POWER OVER WI-FI(POWIFI)

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Abstract: Power over Wi-Fi(Po Wi-Fi) is a unique Wi-Fi system which can be connected to our regular, household appliances. It transmits Wi-Fi signals using 10,000 times less power than our current routers. Low power sensors can be embedded in our appliances, connecting them to our mobile phone, making our phone behave like a remote control for our appliances, making them work in harmony and sync. It also acts as a power source, and has been known to provide energy to a temperature sensor, a low resolution camera, and a charger, and at the same time, it doesn't degrade the strength of the power signals.

Keywords: transmit, embedded, dc signals, sensors, proximity, ubiquity, enqueues

I. INTRODUCTION

The University of Washington has created a unique wireless infrastructure system which can be connected to our regular, household appliances. It transmits Wi-Fi signals using comparatively less amount of power than our currently used routers. Low power sensors are embedded in our appliances, connecting them to our mobile phone, making our phone behave like a remote control, a timer, and much, much more.

The best part about Po Wi-Fi is that we can relate it to our day-to-day life. The Wi-Fi's ubiquity means we can harness power everywhere. Especially helpful for working women, who come home from a stressful day at work. All they have to do now is click on their phone, and a hot cup of coffee is ready. The dishes are cleansed and the oven is preheated to bake their dinner, the router acting as a power source. It makes life much simpler. You can even activate your gadgets with timers and reminders, so that you never have to worry about forgetting or making any errors.

Power over Wi-Fi (Po Wi-Fi) allows the Wi-Fi signals themselves to be converted into DC signals, in turn, the sensors present in the appliances. Using the IoT technology, all the Wi-Fi devices and the appliances can be interconnected into a single energy loop, which itself is powered by the Wi-Fi signal, allowing our house hold appliances to work in perfect harmony and sync, based on proximity, and context. Po Wi-Fi has currently won "The Best of What's New Awards" of the popular science magazine, Popular Science.

II. WORKING

Wi-Fi routers can transmit power. Po Wi-Fi works by forcing routers to send out a constant 1W signal, rather than the intermittent kind used currently, which is then captured and turned into DC power by harvesters. The technology is promising, but it's evidently not right for charging your smartphone, your tablet, your laptop or other power-hungry devices. There is certainly potential for smaller devices though, and things are only at the proof of concept stage- just don't expect your phone to be charged using Wi-Fi. To put things into perspective. Computer World calculates that the electricity generated this way is 100,000 times too low even to run a smartphone, without giving a thought to charging.

III. USES

A. As a Power Source

In terms of a power source, Po Wi-Fi so far has been proved far field wireless power without compromising or degrading the network's performance. The Po Wi-Fi can power up devices to 17-28 feet away from a standard Wi-Fi router. This means you can be recharging batteries just by having them in the same room.

B. As a Remote Controller

In terms of being a remote controller, all our household appliances can be controlled via our smartphones. As each home appliance is embedded with a micro sensor, which can control the working of the device. A harvester is integrated inside the device will convert the Wi-Fi transmission signals into DC Voltage.

IV. THE INSPIRATION BEHIND PO WI-FI

Nikola Tesla, the famous inventor, electrical engineer, and future thinker of the late 19-20th century, dreamed of eliminating wires for both power and communication. The world already has reliable wireless communication around the world, so power must be next in line. Po Wi-Fi could help make this happen. It has said to have taken inspiration from Tesla theory: The race to wireless power.

The people who worked on Po Wi-Fi are:

A team of engineers Vamsi Talla electrical engineering doctoral student and Shyam Gollakota assistant professor of Computer Science and Engineering, from the University of

Washington have developed the Power Over Wi-Fi (Po Wi-Fi) system.

This team of two has published an online paper titled- Powering the Next Billion Devices with Wi-Fi, telling us how they have harvested energy from Wi-Fi signals, and had used the harvested power, to power a temperature sensor, a low-resolution gray scale camera and a charger of a fitness tracker. The pre-authors have involved electrical engineering students from the University of Washington, Bryce Kellogg and Saman Naderiparizi, who is a research associate, Benjamin Ransford, an associate professor of computer science and engineering and, Joshua Smith, an electrical engineer.

V. PoWiFi and Sensors

The two main elements of a Po Wi-Fi are:

1. A Wi-Fi transmission strategy that delivers power on multiple Wi-Fi channels and
2. Energy harvesting hardware that can efficiently harvest from multiple Wi-Fi channels simultaneously.

A. Design of a Po Wi-Fi Router

Like other Wi-Fi routers, Po Wi-Fi is also having the same design but with different functions. Thus, PoWiFi opportunistically injects power packets across multiple Wi-Fi channels with a goal of maximizing cumulative occupancy. The PoWiFi, it injects 1500-byte UDP broadcast datagrams with a 100 us network-packets delaying at the highest 802.11g bit rate of 54 Mbps on the three non-overlapping 2.4 GHz Wi-Fi channels. A PoWiFi *enqueues* these broadcast packets only when the number of frames in the wireless interfaces transmit queue is lower than a threshold (five frames). If the queue's depth is at or above this threshold, then there are already enough power & Wi-Fi client packets in the queue have to maximize channel occupancy.

PoWiFi router performs carrier sensing and transmits broadcast packets at the highest 802.11g bit rate, its individual frames are as short and unintrusive as possible. PoWiFi thereby provides better than equal share fairness for transmission from other Wi-Fi networks.

When PoWiFi knows a harvester's electrical characteristics, it can tune its transmission strategy to precisely fit the device's power requirements.

B. Sensors

A sensor is a device which is used to detect or measure a physical property and records, indicates, or otherwise responds to it.

Sensors are the most important component for the PoWiFi. Due to sensor the device at both the ends can detect each other. Usually the sensors are integrated with the device to which the PoWiFi needs to send the signals. Example: Temperature device. In this device a temperature sensor is used to sense the temperature.

C. The Effects on other Wi-Fi users

The PoWiFi system aims to provide high cumulative channel occupancy to deliver power, without damaging the strength of the Wi-Fi's traffic.

To check whether the Wi-Fi signal is stable, Po Wi-Fi utilize it, and track the strength of the signal's traffic.

Let's compare four different schemes:

- Baseline- the PoWiFi is disconnected from the router i.e., the router receives no extra traffic on any of its interfaces.
- Blind UDP- The router transmits the UDP's broadcast traffic, at 1 Mbps so that it channel occupancy is maximized.
- PoWiFi- The router sends the UDP broadcasting traffic at 54 Mbps and the queue threshold check used §3.1.
- No Queue- The router sends the UDP broadcast traffic at 54 Mbps but the queue threshold check is disabled.

D. The Effect on nearby Wi-Fi networks

1. High cumulative channel occupancy transmission.
2. Rectifier-aware power transmission.
3. Scalable concurrent power transmission.

E. The Most Important Components Required For PoWiFi:

A. A Rectifier

Rectifiers are used to convert the Wi-Fi transmission signals in to DC voltage signals and store them in a capacitor; so that the device in which the rectifier is integrated it can use the transmission signals so power up the device.

The Equation for rectifier is:

$$V_{d.c.} = \frac{2V_{max}}{\pi} = 0.637V_{max} = 0.9V_{RMS}$$

A. Harvester:

B. HARVESTER:

Harvester is also one of the most required for our device. It is the component that is used to receive the Wi-Fi transmission signals and send it to the Rectifier so that rectifier can convert it. This component is integrated inside the device which needed to be powered up.
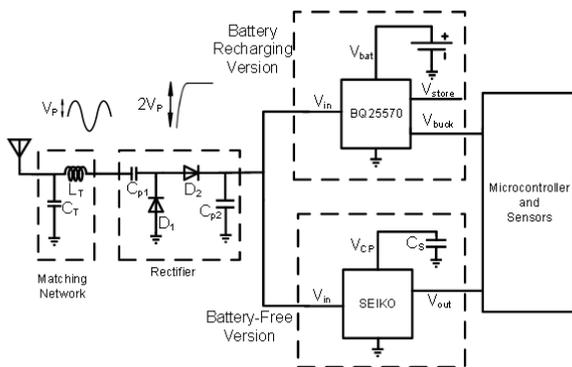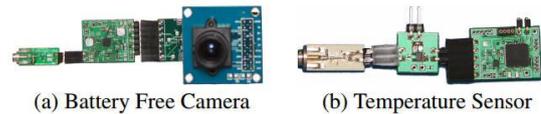
Figure 4—PoWiFi harvester schematic. PoWiFi co-designs the matching network, rectifier, and DC–DC converter to achieve good impedance matching across Wi-Fi bands. The figure shows the optimized DC–DC converters for both battery-free and battery-recharging versions of our harvester.

VI. DEVICES THAT ARE BEEN TESTED WITH PO WI-FI

A. Temperature Sensor using PoWiFi

Usually an LMT84 temperature sensor and MSP430FR5960 microcontroller to read and transmit sensor data are used with an harvester. For this only 2.77µJ is used to operate the Power and the entire measurement and data-transmission operation.

The rectifier is present in the battery-recharge sensor which is followed by the TIbq25570 power management chip to wirelessly recharger are two AAA 760 mAh

B. Camera operated through PoWiFi.

An OV7670, a low-power VGA image sensor and interface it with an MSP430FR5969 microcontroller are the components that used in this camera.

10.4ml of power is used to capture per-image. This camera is battery-free which means it uses the wirelessly rechargeable 1mAh lithium-ion coin-cell battery at 3.0V.

This camera can be operated up to 17 feet away from the router due this battery-free battery.

C. Hotspot used as Charging Spot

A simple router can be converted into a wireless charging hotspot with use of PoWiFi. With this kind of router we can recharge devices such as wearable devices.

A 2dBi Wi-Fi antenna is attached to this router with a custom harvester that we optimize for higher input power.

This device hasn't been a success after the test but the developers are trying to make it success so that each and every person can use the antenna for free power.

(a) Battery Free Camera   (b) Temperature Sensor

VII. OUR PROPOSALS

A. Power Supplied to PoWiFi via Solar Panel:

So far what we have learnt about Po Wi-Fi, states that it is a game changing energy source. But have you ever stopped to think? An energy source which can power up home appliances… won't it take up a lot of electricity? Won't our bills fly out of the roof?

One of the main reasons people don't buy smart appliances is because they can't afford it. Won't the same apply to Po Wi-Fi.

Our proposal is that we power up the Po Wi-Fi router using solar panels. That way, the amount of electricity used is less, and we can use smart resources. Charge the panels in the morning, and you'll have enough to utilize in the evening. The best part about solar panels is that it is portable, and can be used even outdoors.

We can connect the solar panels directly to the Po Wi-Fi power cable, so that as soon as the sun rays fall on the solar panel, they get converted to power packets, and those power packets are stored in the charge storage, similar to the technology of solar panels. It's cost friendly compared to the electricity from the wall sockets.

B. Powering Smart Home via PoWiFi:

As we told in our previous proposal how we wanted to use the solar panel as a power source for our PoWiFi so that electricity can be saved. After the storage of power via through solar panels in the PoWiFi what should we do is the question raised, so we can utilize that power in our home for the home appliances.

Like now a days we can find Wi-Fi router in each and every home so if we replace those basic router with our PoWiFi or if those routers are modified with the latest technology we can use those routers to supply power to our home appliances.

As a example, let's take a coffee maker in which if we integrate a harvester, a temperature sensor and the use of Wi-Fi technology we can operate the coffee maker with our wireless devices such as Smartphones, iPhones etc.

This proposal will be a lot usefully for all housewives, working women's and bachelors so that they won't have any problem of cooking. They just need to press few buttons on there mobile and everything start with a click of button and person can have whatever they want.

VIII. ACKNOWLEDGMENT

creative inputs. And lastly, I would like to thank Bhavan's Vivekananda College for giving us a platform for exhibiting our thoughts and ideas.

IX. CONCLUSIONS

We can conclude by saying that Po Wi-Fi is one of the latest trends of IoT, which can benefit the world in a long run. The team that proposed this theory, also tested the Po Wi-Fi system in six homes, and it was proved that there was no reduction in the page loading or video streaming speed.

This proves that the quality of Wi-Fi signals is not affected. While the basic initial experiments have tested only low power devices, we believe that the system can be made more efficient, especially by charging with the help of solar panels.

The best part about Po Wi-Fi is that it has two uses, one to power devices simply by leaving them in a Wi-Fi zone, and another to make our phone behave like a remote control for household appliances.

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