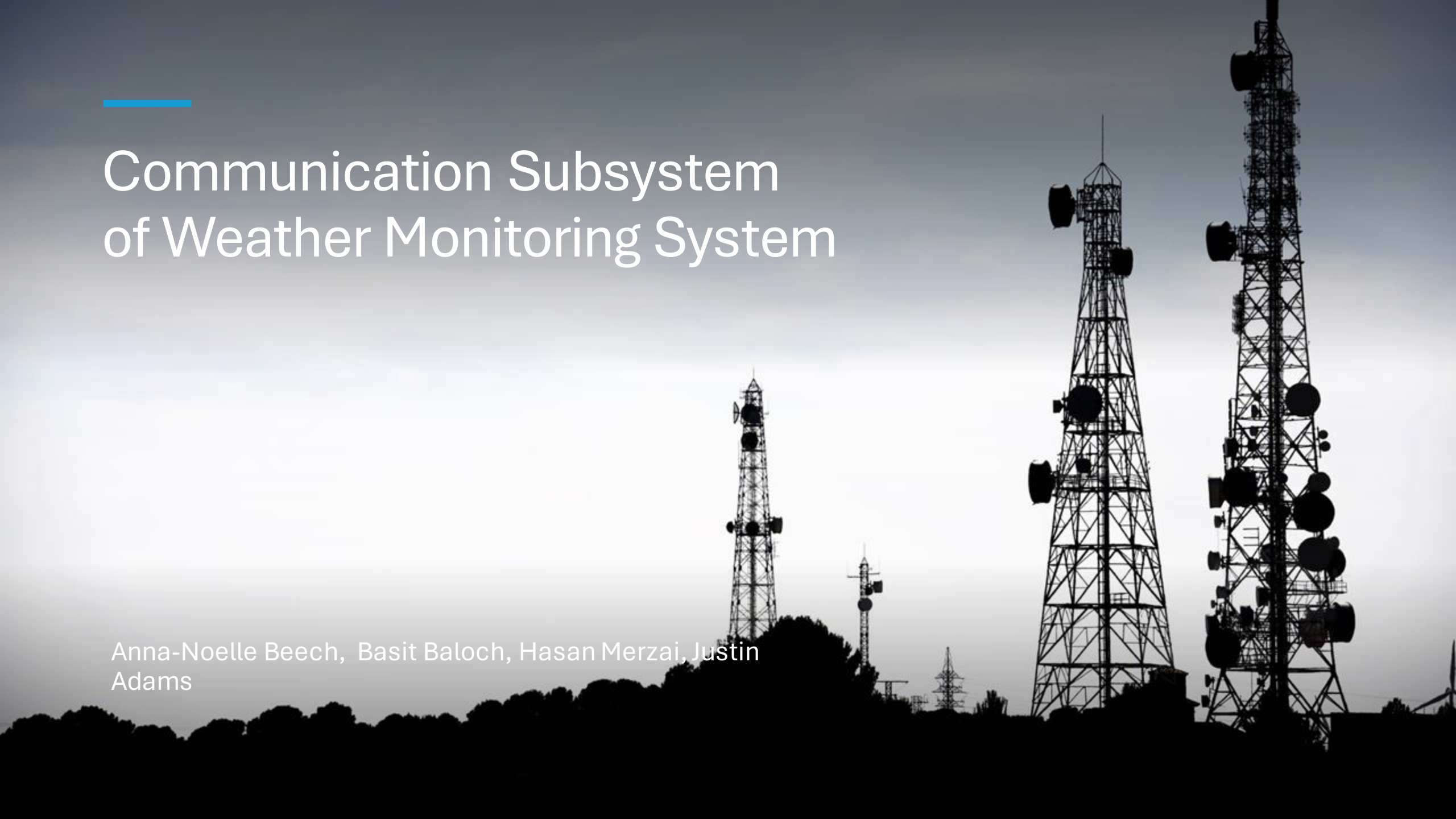
Communication Subsystem of Weather Monitoring System



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Problem Statement

The New York State Department of Environmental Conservation needs a better understanding of the impact of climate change on microclimates within New York State so that they can mitigate adverse effects and take appropriate preventative measures.

Inspiration

Vevor 7 in 1

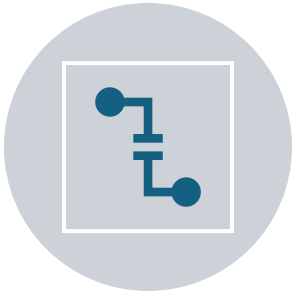
Tempest

Ambient

- All have in common multiple sensors, Wi-fi connectivity , and solar power
- Inspired most by Tempest using only a smartphone interface, potentially reducing cost.
- Limitation gap we plan to close is offline storage

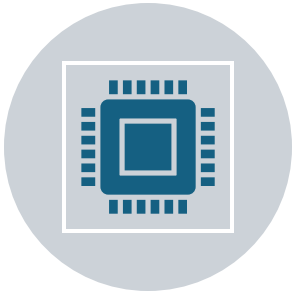
Critical System Requirements

Range: The communication system should have a range of about 0.5 miles(max) to transfer data between outdoor and indoor units and potential connectivity with the NYDEC server or signal.



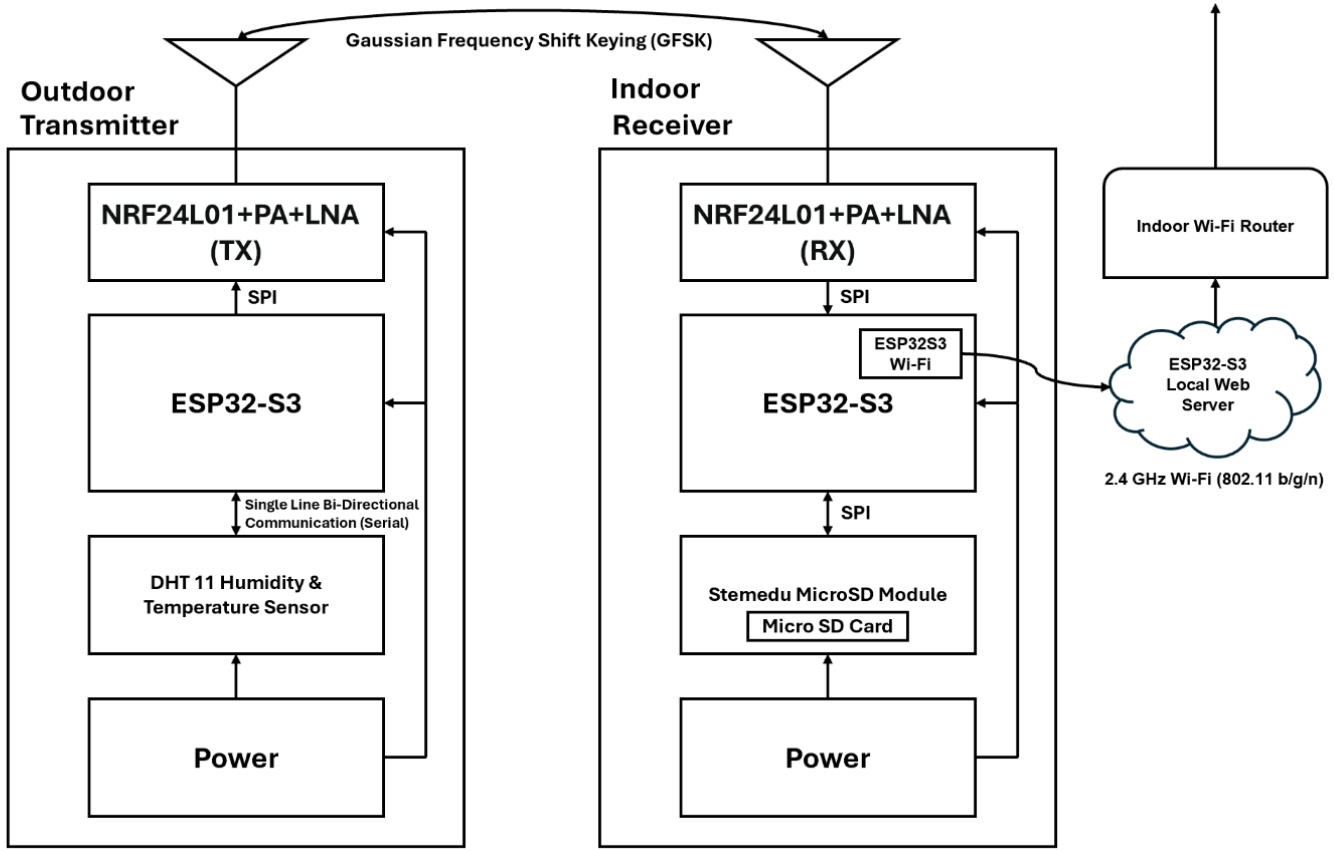
Power Consumption: The outdoor unit should maintain low power consumption under 50mW to ensure continuous sustainable operation. The indoor unit is connected to wall power, so power is not a constraint.

Wireless Communication: Utilize RF communication for wireless connectivity between outdoor and indoor units and Wi-Fi to the NYDEC server, ensuring seamless data transfer.



Time: The system must collect and send live data every minute to replicate and ensure relatively real time data.

System Design



Key Decisions: Microcontroller

Microcontroller

Criteria	Weight (1-5)	ESP32-S3	ATmega328p	Raspberry Pi Pico W
Cost-effectiveness	5	3	5	1
WI-FI	5	5	1	5
Number of GPIO pins	3	5	3	5
Power Efficiency	4	4	2	5
Core count (dual/single)	2	5	3	5
Total		81	50	75

Selected MCU : ESP32 - S3

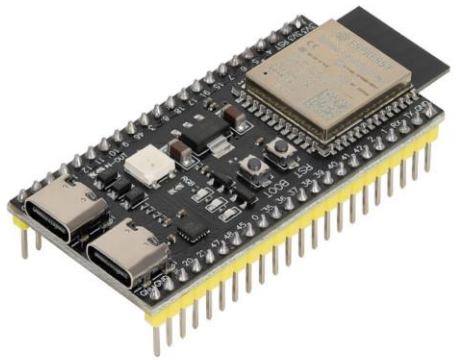
Key Decisions: Data Transmission Module

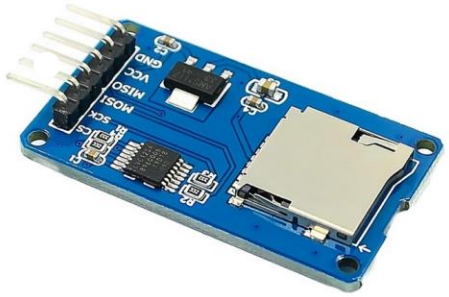
Data Transmission Module				
Criteria	**Weight (1-5)**	**NRF24L01+PA+NLA**	**HC-12**	**LoRa sx1278**
Range	5	4	3	5
Transmission speed	4	5	3	2
Power efficiency	4	5	5	5
Cost-effectiveness	5	4	5	3
Simplicity	2	3	5	1
Total		86	82	72

Selected module：NRF24L01+PA+NLA

Parts

Junior Design Project 4A - Weather Monitoring System (Communication)			
Units	Item	Unit Price	Total
2	NRF24L01+PA+LNA RF Wireless Transceiver Module	$4.80	$9.59
2	ESP32- S3	$4.85	$9.70
1	Micro SD Card Module	$3.00	$3.00
			Complete Total
			$22.29

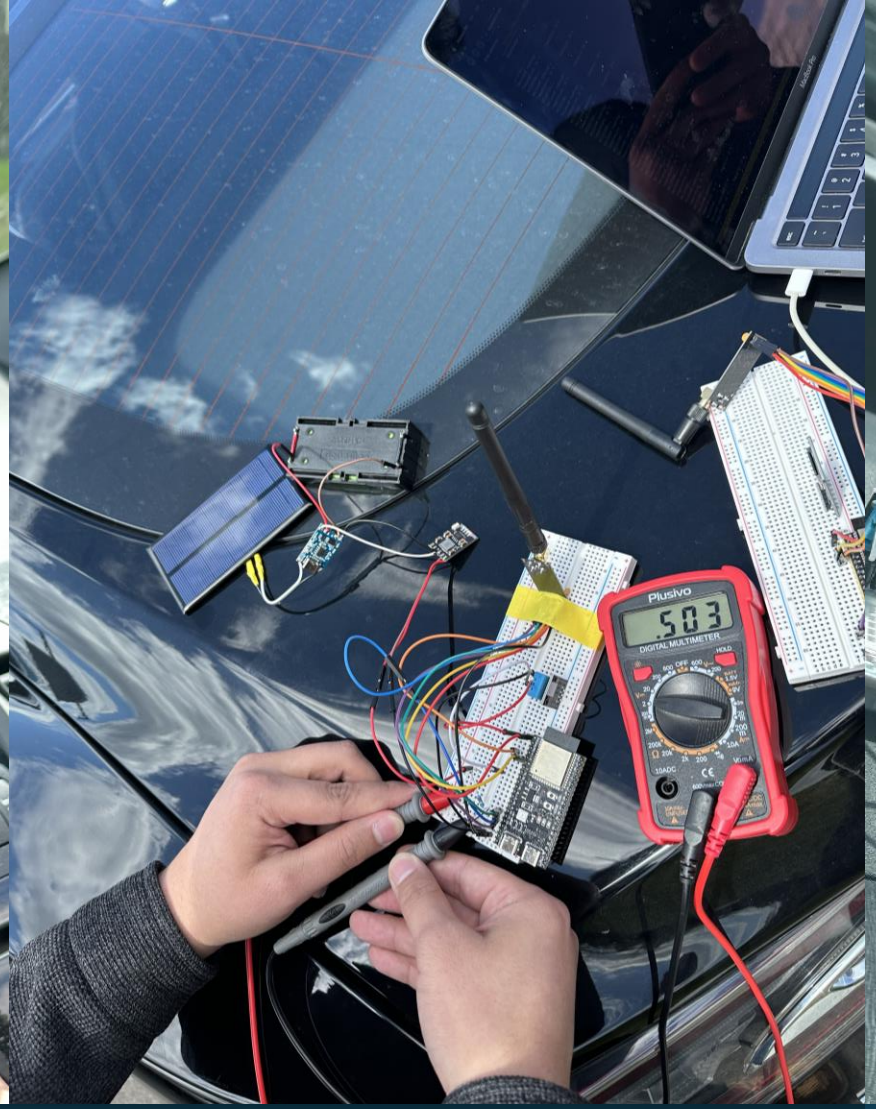




Additional Parts outside of our scope for testing:

- Humidity and Temperature (DHT) sensor
- Solar panel
- Battery Protection
- Lithium-ion Batteries


Monitor
CDC/ACM, 115200
SEND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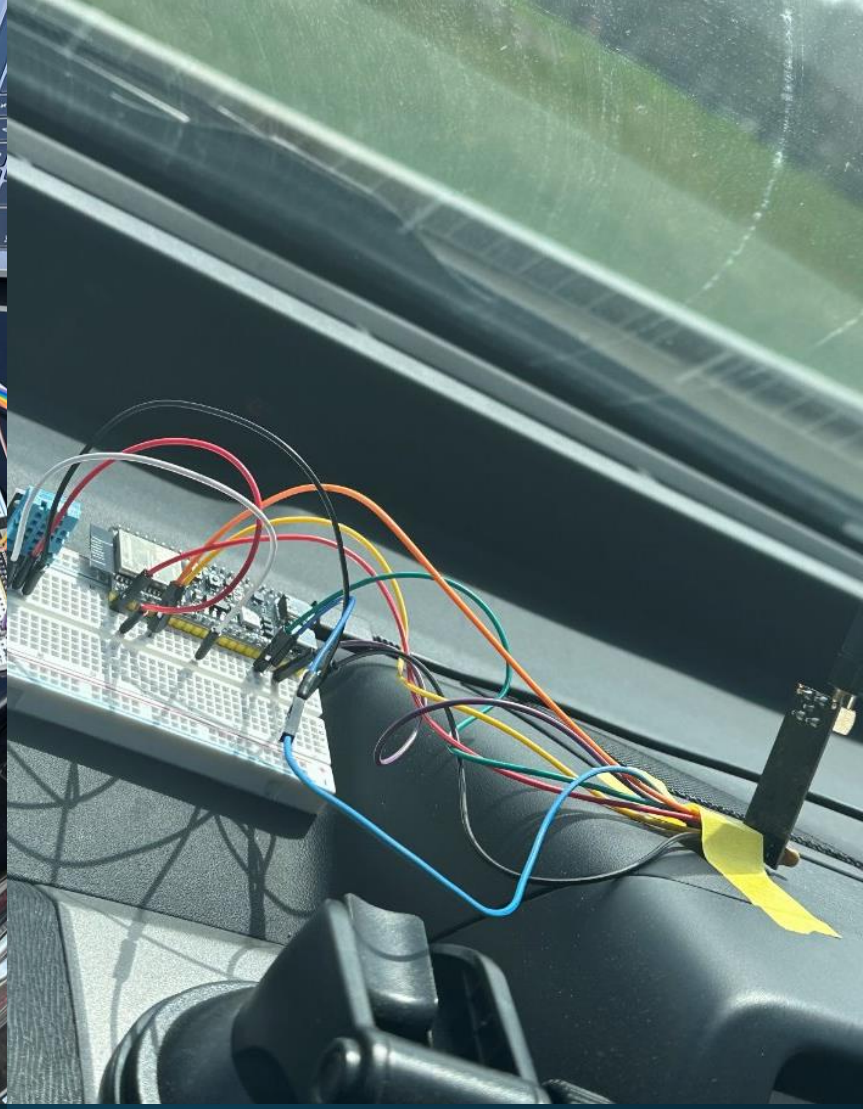
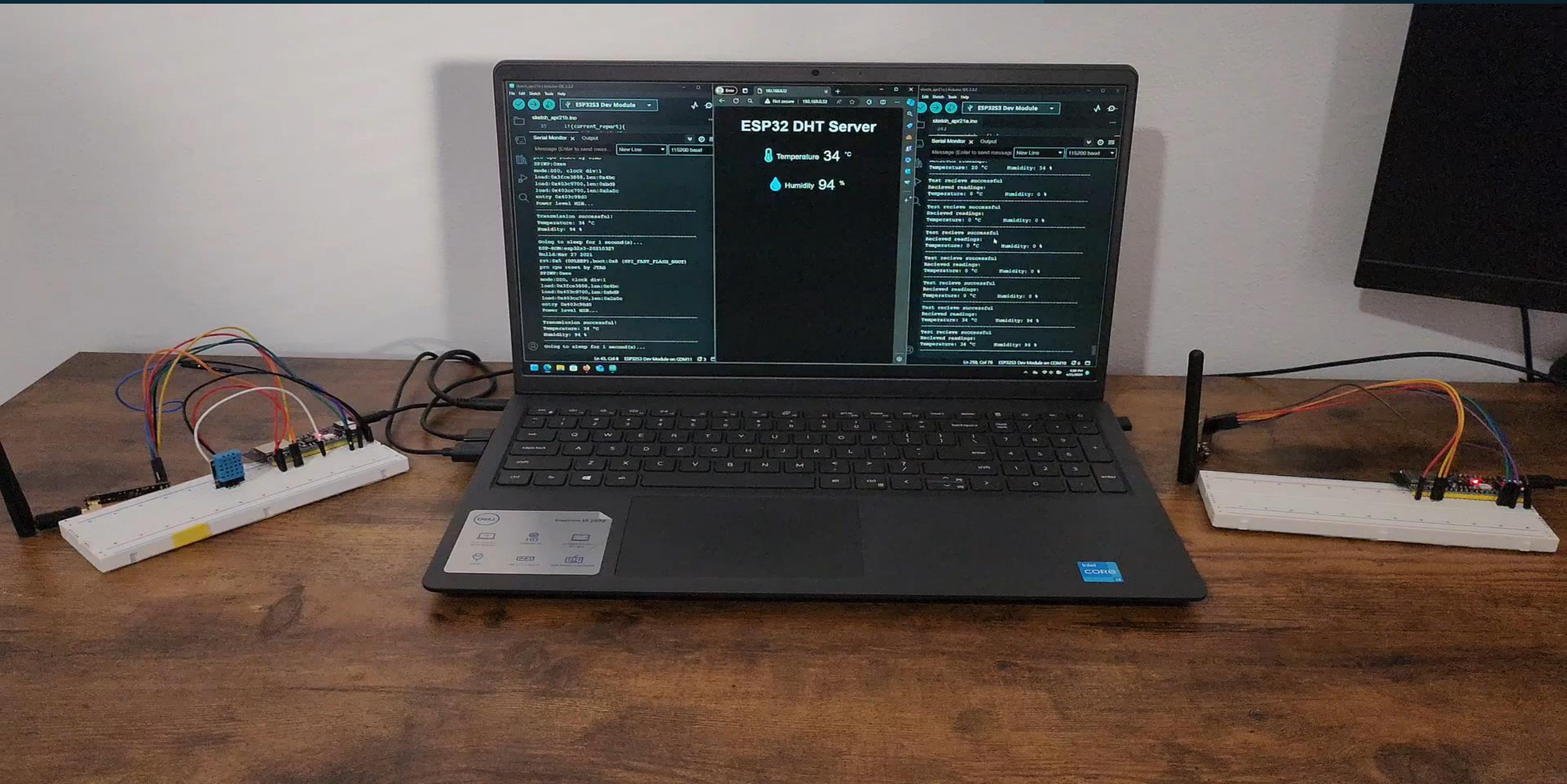
DIGITAL MULTIMETER



Testing

Demo



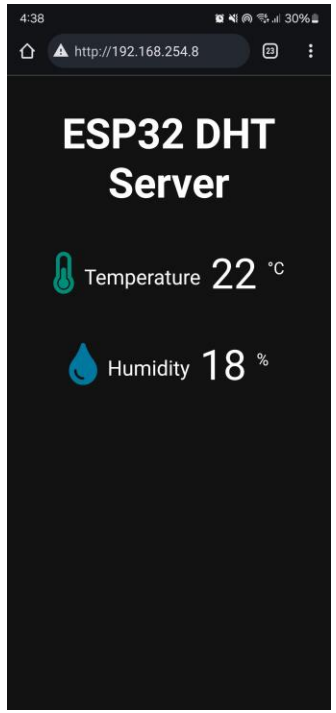
Testing Results Analysis

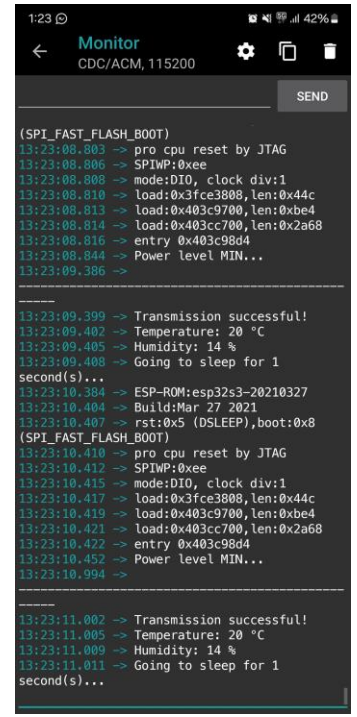
Communication Testing					
Distance (meters)	Distance (miles)	Transmission (TX)	Recieving (RX)	Wifi Connection	Web Interface
105	0.065	✓	✓	✓	✓
475	0.295	✓	✓	✓	✓
550	0.342	✓	✓	✓	✓
684	0.425	✓	✓	✓	✓

Power Testing			
Voltage In	5V		
Voltage(max)	0.936V	Power **(Min)**	Power **(Max)**
Voltage(min)	0.168V	74 mW	181 mW
Resistance	11 Ohms		
Current(max)	39.6 mA		
Current(min)	15.3 mA		

System has a successful range of up to 0.425 miles.

Power consumption is higher than expected.





Recommendations for Future Work

1. Edit the html code to make the web user interface better
2. Use a better linear voltage regulator and a MOSFET to reduce power consumption
3. Add 3d housing for both units
4. Implement offline storage

Q & A

Thank You!