Wireless Temperature Sensor Network

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Background

Temperature throughout the entire building is managed through one central HVAC system.

- Goal is to keep every room at a constant temperature
- As the seasons change, the HVAC system needs to be manually adjusted

Heating
Ventilation
Air
Conditioning

Background

Customers:

- CEA Student Body
- Professors
- Staff
- Guests
  - Corporate Representatives
  - Collegiate Representatives
  - Sponsors ($$$)
  - Family
  - Friends

Needs/Demands of the customers:

- Comfortable temperature of classrooms/offices
- Constant temperature between rooms
- Appropriate Adjustment of HVAC system relative to the current season
- Efficient temperature management throughout the day

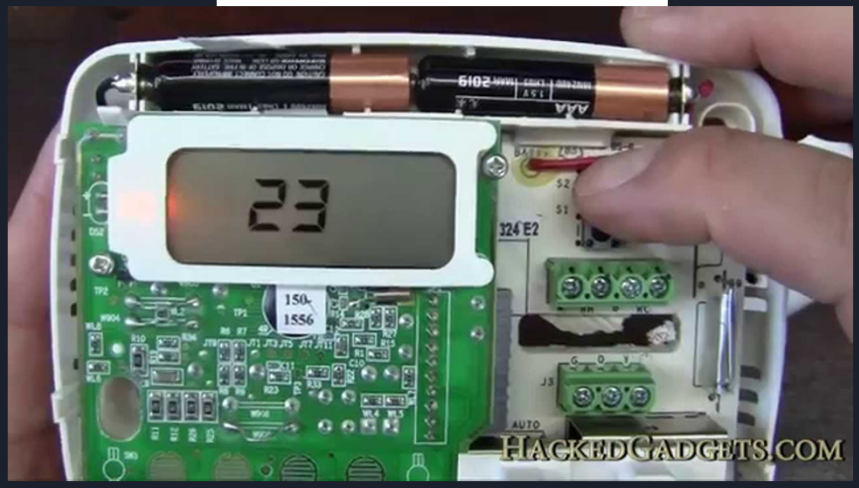
Problem Formulation

The temperature within rooms of Lewis K. Downing are being managed inefficiently.

- Temperature is NOT consistent between rooms
  - Overheating and under-heating of rooms is an inefficient use of electricity
- Different rooms serve different purposes
  - Requires different temperatures (Ex. Computer labs)
- Temperature is not kept consistent within one room
  - Cooler in morning and evening
  - Warmer in afternoon

These factors affect the overall comfortability of all personnel within the building.

Problem Formulation



From an engineering standpoint:

- No processing power is being used to manage the temperature between rooms.
  - Also between different areas in one room
- Most active temperature sensors are built into the HVAC system itself
  - Does not measure the temp in each room accurately, in real time
- Electricity usage and HVAC usage is not recorded accurately

Problem Statement

Currently, the temperature management system within the Lewis K. Downing building through the use of a commercial HVAC is inaccurate and inefficient, raising a need for a customized, hybrid HVAC system which can sense and adjust the temperature in each room separately in real time.

Design Requirements

- Implement performance diagnostics to check the operation of the system periodically
- Offer rerouting capabilities if a node malfunctions
- Offer encryption/decryption algorithms for security purposes

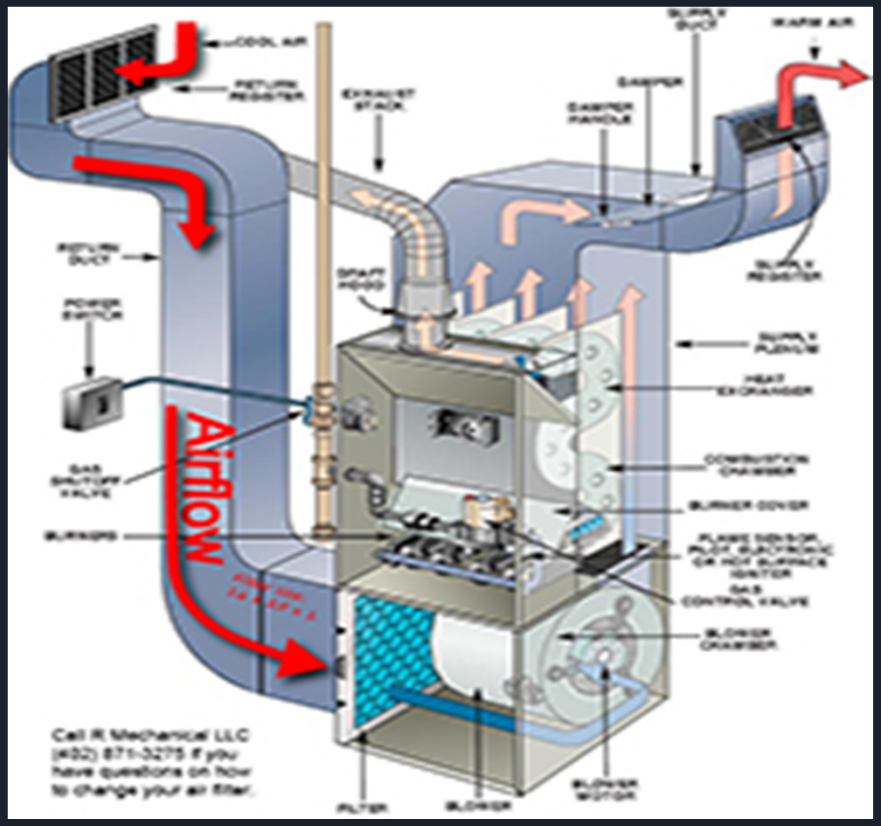
Cost:

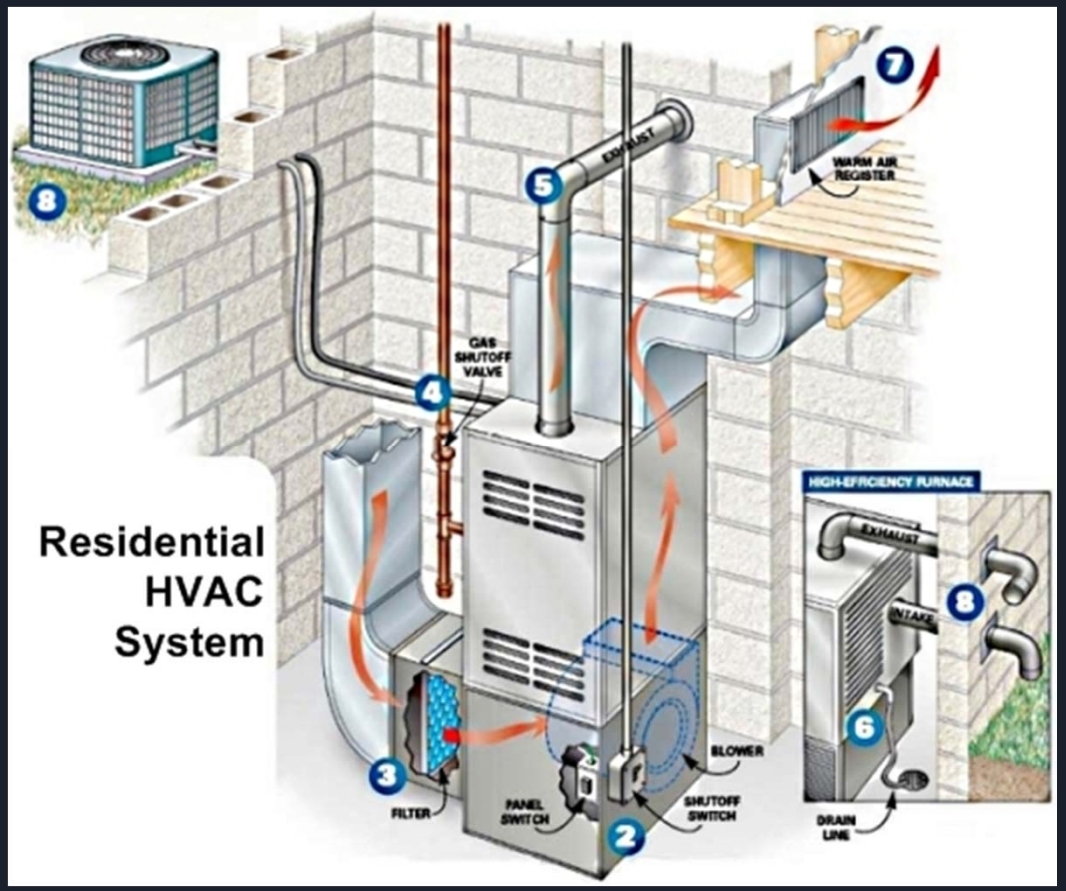
- Arduino Microcontrollers (5) with temperature sensors
- Raspberry Pi 3 (database)

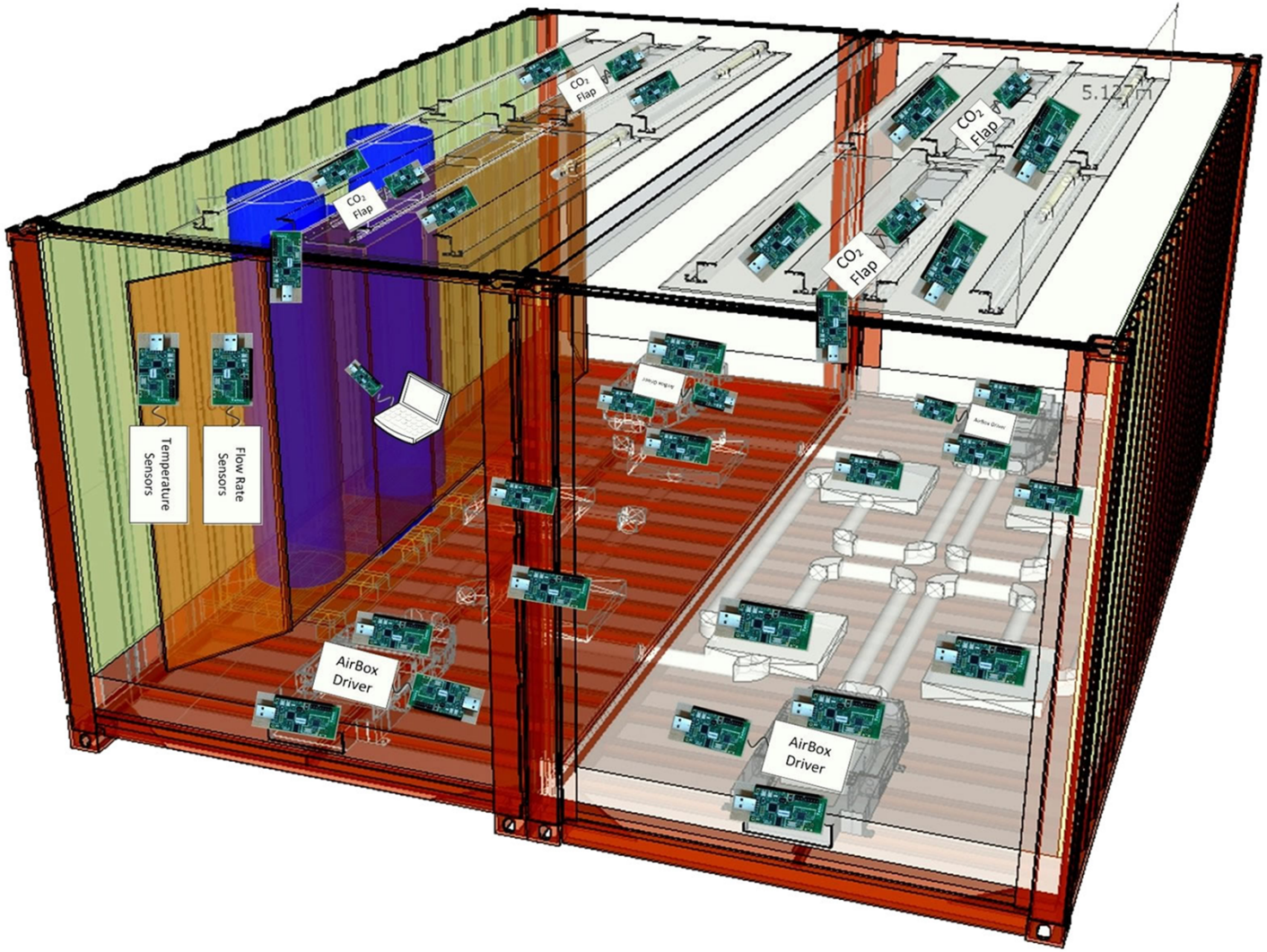
Energy/Power:

- Should meet the SAE Standard J1455 regulations regarding environmental practices for electronic equipment

Current Status of Art

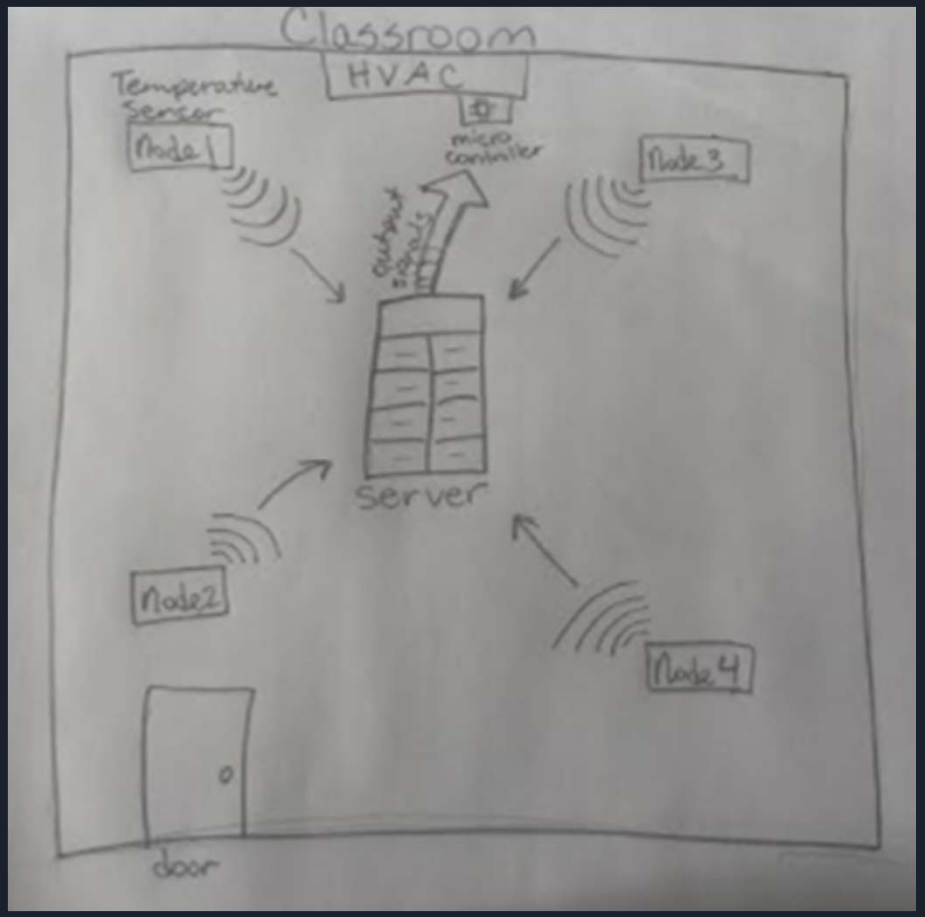



Residential
HVAC
System
8
7
WARM AIR
REGISTER
5
EXHAUST
GAS
SHUTOFF
VALVE
4
HIGH-EFFICIENCY FURNACE
EXHAUST
INTAKE
8
6
3
FILTER
PANEL
SWITCH
2
BLOWER
SHUTOFF
SWITCH
DRAIN
LINE


CO_2 Flap
CO_2 Flap
CO_2 Flap
CO_2 Flap
5.127m
Temperature Sensors
Flow Rate Sensors
AirBox Driver
AirBox Driver

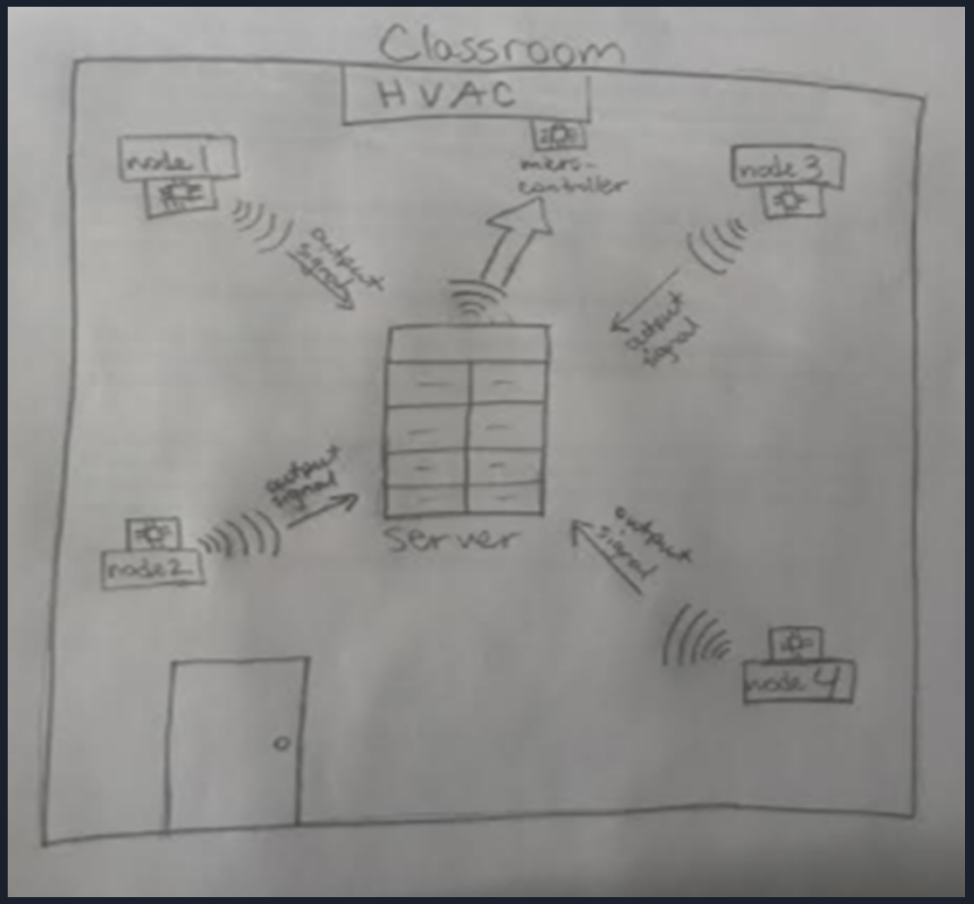
Solution Approaches

Concept 1:



Solution Approaches

Concept 2:



Solution Approaches

Concept 3:

- Attach one external temperature sensor directly to the HVAC unit.
  - Minimizes the distance signals have to travel.
  - Could also be used for error detection of the HVAC's internal system.
  - No external server

Concept 4:

- Using an FPGA device to control the input signals being passed from the sensors to the HVAC
  - FPGA would act as a small scale processor, propagating certain signals from the sensors to the HVAC.
  - No external server.

Solution Selection Process

- The categories used in the decision matrix included:

Cost, Functionality, efficiency, Reliability, and Practicality

- After weighing through the pros and cons of each solution concept in each category, the team decided to narrow down the selection to **Concept 1** and **Concept 2.**

Solution Selection Process

Concept 1:

Pros:

- Not having processors on each node cuts down on cost
- Having an external server provides storage for recording measurements
- Easy to troubleshoot

Cons:

- May cause a slight increase in latency
- Increases the strain on the server's processing power

Concept 2:

Pros:

- May slightly decrease latency
- Reduces strain on server's processing power

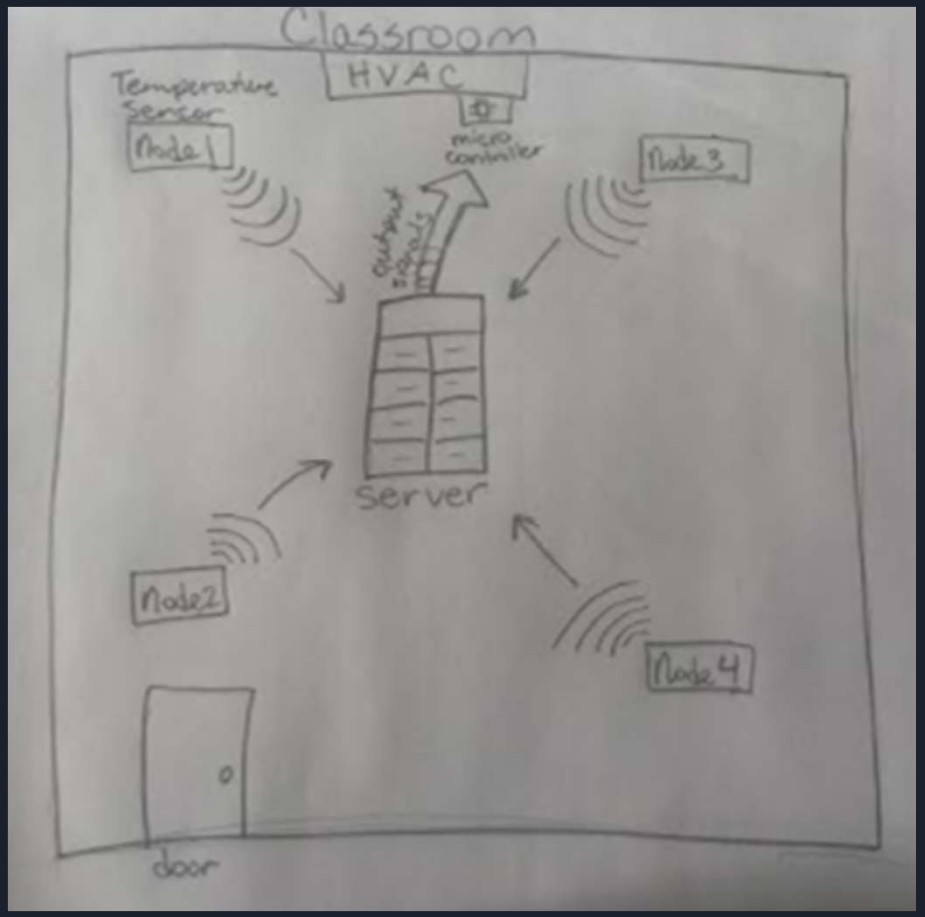
Cons:

Puts strain on each node's processing power due to continuous sensing and processing of data

Harder to troubleshoot each node

Final Solution

Concept 1:



Conclusion

Problem:

Currently, the temperature management system within the Lewis K. Downing building through the use of a commercial HVAC is inaccurate and inefficient, raising a need for a customized, hybrid HVAC system which can sense and adjust the temperature in each room separately in real time.

Proposed Solution:

A network of wireless temperature sensors that takes measurements of the temperature in different sections of a room, averages those measurements, and transmits that data to an external database that wirelessly controls the operation of a customized HVAC system.

Thank You

Any Questions?