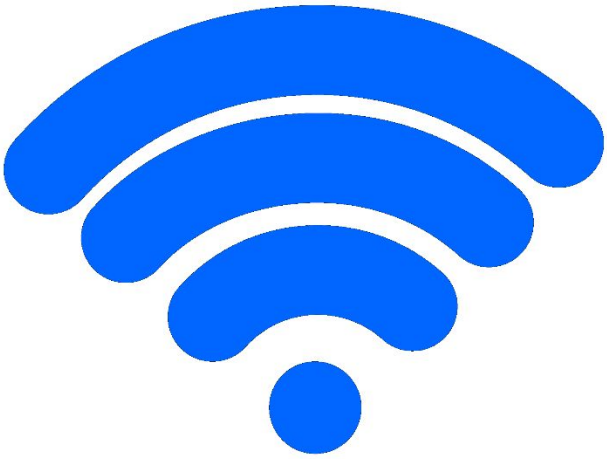
# UCF EEL 4914: Senior Design I

Solar Powered Wi-Fi Hotspot

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**Group 7**

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# Project Narrative:

How often have you had the urge to just sit outside and do your work, answer emails, or just casually surf the web, but you simply cannot because the wireless signal won't reach that far? Or while on campus walking from building to building just to have the Wi-Fi drop out on you, so you have to choose, walk bored to your destination, or use up mobile data that potentially exceeds the monthly limit or not powerful enough due to the "game" mobile carriers in the U.S. have with the consumers. To point out, in a perfect world a person can walk from their house to the mailbox down the road without disconnecting to the internet because their router was not powerful enough to provide the Wi-Fi signal. However, this "perfect" world ideology is not that far off when the country of Estonia becoming the first country to give Wi-Fi access in a majority of its 45,339km$^2$ area despite their GDP being "22.46 billion US dollars" [1].

What Group 7 proposes is a way to provide Wi-Fi without complicating how things are right now in terms of looks, appearances, and maintaining a futuristic vibe in the form of a solar powered umbrella that also works as a Wi-Fi amplifier and a light source. This particular apparatus will be called Solar Powered Wi-Fi Hotspot but throughout the paper it will be referred to as Umbrella for simplisticity. The way this apparatus is going to work is that it will be a portable umbrella, similar in design to that of a beach umbrella, that can be carried to various different areas like other beach umbrellas. However, what makes this umbrella different than any of the others is that it will have solar panels in the canopy portion of the umbrella. While in the shaft portion will have an outlet in case one needs to charge a device like a phone and in the bottom portion there will be a weight/block where an extra battery will be added for when the device is being used in areas with little to no sunlight or at nights. Overall, the design will try to stay with a design similar to a beach umbrella in order to be portable, efficient, and not have noticeable difference compared to other umbrellas.

This particular project can aid even the Golden 1 Center in Sacramento, California which is labeled as one of the most technologically advanced stadiums in the U.S. as of January 2017. The particular way this project will aid the Golden 1 Center is just outside the stadium they have two 25-foot LED screens waiting to be used. Currently "They're talking with musicians about what it means to play a concert for the fans both inside and outside the arena" [2] which means that in a not so distant future this stadium will have people just outside the stadium seeing what event is going on outside, however a problem arises in that the stadium itself does not have the same power of internet outside as it does inside, and if the Golden 1 Center want to truly achieve their goal of "people want to stay connected. They want to send and receive texts, snaps, Instagrams, and Ellos. (Probably not so many Ellos). The arena's job is to enable those connections" [2]. In other words, the stadium was made to handle lots of traffic because currently Golden 1 is capable of handling "500,000 Snapchats per seconds" [2] while the maximum capacity of the stadium is 19,000 so it is theoretically impossible to remotely achieve this capacity. However, if the connection available inside is distributed outside by using Umbrella the Stadium is able to reach a higher audience to attempt their limit of 500,000

snapchats per seconds which again is theoretical impossible since as of 2013 the population of Sacramento, California is 479,686 and even if Sacramento reached a population of over 500,000 since 2013 it will require for all of them to have a smartphone capable of sending a snapchat and be able to fit in Golden 1's 72,390$m^2$ area to even attempt to reach the limit.

An immense issue that will arise whether Umbrella is implemented in a location or not is internet traffic and the answer to that issue is that as time progresses and technology switches from coaxial/copper cables to fiber optics it will allow for this special lamp to not have any complications with limiting internet traffic due to fiber optic cables "has a higher bandwidth capacity and can easily transmit traditional applications such as phone, broadband internet, and digital tv with plenty of capacity left over for other advanced applications in the future" [3]. These fiber optics cables are "usually upgraded by changing the electronics that creates the light pulses, and not by replacing the cable itself. That's why fiber networks are said to be futureproof" [3]. Going back, to the Golden 1 Center "they've run 650 miles of fiber-optic cable and 300-plus miles of copper throughout the arena" [2]. Another, company that takes advantage of fiber optics is Florida's own Smart City Telecom who will be overlooking Wi-Fi and internet services during Super Bowl 51 which will be held at NRG Stadium in Houston, Texas where the Stadium has a capacity of 71,795 for Football games and 80,000 for concerts. The way in which Smart City Telecom will handle the traffic from the Super Bowl attendees is that "Beneath NRG Stadium home of the NFL's Houston Texans, Smart City Telecom has installed complicated network of fiber-optic cables and camouflaged transceiver. The firm will have a crew on site during Sunday's game to monitor the network and ensure it performs as expected." [4].

Continuing, from the Super Bowl one of the biggest tradition from American Football, especially for their biggest event of the year, is the concept know as Tailgating in where fans gather in the parking lot and do barbecues, drink some beers, and interact with some of the fans that will also be attending the game. Although, this concept of Tailgating is fun this event has yet reached the 21st century due to how very rarely do these sports arenas have Wi-Fi connectivity in their parking lots which is where these Tailgating events take place. What these parking lots, in where these events are held, are missing is Wi-Fi connectivity because if a fan decides to play some music on their phone or watch the pregame show on their phone it will cost them data which for some mobile carriers is limited and streaming apps consume a hefty amount of data. However, if an apparatus that can distribute Wi-Fi signal to the parking lot is implemented then fans would be able to watch pregame shows or applications such as Twitter, Snapchat, Instagram, Facebook, and various different social media. The particular apparatus that will be able to do such a task is Umbrella and the only thing that will change in the parking lots is how from a set number of lamp post one has a slightly different appearance. All things considered, Umbrella would not be a product that revolutionize the technological industry the way other products have done in the past but instead improve the average person's quality of life when it comes to internet access. Now, that Umbrella's main functionality was addressed the next step is executing this project design where the exact specifications of the project will be addressed ranging from the solar panel to the lighting of the lamp, a rough diagram on how this apparatus

will truly function, the cost of the pieces that will construct the apparatus, a matrix where various different factors will be considered, and a plan of action in the final construct of the apparatus.

## Specifications:

- Light
    - The light should illuminate the area around it sufficiently to keep students safe
    - The light should be as efficient and green as possible, and use the least power
    - The light should be connected to a backup power source
- Solar Panel
    - The solar panel should be large enough that it it allows for maximum sunlight to be harnessed
    - The solar panel should not be too large as to be too expensive
- Battery
    - The battery should be large enough that it can be charged fully in the time that the sun is out on average
    - The battery should not be too large as to be more expensive than necessary
    - The battery should be long lasting, durable and reasonably easy to swap out after years of use and deterioration
- Wi-Fi Repeater
    - The Wi-fi repeater should offer an extended Wi-Fi range at a minimal loss of speed
    - The Wi-fi repeater should be a dual band repeater, to minimize speed loss [6]
    - The Wi-fi repeater should have dual radios, to minimize speed loss
    - The Wi-fi repeater should have the maximum range that we can accomplish while still being optimally efficient
    - The Wi-fi repeater should be capable of offering the same levels of security that exist on the networks that it will be repeating
- Overall Package
    - The device should be portable and lightweight
    - The device should be optimized for efficiency and performance
    - The device should be able to withstand moisture and extreme temperatures

## Constraints:

This project like any other has various constraints that are going to be addressed in both the research documents and the actual construction of the apparatus. Various different constraints will come up throughout the semester but the most eminent ones are cost, time, technology, and a few other constraints. Underneath each of these areas are elaborated in some detail in and a possible solution is brought up.

Cost: As college students we have a limited budget to complete this project. We will need to purchase various major components for the design and construction of our product. Through this process we will likely have to purchase parts, revise decisions and purchase new parts to match these changes. This will likely happen a few times, so even by budgeting early and planning to the best of our abilities we will have to be very mindful of our finances. A possible way to save money in the long is to try and have the research done beforehand so that there is enough time to find various sites to purchase the parts instead of buying parts on the first few sites seen because of time constraints.

Time: This project is to be taken from idea to fruition within the span of 2 university semesters. This is not a very long time for a full process and adds to the difficulty of the task at hand. In order to overcome this constraint we will have to be working diligently throughout the lifespan of the product development to complete the project successfully in the time allotted. Not only is the time for the entire project short to be efficient but organizing the everything for the project at least one week ahead of the due dates for each assignment in order to fix and correct any possible mistakes presented. Lastly, the biggest time constraint that this project will endure is that this group will not have the same time as other Senior Design students because part 2 of this course will be taken in the Summer where the semesters are shorter.

Technology: With technology evolving at the rate which is does, there is always something smaller, faster and more powerful on the horizon. Unfortunately as mentioned above, time is not on our side, so we cannot wait for the latest and greatest to integrate into our product. As a result, we will have to seek out the latest innovations currently on the market, that are viable within our financial constraints, to integrate into our design.

Support and Willingness to Purchase of Institutions: Ultimately the intention is for this product to be wanted and adopted by universities such as UCF as well as people who love the poolside, and any place that will love to have a solar powered umbrella that with spotty Wi-Fi signals. As a result, we have to prepare a product that is attractive enough to either various institutions or individuals for them to be willing to purchase our product. Arguable, the best way to do this will be to design and build a product that is as efficient, cost effective, and easy to install and sue as possible.

Working as Group: This is the hardest constraint in the entire project because if we as a group are not able to communicate and organize as a group the entire project will never be completed no matter how many semesters we have because people will either argue about ideas get nothing done, and/or will not be happy because their ‘own’ ideas were not implemented for the final product and as such their production in throughout the entire project will not be there because they have no interest in the project.

## Block Diagram:

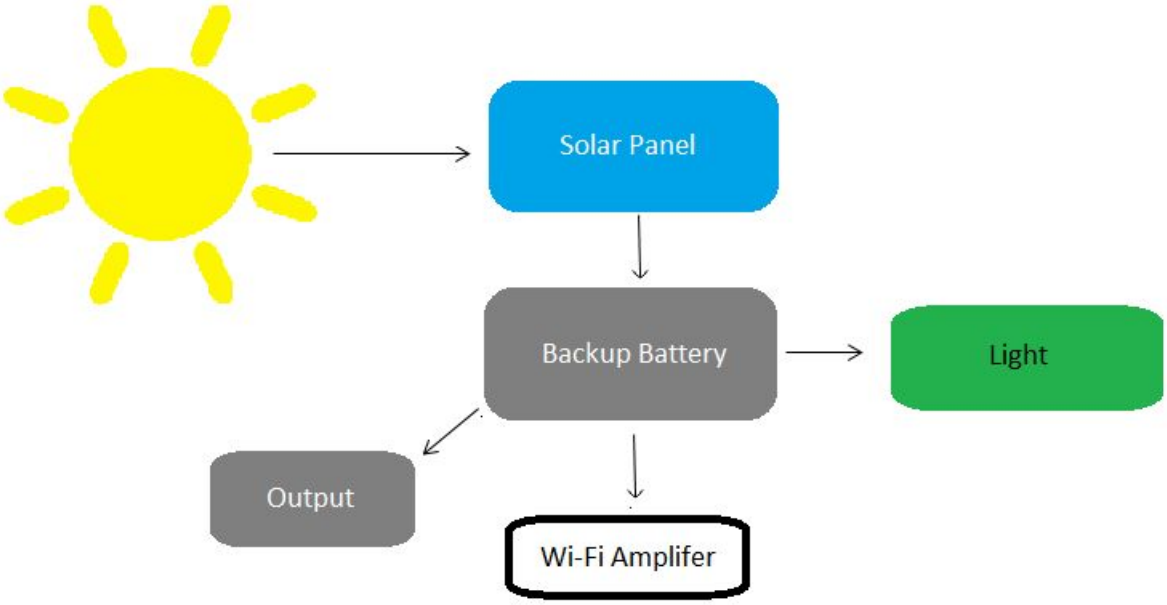


Figure 1: Block Diagram

| | | |
|---|---|---|
| Solar Panel | Freddy Artigas | Research |
| Light | Kevin Diaz | Research |
| Wi-Fi Amplifier | Alan Birmaher | Research |
| Battery Backup | Aaron Dobo | Research |

Table 1: Assignments for Members

## Engineering-Marketing Trade Off Matrix:

In theory putting all of the bells and whistles on a product sounds like a million dollar idea. However in practice one must understand that those bells and whistles come with a price. Whether they draw in and use more power, or make the product to large or heavy, or just drive up the price to where no one will buy it. The Engineering-Marketing Tradeoff Matrix pulls together what can be done in theory, and compares them to what can be done in practice. Below is the trade off matrix for the "Wireless implementation with Solar Energy" project.

- \+ = Positive Polarity (Increasing Requirement)
- \- = Negative Polarity (Decreasing Requirement)
- ↑↑ = Strong Positive Correlation

- ↑ = Positive Correlation
- ↓↓ = Strong Negative Correlation
- ↓ = Negative Correlation
- Engineering Requirements
- Marketing Requirements

| | | Efficiency | Output Power | Weight | Cost | Dimensions |
|---|---|---|---|---|---|---|
| | | + | + | - | - | - |
| Long Signal Range | + | ↓ | ↓ | | ↓↓ | |
| Eye Appeal | + | | | | ↓↓ | ↑↑ |
| Ease of Install | + | | | ↑↑ | ↓↓ | ↑↑ |
| Mobility | + | | | ↑↑ | ↓↓ | ↑↑ |
| Brightness | + | ↓ | ↓ | ↓ | ↓↓ | |
| Low Cost | - | ↓ | ↓ | ↓ | | ↓ |
| Targets for Engineering Requirements | | <25% | <100 Watts | <20lbs | <$1000 | 2 foot radius 4 feet tall |

Table 2: Matrix Table

# Budget:

As four college students we have a limited budget, for this project with a minimum budget of $500 and no more than $1000. We are trying to find a sponsor that will help us lower the budget that will help in paying for any expense from the project construction or increase the existing budget with their help. We also need to have in consideration the process of shipping and try to lower it in price or get it for free.The prices listed below are rough estimates from research. Furthermore, the prices may change once more research is done and the final product is being implemented. So far there is no sponsor for the project and all of the costs will be taking care by the four group members. When purchasing components they will be purchased in multiple quantities in case of failure or any malfunctions but in the table below there will only be one quantity of each item just to show the basic cost of the project.

| Description | Quantity | Estimated Cost | Total Cost |
|---|---|---|---|
| Solar Panel | 1 | $95 | $115 |
| Wi-fi Amplifier | 1 | $120 | $140 |
| Light | 1 | $75 | $75 |
| Battery Backup | 1 | $110 | $115 |
| Pole & Base | 1 | $50 | $50 |
| Total Cost | | $450 | $495 |

Table 3: Parts needed for Umbrella

- Solar Panel: Sainty Solar 255 Watt Solar Panel, GES-6M255 Mono Silver Frame.
- Wi-fi Amplifier: NETGEAR AC1200 Wi-Fi EX6200 Wi-fi range extender - 2.4/5 GHz - 1200 Mbps - Wi-Fi.
- Light: 150 Watt, high pressure sodium, LU 150/ED23.5/ECO, E39 Mogul Base, ANSI S55, Plusrite 2046
- Battery Backup: Shorai Xtreme-Rate 12-Volt LifePo4 LFX Lithium Battery - LFX09L2-BS12.
- Pole & Base: PVC pipe attached to a wooden base with wheels.

# Project Milestones:

| Week Number | Task |
|---|---|
| 1 | Project Idea |
| 2 | Form Group |
| 3-4 | Divide and assign duties |
| 5-10 | Research and finalize part list<br>Design PCB layout<br>**60 Pages due 3/31/17**<br>**100 Pages due 4/14/17** |
| 11-14<br>15 | Write and and finalize final documentation<br>**Final Document Due 4/27/17**<br>Order necessary parts |
| | **End of Spring Semester** |
| 16 | Parts check |
| | **Beginning of Summer Semester** |
| 18-20 | Build initial prototype |
| 21 | Hardware and Software check |
| 22-25 | Assemble final product |
| 26-28 | Test and fine tune |
| 29 | Presentations |

Table 4: Weekly Milestone Objective

# Conclusion:

For the past century the human race has been perfecting the indoors. But why stop there? Why do we discriminate against the outdoors? That is what Group 7's Solar Powered Wi-Fi Hotspot purpose is to allow anybody to open up their umbrella and be able to access Wi-Fi from the shade provided by their own umbrella. Especially in states like Florida, Arizona, and New Mexico where the sun can burn anything and makes it sometimes impossible to even sit outside unless you are inside a pool or in an air conditioned area. This apparatus will have the major

components of solar panel, battery, light pole, and Wi-Fi repeater. In addition this apparatus will not come with any ease but instead encounter problems such as cost, time, technology, and other factors. In the end, Umbrella will be an apparatus that will be constructed with the mindset of usefulness, utility, economic, and enjoyment.

# References:


***[1]*** *"Estonia GDP," in Trading Economics. [Online]. Available: http://www.tradingeconomics.com/estonia/gdp. Accessed: Feb. 1, 2017*

***[2]*** *D. Pierce, "The highest-tech stadium in sports is pretty much a giant Tesla," in Business, WIRED, 2016. [Online]. Available: https://www.wired.com/2016/06/highest-tech-stadium-sports-built-like-tesla/. Accessed: Feb. 1, 2017*

***[3]*** *"FAQs about Fiber Optics," in Citizens-Tel. [Online]. Available: http://www.citizens-tel.net/FTTH.pdf. Accessed: Feb. 1, 2017.*

***[4]*** *M. Santana, "Smart City's network head to the Super Bowl," in Orlando Sentinel, 2017. [Online]. Available: http://www.orlandosentinel.com/business/os-bz-cfb-smart-city-super-bowl-20170126-story.html. Accessed: Feb. 1, 2017.*

***[5]*** *J. Brandon, "Beyond Sunset: The different phases of twilight, "in Digital Photography Techniques, Digital Photography School, 2011. [Online]. Available: http://digital-photography-school.com/beyond-sunset-the-differen-phases-of-twilight/. Accessed: Feb. 2, 2017*

***[6]*** *"Wi-Fi Booster Repeater Extender Differences," in Repeater Store. [Online]. Available: https://www.repeaterstore.com/pages/wi-fi-booster-repeater-extender-differences. Accessed: Feb. 2, 2017*