

Power Consumption of Email Footers (2022)

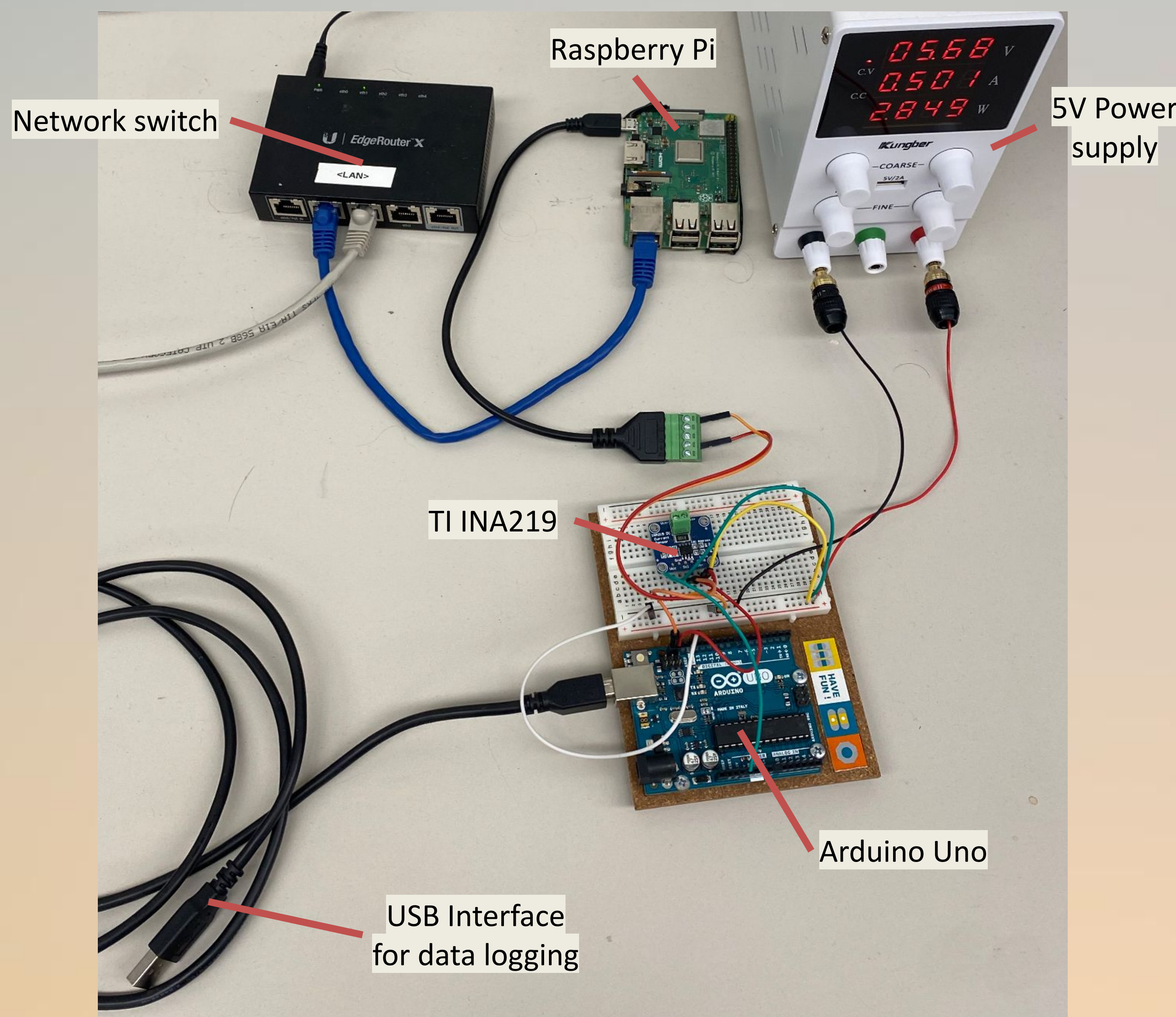
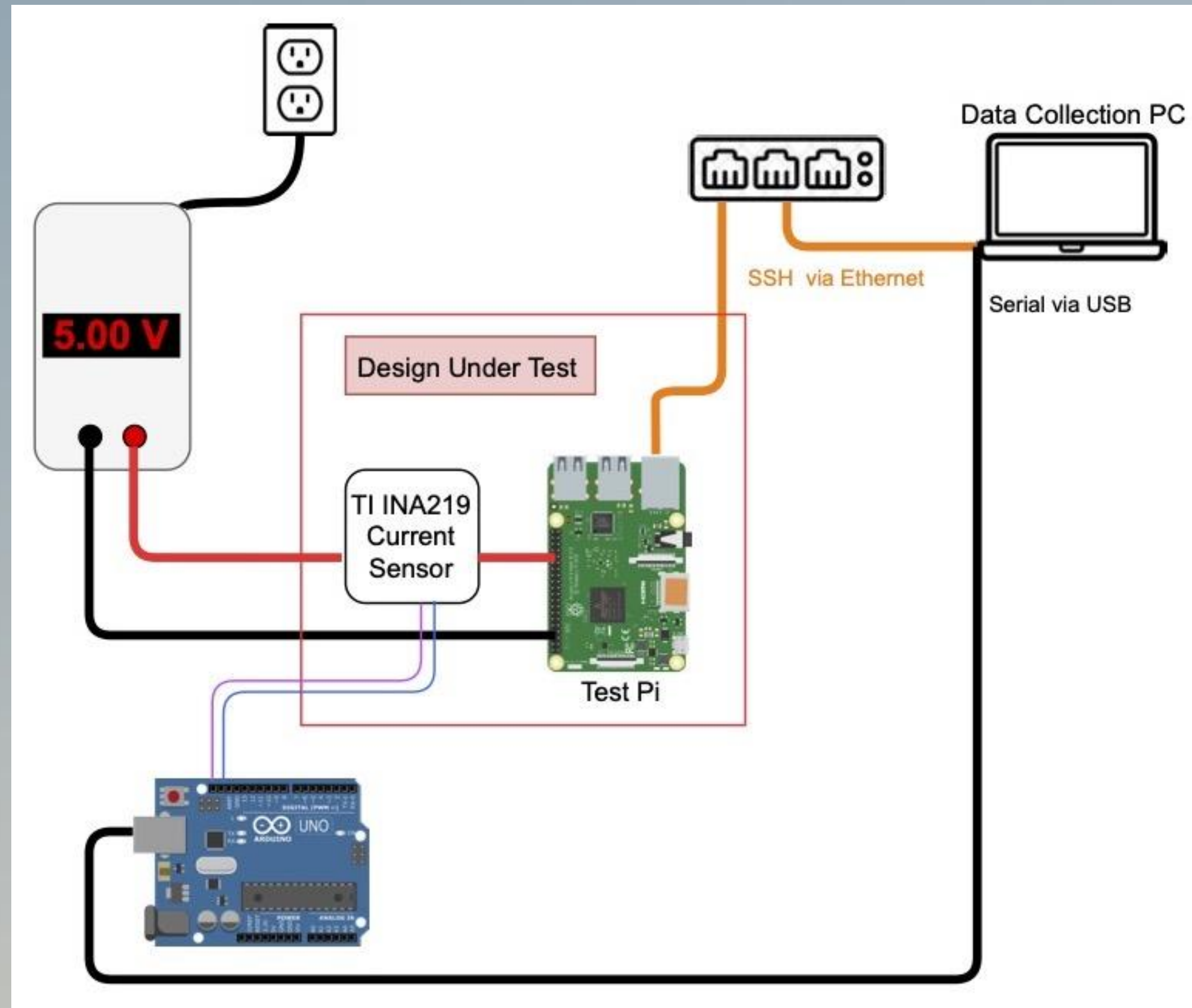
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Objectives

Our project aims to explore the energy cost of various computing operations.

System Components



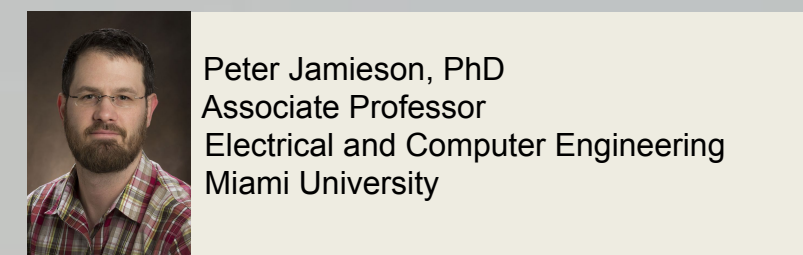
System Information

- TI INA219 Current sensor
 - ◆ Communicates with Arduino over I²C
 - ◆ Up to 26V, 3.2A
 - ◆ ±1% tolerance on current sense resistor
 - ◆ ±0.8mA current sense resolution
- Raspberry Pi 3B+ (5V)
 - ◆ Idle current draw (w/o) peripherals: ~470mA
 - ◆ Current draw pinging device on network: ~700mA
- Arduino/Python Data Logging System
 - ◆ Arduino Uno transmits INA219 sensor data over USB to PC
 - ◆ PC logs incoming serial data to SQL Database using a Python script
- Raspberry Pi is controlled over SSH on LAN with PC

Experimentation and Scripts

- Text file transfer
 - ◆ 22 Mb and 44 Mb
- Image file transfer
 - ◆ Original double, half resolution
 - ◆ Redhawk logo (4-color), “M” logo (2-color), Headshot (full-color)
 - ◆ BMP, PNG

Image and text files are sent using a Python script and “scp” secure copy command. The send script is executed in different trials on the PC and Pi, and with different source and destination locations for the files that are to be transferred. We monitor the power consumption of the Pi for each trial.



Example email footer images



Results

BMP vs PNG

BMP files are uncompressed and lossless. PNG files are compressed and lossless.

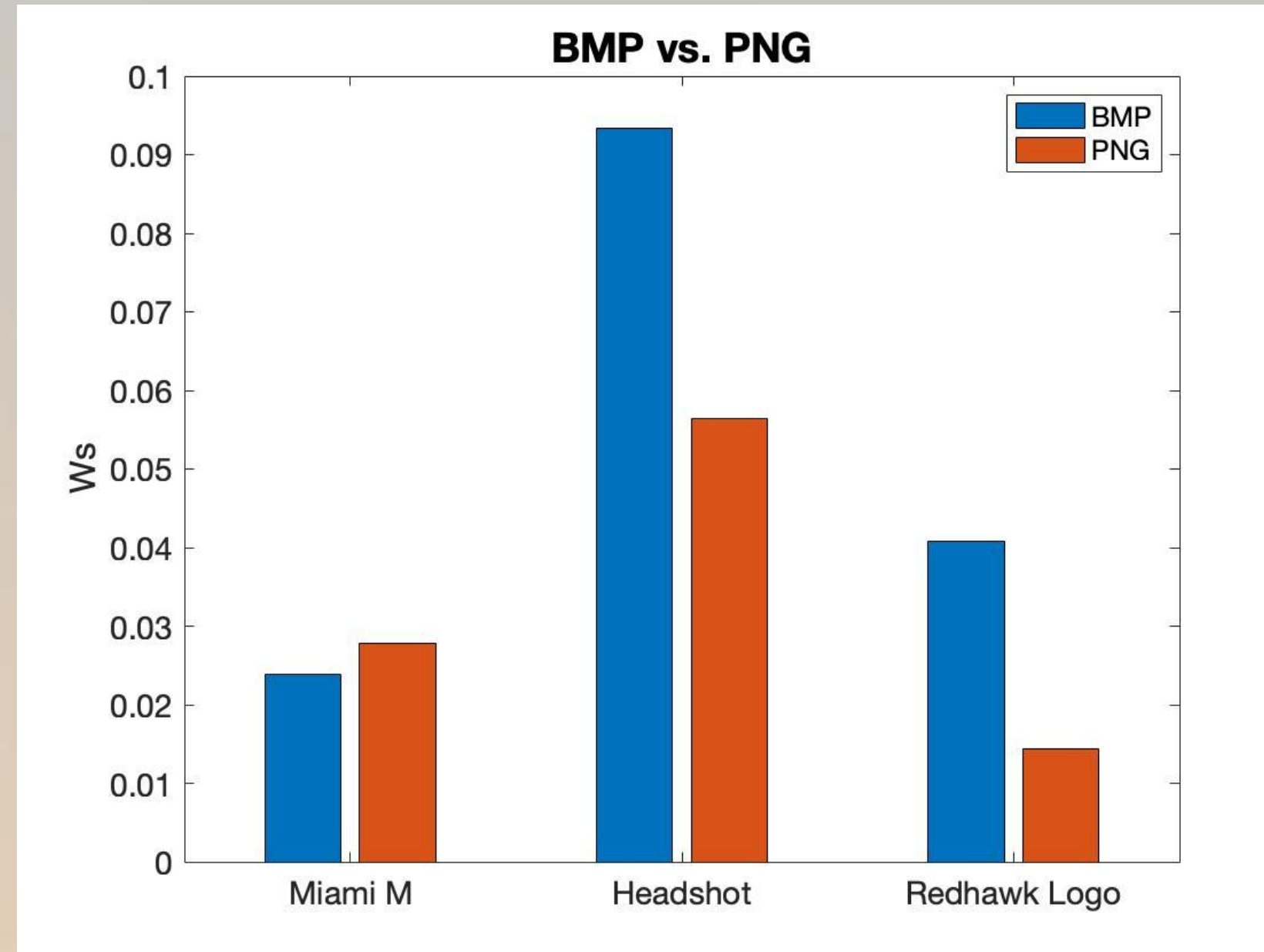


Image Size

Double size, original size, half size

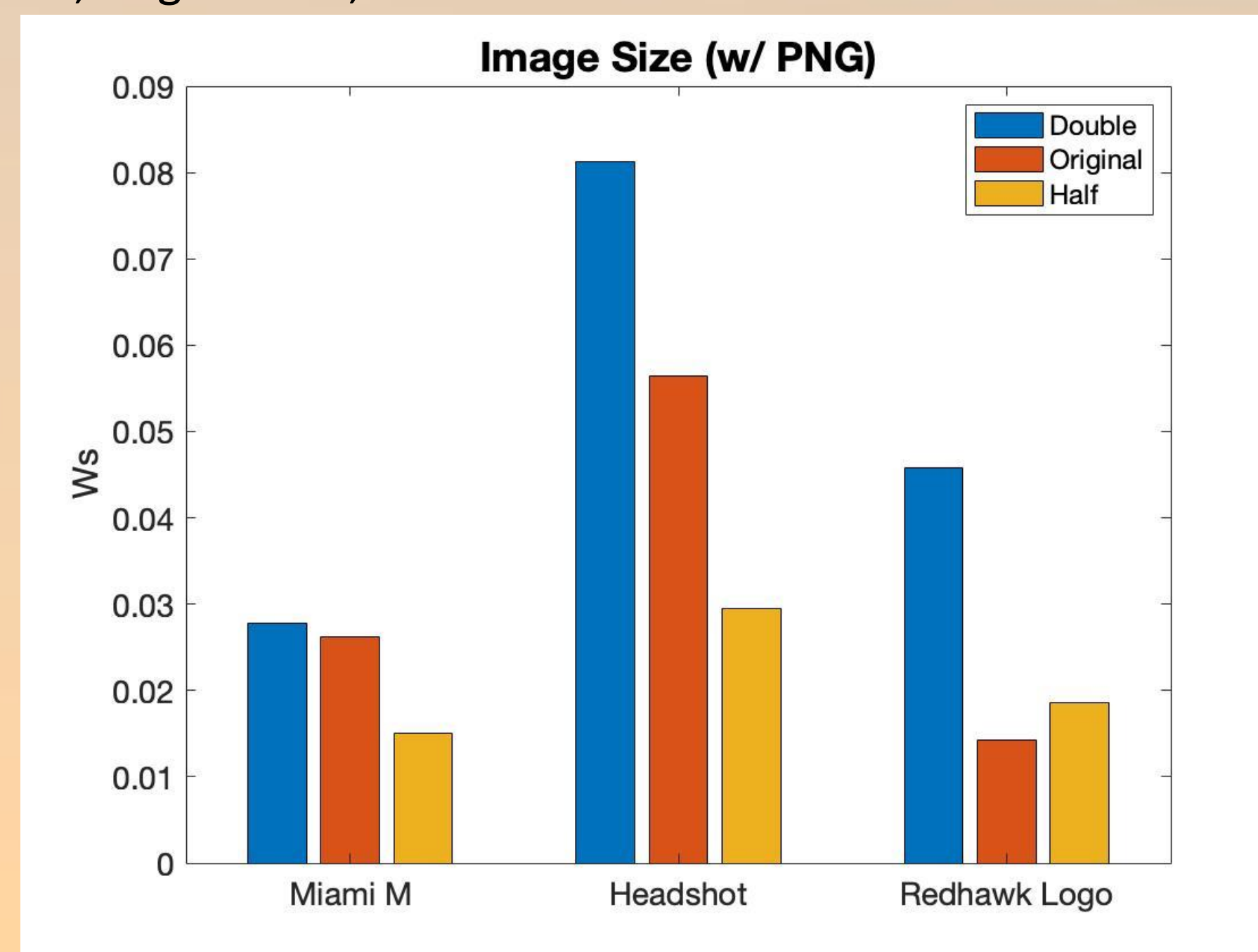
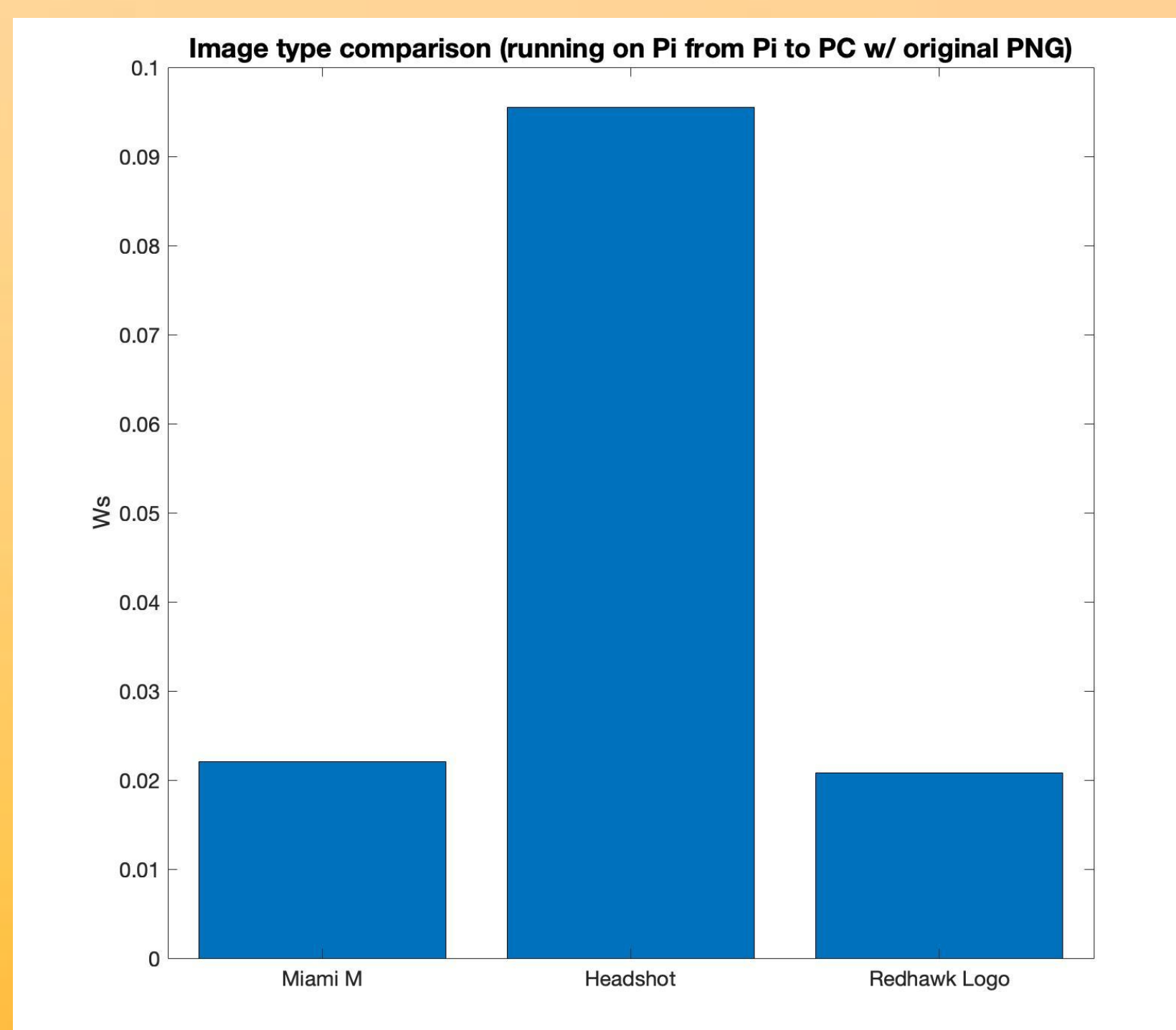


Image Type Comparison

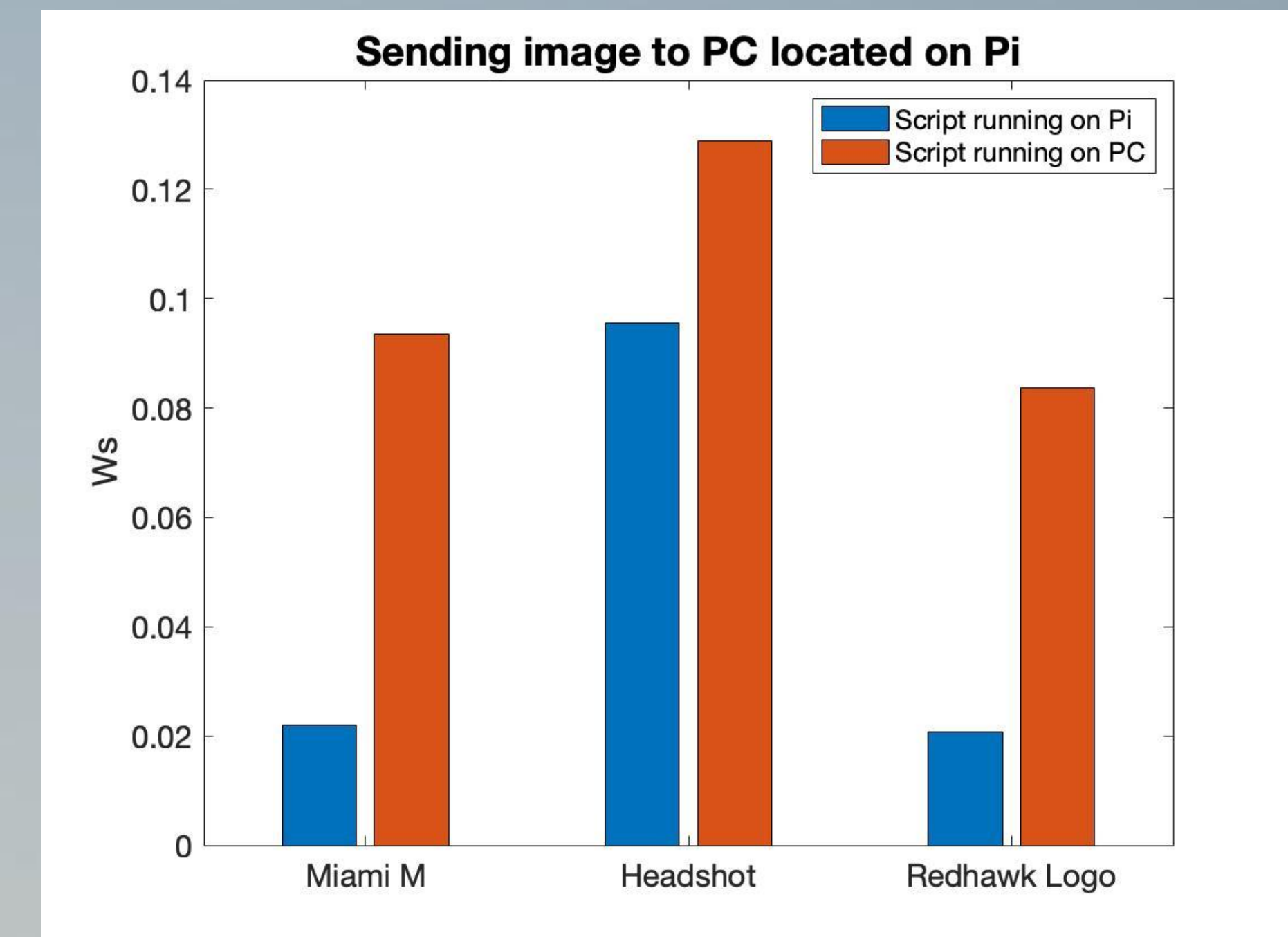
Full color headshot, four color Redhawk logo, two color Miami “M” logo



Results (cont'd)

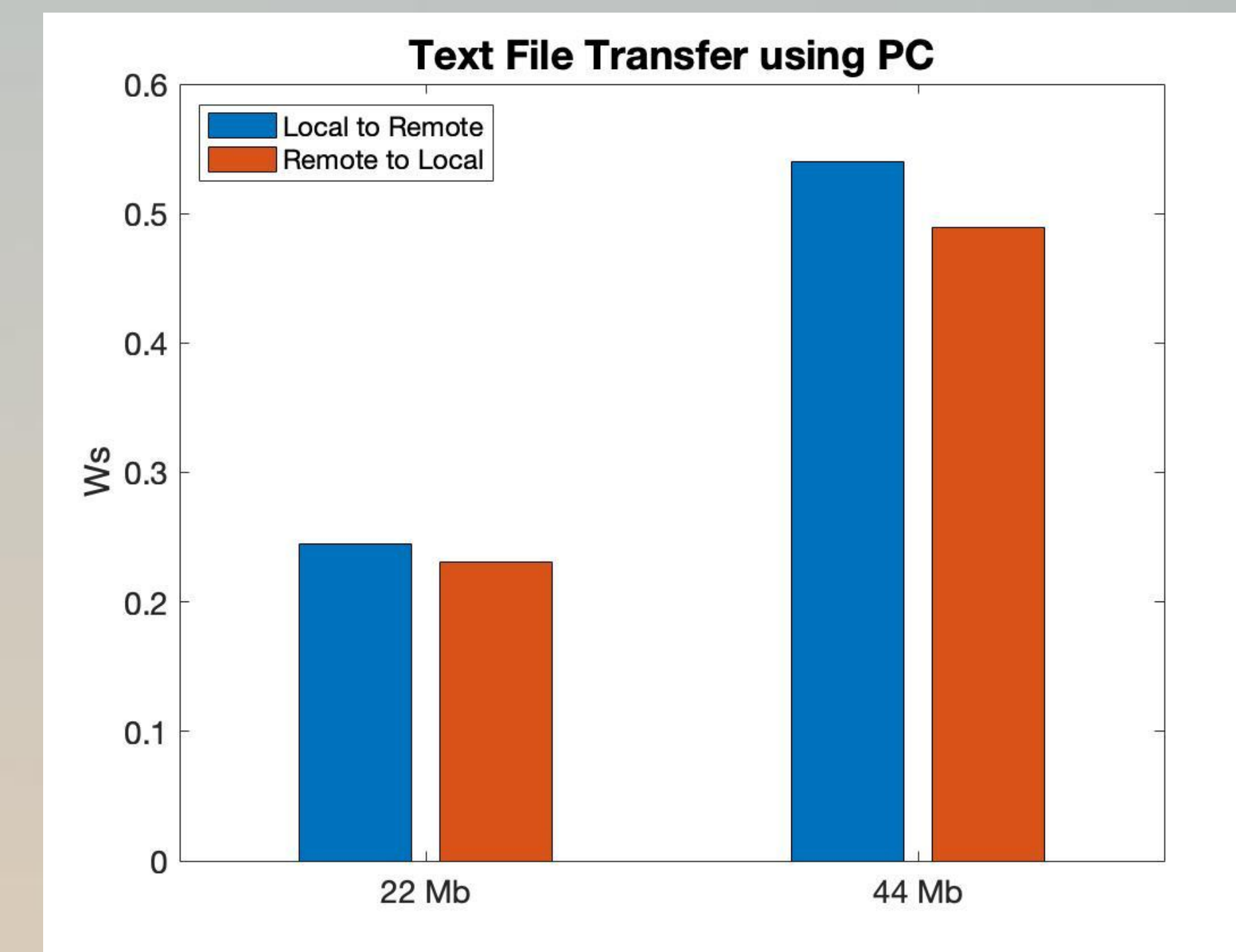
Image Location & Script Execution on Pi vs PC

Comparing power consumption for sending image located (1) Pi to PC and (2) PC to Pi when scripts are executed on both Pi and PC



Text File Transfer

Sending a 22 Mb text file vs 44 Mb text file from PC



Why Should You Care?

- All electronic computing operations have some small measurable cost, including file transfer operations used when sending and receiving emails.
- Images in email footers with non-uniform color distribution like headshots use comparatively more power than other images that have more uniform colors like logos.
- In our tests, a typical 600x900 headshot image would use 1 kwh for every 60 million emails sent and received.
- Removing images over the some 300 billion emails sent every year could power approximately 1200(stat) homes.

Conclusion

- Sending images in email footers consumes a small amount of Power.



GitHub Link