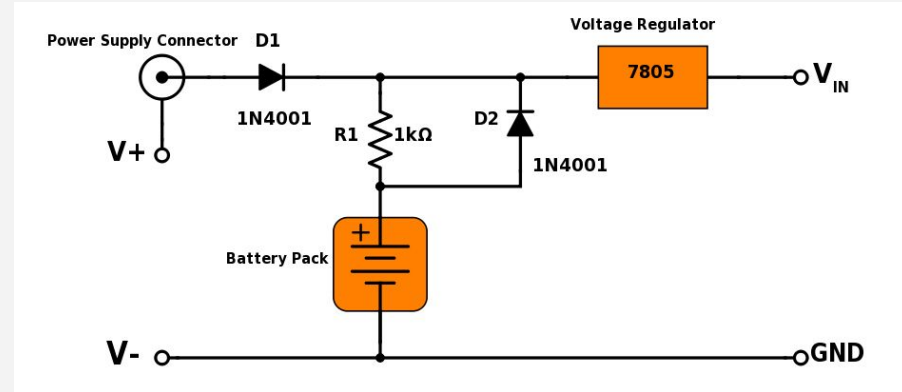
Implementation Plan (Software)

- Pathfinding
- Communication Protocol

Cost & Supply

VS
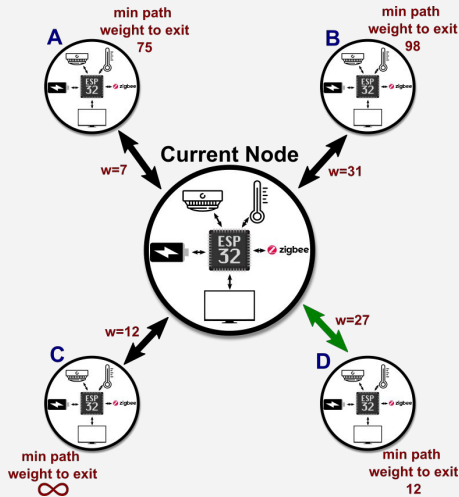
Scalability

VS
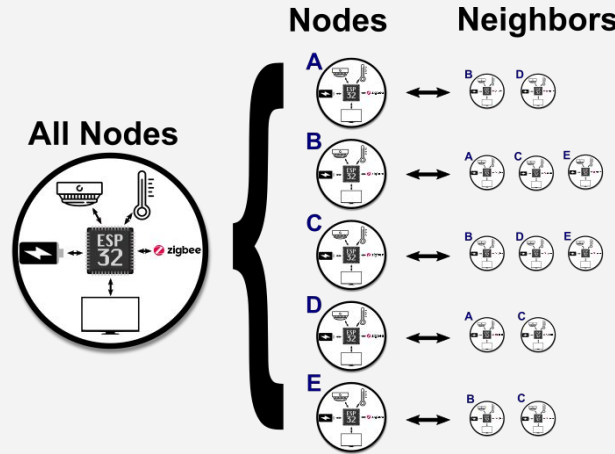
Low Latency

Reliability during outages

Testing, Verification, and Validation

Measuring Functionality	Test Inputs	Passing Test Output	Risk Factors/Unknowns
Ability to detect fire	Read smoke and temperature data from a candle	Fire detected when temperature is above 135 degrees F	Range/distance of fire for scalability
Path Finding	Nodes, edges, exit nodes	Correct and optimal paths to exits from each node	Latency between nodes
Communication between nodes	Arbitrary messages sent from transmitting nodes	Information transmitted is displayed correctly on receiving node	Dropped messages
Display directions on LED	Program sends command specifying a direction	LEDs on node match command given (ie correct NSEW arrow)	Sufficient information to find next node
Generate path on LCD	Program output describing path to next node	Description/Graphic displayed matches program	Written instructions vs displaying floor plan highlighting nodes

Project Management/Gantt Chart

Jason

- Arbitrary path finding (on computer) • Neha • Feb 6 – Feb 10
- Arbitrary path finding (on Arduino) • Neha • Feb 11 – Feb 19
- Arduino lights up LED based on pathfinding • Neha • Feb 16 – Feb 24
- Make heuristic function and compare Dijkstras to A* • Neha • Feb 23 – Feb 28
- ZigBee network setup • Neha • Mar 1 – Mar 4
- Recognize other nodes on the network • Neha • Mar 10 – Mar 14
- Integrate data transfer between nodes and reading sensor data • Neha • Mar 14 – Mar 17
- Testing to make sure sensor data sent between nodes is accurate and timely • Neha • Mar 18 – Mar 21
- Integrate path finding to use sensor data from other nodes • Neha • Mar 22 – Mar 26
- Test to make sure path finding is correct and optimal • Neha • Mar 28 – Apr 1

Neha

- Eagle research • Aidan • Feb 6 – Feb 10
- Breadboarding • Aidan • Feb 13 – Feb 17
- PCB Planning based on breadboard design • Aidan • Mar 20 – Mar 24
- Finalize PCB to send for fabrication • Aidan • Mar 27 – Mar 31
- Wait for PCB to be manufactured and returned • Aidan • Apr 3 – Apr 12
- Reconstruct node using PCB based on breadboard • Aidan • Apr 12 – Apr 19
- Finalizing hardware components based on weekly meeting • Aidan • Feb 14 – Feb 16
- Deciding on a display to interface with esp32 • Aidan • Feb 15 – Feb 17
- Figuring out how to output to display • Aidan • Feb 27 – Mar 10
- Design report preparation • Aidan • Feb 19 – Mar 3

Aidan

- Research sensors • Jason • Feb 6 – Feb 9
- Read data from temperature sensors • Jason • Feb 16 – Feb 20
- Read data from smoke sensors • Jason • Feb 20 – Feb 23
- Create fire alert threshold • Jason • Feb 23 – Feb 28
- Scope out battery requirements • Jason • Feb 6 – Feb 13
- Automatically send alert message to other nodes • Jason • Mar 1 – Mar 6
- Recieve and handle messages from pathfinding • Jason • Mar 6 – Mar 10
- Display arrow directions on LCD • Jason • Mar 10 – Mar 17
- Display map directions on larger LCD • Jason • Mar 10 – Mar 17
- Detection testing with real fire and smoke • Jason • Mar 28 – Apr 7

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
- MVP
  - Optimal path generation based on inputted floor plan and fire detection from distributed node system
  - Display easy to follow path to direct occupant out of building