EE/CPRE/SE 491 WEEKLY REPORT 02

Introduction

Date: February 09- February 15
Group Number: 21
Project Title: Battery-less IoT Devices
Advisor: Dr. Henry Duwe
Clients: Dr. Nathan Neihart, Dr. Daji Qiao

Team Members:

Derek Nash – *Meeting Scribe, Power Systems Engineer, Test Engineer*

Matt Goetzman – *RF Systems Engineer, Test Engineer*

Mohamed Gesalla - *RF Systems Engineer, Test Engineer*

Adithya Basnayake – *Report Manager, Power Systems Engineer, Test Engineer*

Mohammed-Al-Mukhaini – *Meeting Facilitator, Embedded Systems Engineer, Test Engineer*

Bradley Rhein – *Embedded Systems Engineer, Test Engineer*

Weekly Summary

During this week, our main objective was to test the feasibility of using Wi-Fi to power our IoT device. Before moving forward with this concept of using Wi-Fi to power a device, we had to make sure that we receive enough power output to make our IoT device battery-less and to keep it running for a considerable amount of time. As a group we came up with a testing procedure and tested the Wi-Fi in Coover building. As a result from the data we collected, we got a better understanding on the average output power from Wi-Fi and what kind of antennas we will have to use in our IoT device to harness energy through Wi-Fi and provide sufficient power.

Past Week Accomplishments

At the beginning of this week, all the 6 members gathered to conduct our Wi-Fi test. We decided to do the testing in Coover 1012 classroom after 8.30 pm since there will be less Wi-Fi disruption and there were 2 routers for testing in this classroom. Our Wi-Fi test procedure was simple. We used a Wi-Fi analyzer app on our phones to measure the strength of the Wi-Fi signal in dbm (decibels with reference to 1mW). Data was collected at different vertical heights straight down from the router. Measuring vertically down from the router resulted the strongest signals. These results were recorded in an excel sheet to be converted to nanowatts and to be plotted for examining. To ensure the accuracy of the collected data, 4 mobile phones

with Wi-Fi analyzer apps were used. The table and the graph below summarize the data collected and the trends observed from this data.

Test to investigate the power output from Wi-Fi

Location of the test: Coover 1012
Tine of the test: After 9pm
Test date: 02/11/2019

Apps used to test the Wi-Fi:

Bradley	WiFi Analyzer
Derek	WiFi Analyzer
Mukhaini	WiFi Analyzer
Gesalla	WiFi Analyzer

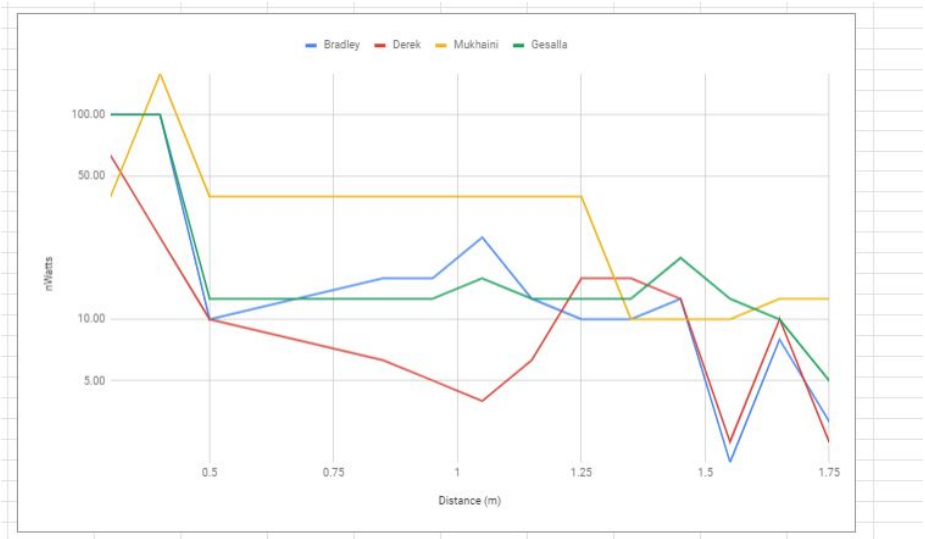
Limitations of the Apps: -40 dB Maximum Value for App

Angle from the router: vertically 90 degrees below the router

Convserion: dbm to nWatts

Distance(m	Wi-Fi strength in dbm				Power in nWatts			
	Bradley	Derek	Mukhaini	Gesalla	Bradley	Derek	Mukhaini	Gesalla
1.85	-55	-56	-49	-53	3.16	2.51	12.59	5.01
1.75	-51	-50	-49	-50	7.94	10.00	12.59	10.00
1.65	-57	-56	-50	-49	2.00	2.51	10.00	12.59
1.55	-49	-49	-50	-47	12.59	12.59	10.00	19.95
1.45	-50	-48	-50	-49	10.00	15.85	10.00	12.59
1.35	-50	-48	-44	-49	10.00	15.85	39.81	12.59
1.25	-49	-52	-44	-49	12.59	6.31	39.81	12.59
1.15	-46	-54	-44	-48	25.12	3.98	39.81	15.85
1.05	-48	-53	-44	-49	15.85	5.01	39.81	12.59
0.95	-48	-52	-44	-49	15.85	6.31	39.81	12.59
0.85	-50	-50	-44	-49	10.00	10.00	39.81	12.59
0.5	-40	-46	-38	-40	100.00	25.12	158.49	100.00
0.4	-40	-42	-44	-40	100.00	63.10	39.81	100.00
0.3	-40	-40	-44	-40	100.00	100.00	39.81	100.00

Figure 01: Recorded test results for Wi-Fi strength in dbm and nWatts



Conclusion:
As expected, the closer the phone antenna is to the router, the stronger the Wi-Fi strength resulting a higher power output. Within 1.55m range the power output ranges between 5nWatts and 100nWatts

Figure 02: Linear plot for nanowatts vs distance

With these test results, we met with our advisor to determine the next steps in our project. The power output we see from our test is weak and not sufficient to power the IoT device. Since the test was limited by the types of antennas in mobile phones used, as a next step, we decided to build a prototype with the antennas we think would be the best to harvest energy through Wi-Fi and conduct a similar Wi-Fi test with the prototype.

Member contribution for Wi-Fi test

Derek Nash – *Developed the test procedure, measured distance from the router and collected data from the Wi-Fi analyzer app, researched on designs for a voltage doubler circuit*

Mohamed Gesalla - *Developed the test procedure, measured distance from the router, collected data from the Wi-Fi analyzer app and analyzed collected data*

Mohammed Al-Mukhaini- *Collected data from the Wi-Fi analyzer app, analyzed collected data*

Bradley Rhein- *Measured distance from the router and collected data from the Wi-Fi analyzer app*

Matt Goetzman – *Developed the test procedure, analyzed collected data and researched on suitable Antennas for harvesting energy through Wi-Fi*

Adithya Basnayake- *Developed the test procedure, recorded data and analyzed collected data*

Pending Issues

We were unable to meet with our clients Dr. Nathan Neihart and Dr. Qiao to discuss about the designs and progress made during this week as well. This is a crucial task that has to be completed by the end of next week.

Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Derek Nash	Researched similar Wi-Fi harvesting projects to find ballpark numbers for power harnessed and type of diodes used in voltage multiplier circuits.	6	16
Matt Goetzman	Researched different types of antennas, compiled research into a document. Helped with Wifi tests.	5	15
Mohamed Gesalla	Worked with the rest of the team in finding a mobile app that measures Wi-Fi strength. Collected and helped analyze Wi-Fi data.	5	15
Adithya Basnayake	Worked on developing a procedure for Wi-Fi test, assisted in the Wi-Fi test by recording and analyzing the data, wrote the weekly report	6	20
Mohammed-Al-Mukhaini	Using various smartphones to measure the strength required to harvest energy from the wifi that will later on be used to activate the MPS430. In order to measure the temperature readings at it's basic levels we started writing code for the MSP430 to further test	5	15
Bradley Rhein	Collaborated on how to test Wi-Fi strength and helped collect data during Wi-Fi signal strength tests. Beginning code for MSP430 temperature readings.	5	15

Plans for the upcoming week

As the next step, a test prototype needs to be built with appropriate antennas to harvest energy through Wi-Fi. Derek, Matt, Mohamed Gesalla and Adithya will be mainly involved in building and testing the prototype. Bradley and Mohamed-Al-Mukhaini will be responsible for writing a program to use the microcontroller (MSP430) expected to be used in the Iot Device to collect temperature data from a temperature sensor. This will allow us to determine the minimum energy required to activate and apply our microcontrollers.

Summary of Weekly Advisor Meeting

Discussed the results from our Wi-Fi test and next steps on building an actual prototype and conducting a similar Wi-Fi test using that prototype. Size and cost limitations of this IoT device were also discussed during this meeting.