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Wireless Temperature Sensor Network

2nd EECS Day

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Electrical Engineering and Compute Science Howard University

Kolby Lacy
Senior
Computer Engineering Major

Sean Grant
Senior
Computer Engineering Major

Faculty Advisor: Dr. Hassan Salmani

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
- Different rooms serve different purposes
- Temperature is not kept consistent within one room

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

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.

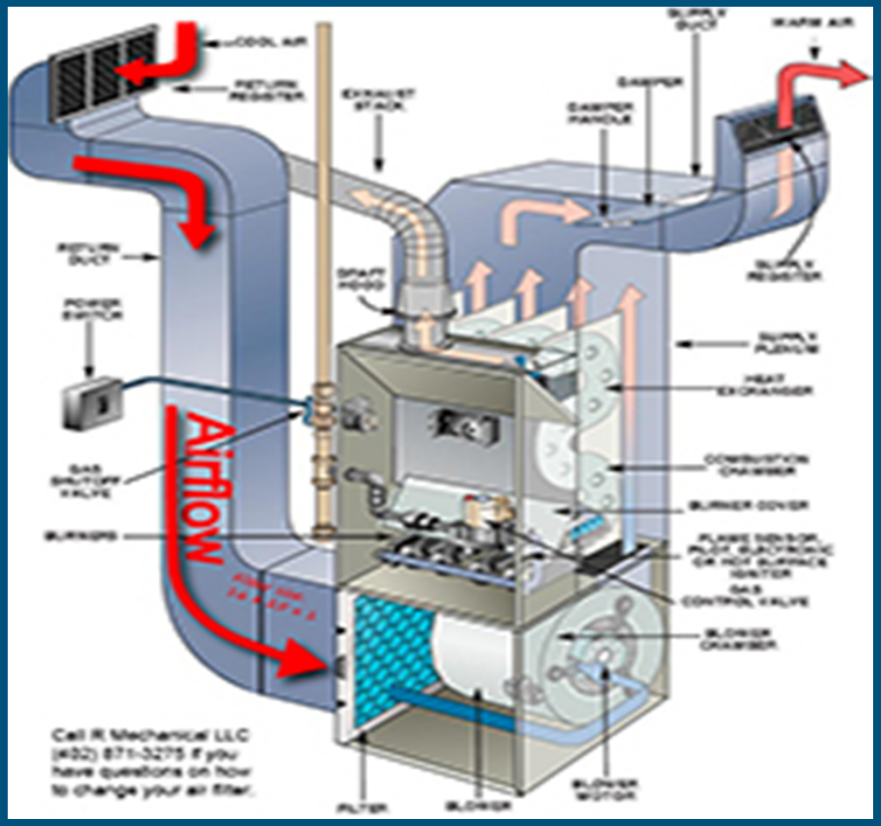
Design Requirements

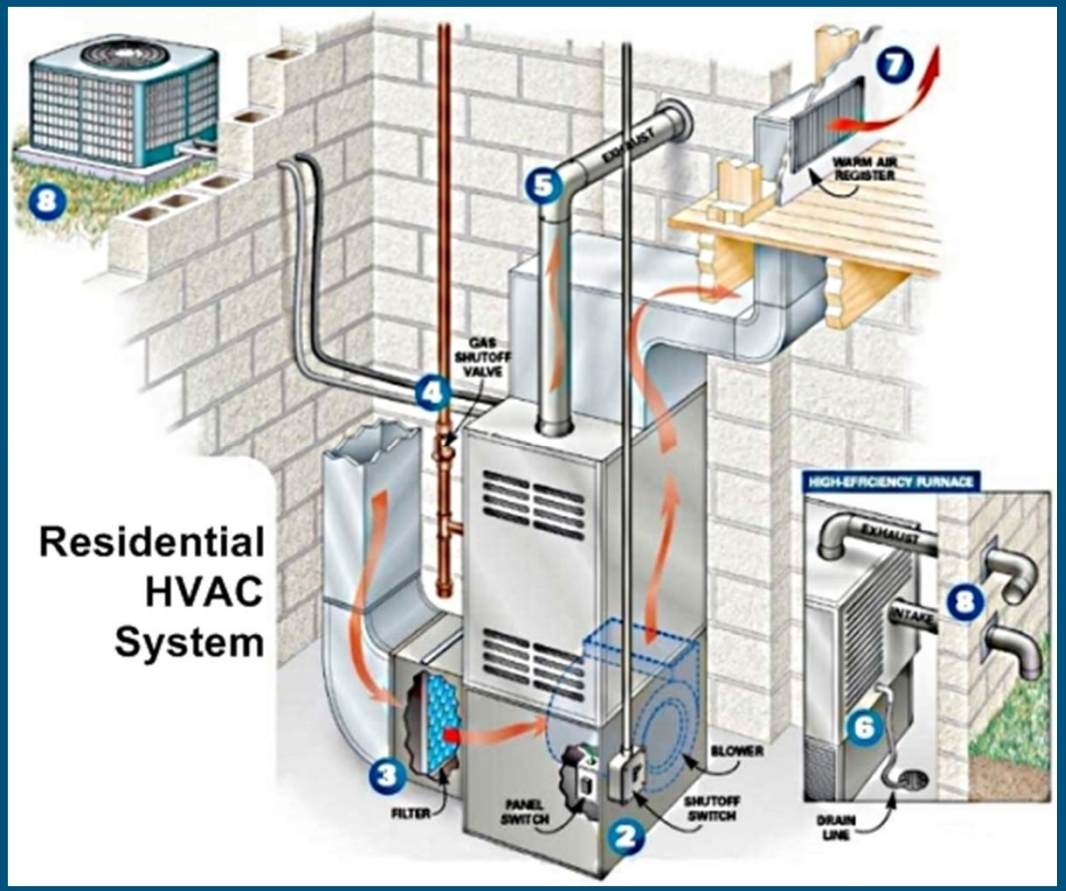
- Implement performance diagnostics to check the operation of the system periodically
- Offer rerouting capabilities if a node malfunctions
- Offer encryption/decryption algorithms for security purposes

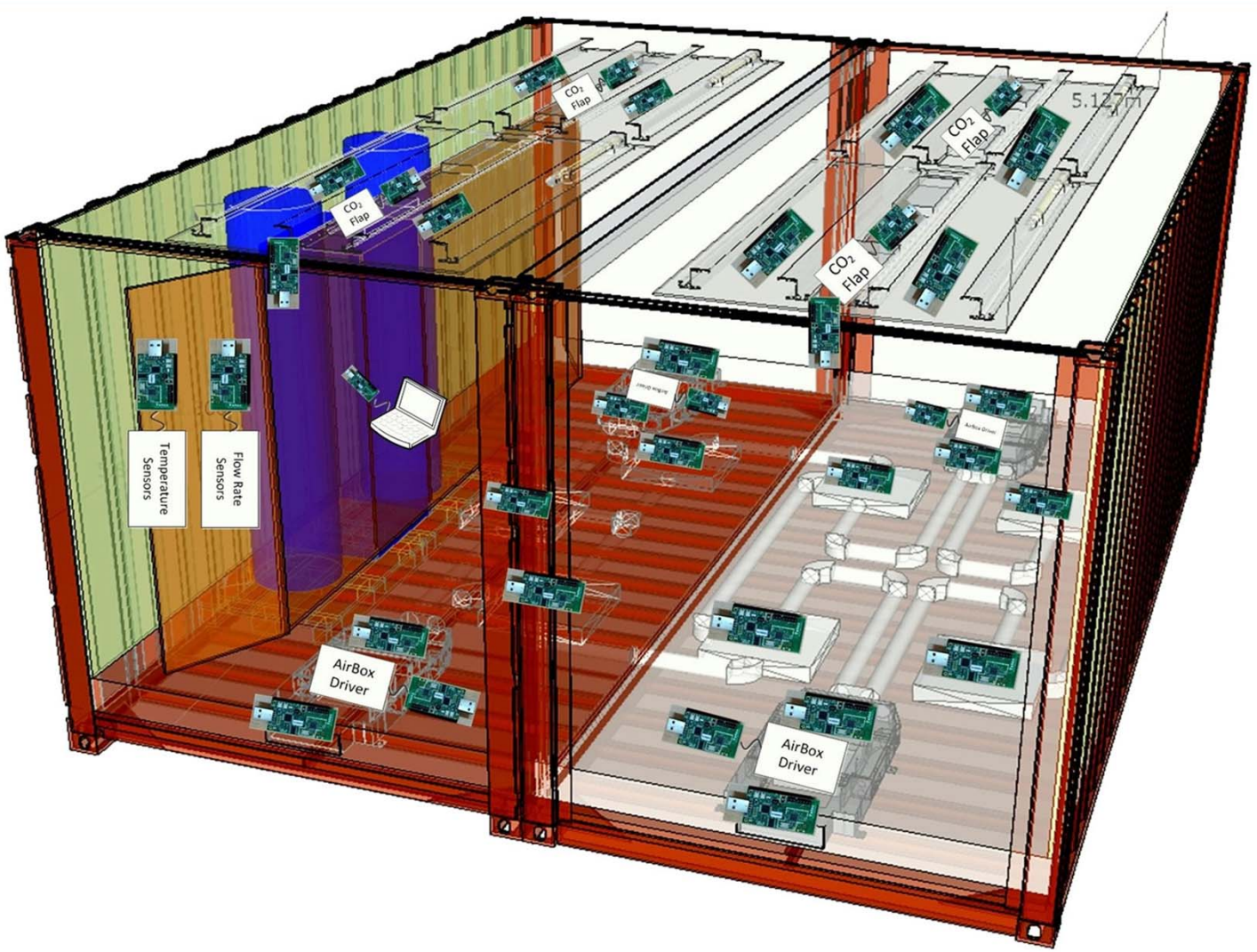
Energy/Power:

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

Current Status of Art

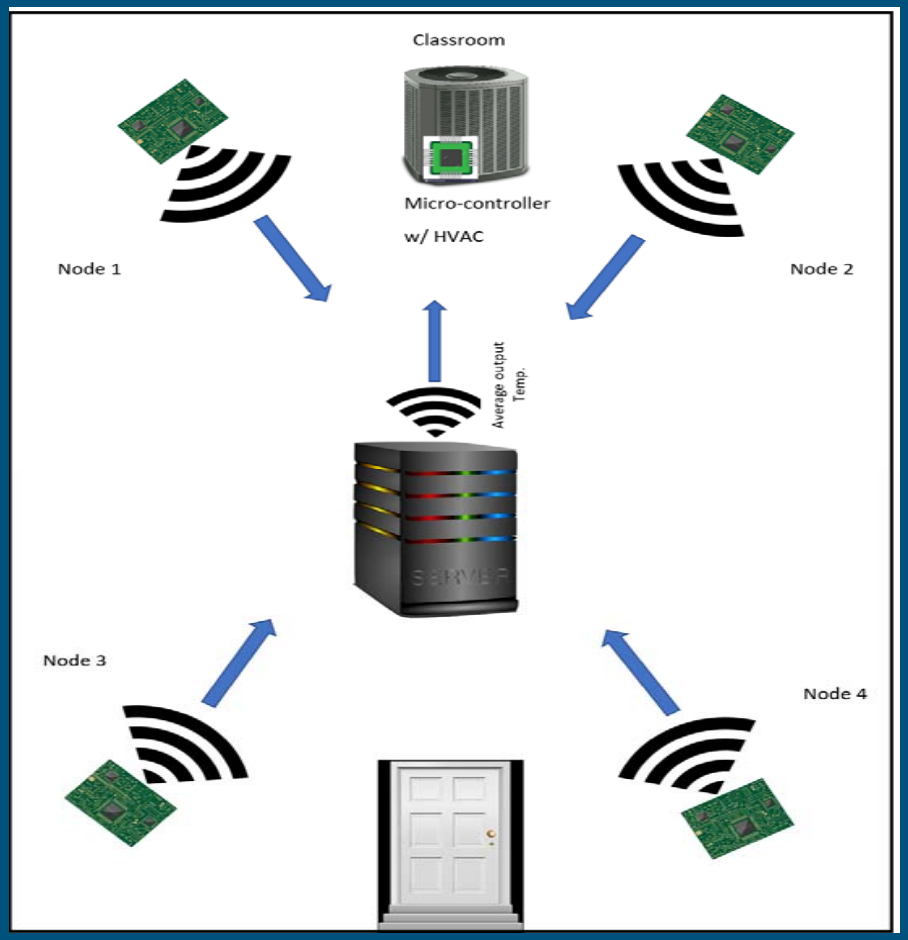



Residential
HVAC
System
EXHAUST
WARM AIR
REGISTER
GAS
SHUTOFF
VALVE
HIGH-EFFICIENCY FURNACE
EXHAUST
INTAKE
BLOWER
FILTER
PANEL
SWITCH
SHUTOFF
SWITCH
DRAIN
LINE


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

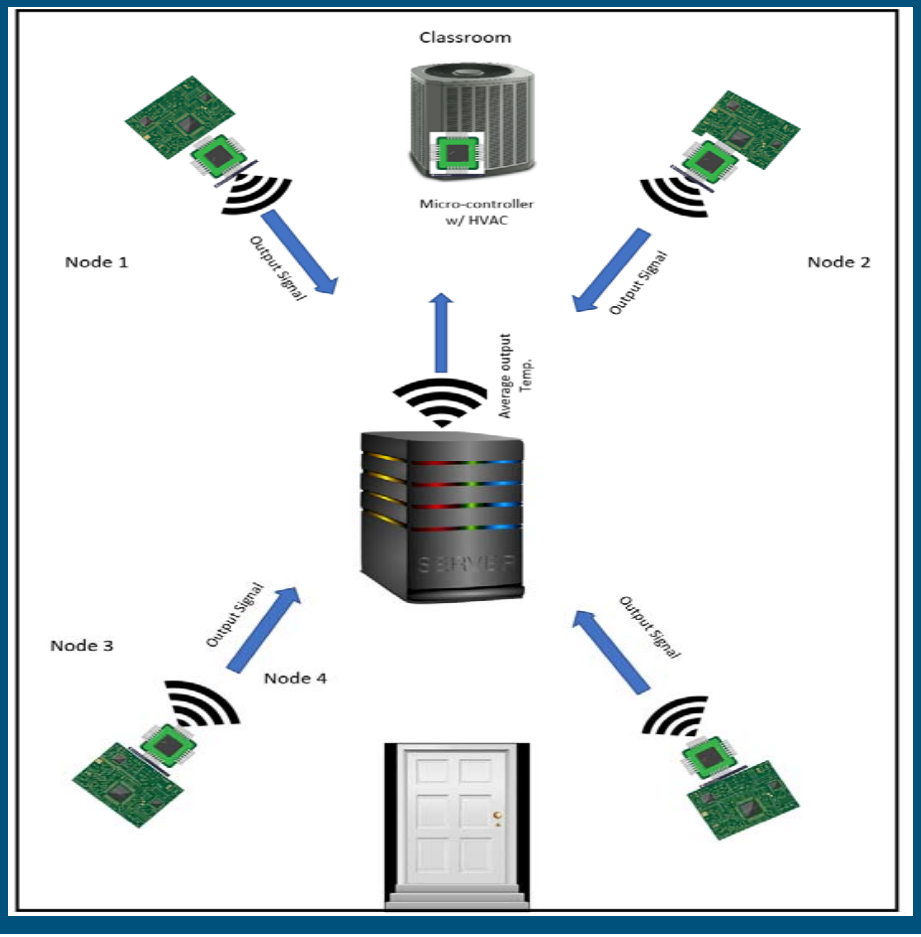
Solution Approaches

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

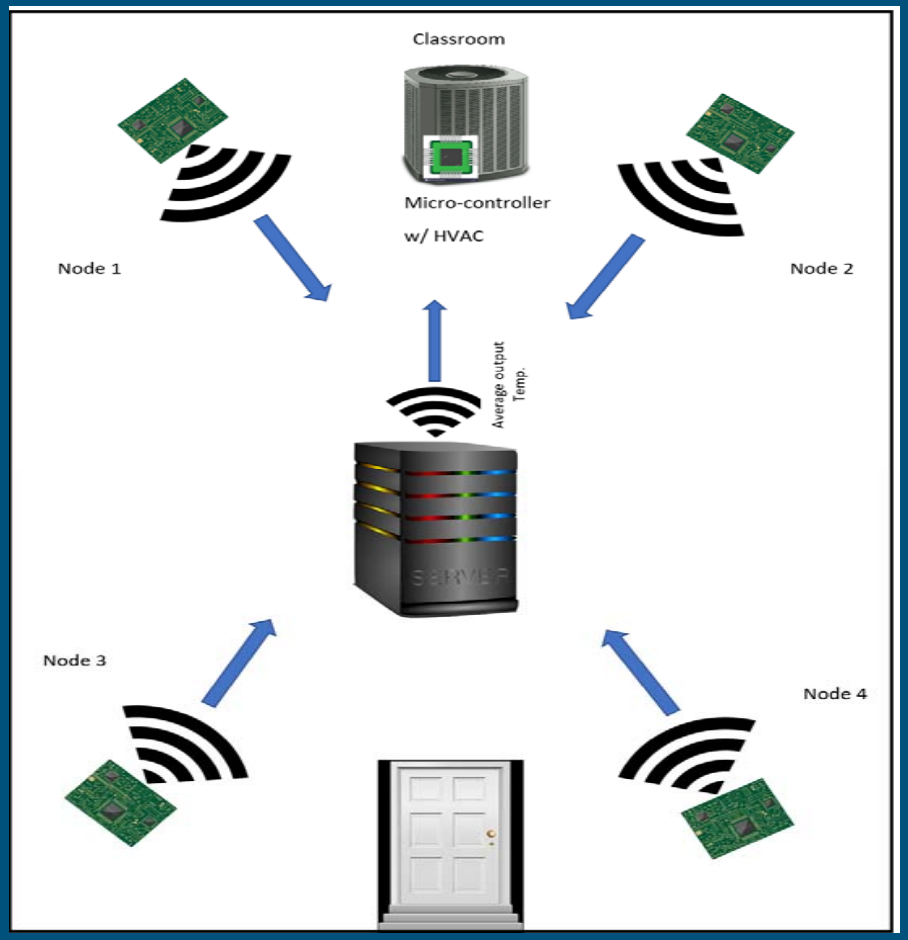
Concept 2:

Pros:

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

Final Solution

Concept 1:

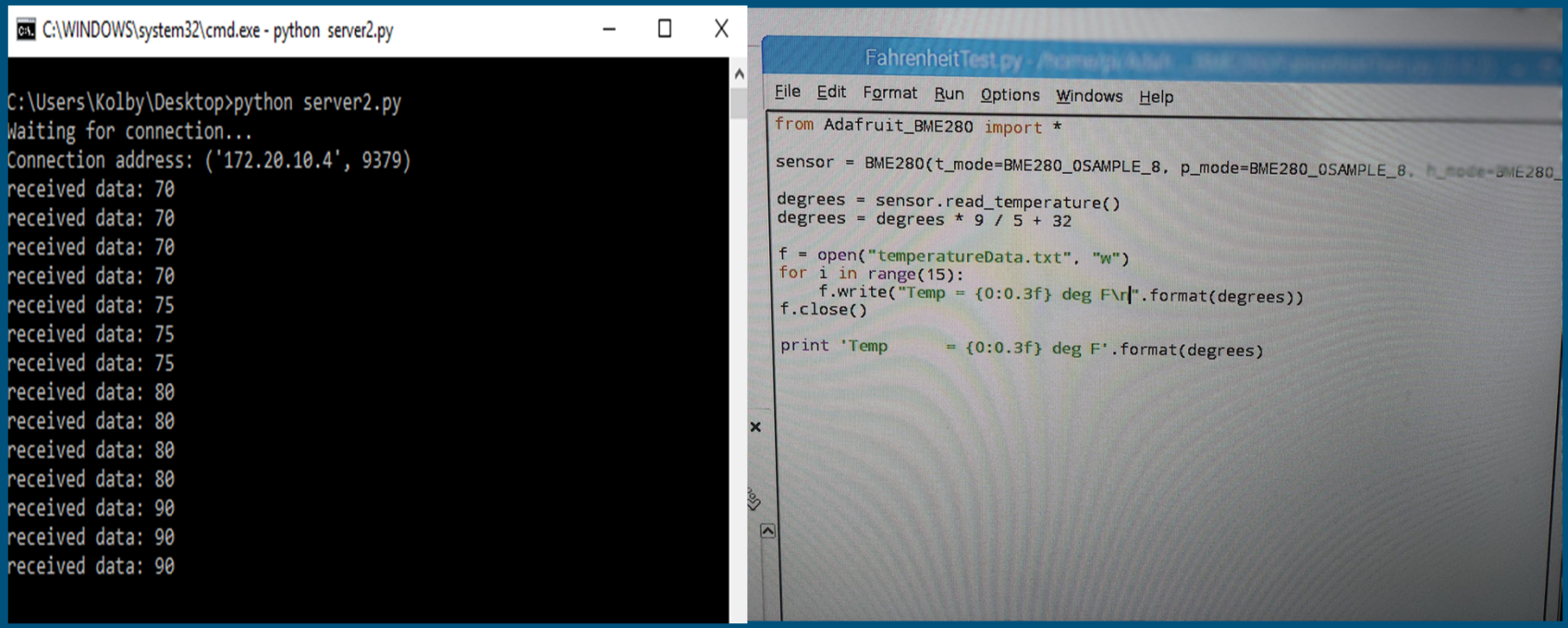


Implementation

- Utilized a Raspberry Pi 3 board
- Developed a database for recording all temperature entries
- Used a breakout board to connect temp. sensor to the Raspberry Pi
- Used an analog temp. and pressure sensor to collect measurements.

Side Note: Last step is to duplicate the code for the one board onto other boards and establish the connection with the database.

Implementation



Conclusion

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

- 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.

Thank You

Any Questions?