IoT based on Wireless Power Transmission

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***Abstract*: In this paper, we have presented the concept of cable less transmission i.e. power without the usage of any kind of the electrical conductor or wires. We present an idea discussed here, how energy can be transmitted as microwaves, so as to reduce the transmission and allocation losses, known as Microwave Power transmission (MPT). We have also cited several aspects relating to history of wireless power transmission systems along with the present day scenario of Power transmission systems and also some of the developmental changes in Wireless Power Transmission (WPT). The Basic Design and Implementation of Wireless power System has also been given. We have also presented the Merits, Demerits and the applications of WPT with monitoring IoT based.**

Key Words: Microwave Power transmission (MPT), Nikola Tesla, Rectenna, Solar Power Satellites (SPS), Wireless Power transmission (WPT), World Resources Institute (WRI), Institute for Soldier Nanotechnologies (ISN). Arduino.

I. INTRODUCTION

Wireless communication is the transmission of the energy over a distance without, the usage wires or cables, where in distances involved may be short or long. Wireless operations permits services, such as long-range communications, that are merely unfeasible using wires. Wireless energy transfer or wireless power transmission is the transmittance of electrical energy from a power source to an electrical load without interconnecting wires. Wireless transmission is useful in cases where interconnecting wires are inconvenient, hazardous, or impossible. The problem of wireless power transmission differs from that of wireless telecommunications, such as radio. In the latter, the proportion of energy received becomes critical only if it is too low for the signal to be distinguished from the background noise. With wireless power, efficiency is the more significant parameter. A large part of the energy sent out by the generating plant must arrive at the receiver or receivers to make the system economical. The most common form of wireless power transmission is carried out using direct induction followed by resonant magnetic induction. Other methods under consideration include electromagnetic radiation in the form of microwaves or laser beam technology. Wireless communication is generally considered to be a branch of telecommunications. It encompasses various types of fixed, mobile, and portable two-way radios, cellular telephones, personal digital assistance (PDAs), and wireless networking. Wireless operations permits services, such as long-range communications, that are impossible and impractical in conventional methods.

A. Conventional Power System

One of the major issue in power system is that the loss occurring during the transmission and allocation of electrical power. As the demand drastically increases day by day, the power generation increases and the power loss is also increased. The percentage of loss of power during transmission and distribution is approximated as 26%. The main reason for power loss during transmission and distribution is the resistance of wires used for grid. The efficiency of power transmission can be improved to certain level by using high strength composite over head conductors and underground cables that use high temperature super conductor. But, the transmission is still inefficient. According to the World Resources Institute (WRI), India's electricity grid has the highest transmission and distribution losses in the world i.e. around 27%. Numbers published by various Indian government agencies put that number at 30%, 40% and greater than 40%. This is attributed to technical losses (grid's inefficiencies) and theft [2]. It is indeed alarming to know the level of losses in Indian electricity and transmission business. These losses not only eat the revenues of the companies but also hinder the financing of future projects, which require huge capital, because of increased risk.

However, it would be worth knowing the categorization of technical and commercial losses that add up to the total losses. The theft comes in the latter category. Majority of theft is happening because the line is open to theft. The pole and the wires are bare and the voltage is at lower level than transmission and thus useful to run the 240 V equipment only. The theft always occurs at 400V and 240V level and not on transmission levels. Not much of energy auditing is done in most of the state utilities. Long low tension (LT) line are being pulled to reach villages under much publicized government schemes. Low tension lines are many times over the High tension lines causing more technical I2R losses. Transformer are running at less than optimal efficiency when in fact they should have the efficiency rate close to 99% since they do not have any moving part . It's a vicious circle. Theft is done when people are not willing to pay the high price of electricity. Power companies, as per the regulatory framework, are assured their 16% ROI in distribution business and hence, the most of the losses are again put back to the consumer with increase in tariff. It's never the power companies which decide the tariff, it's the regulator. Very few people realize this fact. With wired power or energy transfer, we can easily transmit energy of very low to extra high value. But for some places it will be very useful if the energy transfer occur without wire is required. There are different

concepts used in the field of wireless transfer technology. The one more thing is that the percentage of energy transfer is main criteria to transfer between places of very large distances. These are discussed in the sections following.

B. Transformer coupling
Energy transfer between two coil through magnetic fields but in this method, distance between two coils should be too close.

C. Resonant induction coupling (Evenescent wave coupling)
Electro magnetic wave in a high angular waveguide is called as evenescent waves which carry no energy, when if a proper resonant waveguide is brought near the transmitter then a tunnel is formed to the power drawing waveguide which can be converted in DC using rectifier circuits. A prototype model is achieved with 5 meters of ranges with this method.

D. Radio and microwave energy transfer
With this method a long range is possible. In this method microwave is sent to the long distances and can be received through rectenna which extract microwave energy back to electrical energy. But the problem with this method is that the diameter of antenna should be order of kilometer.

E. Laser beam transfer
In this method, laser is beamed to the photo voltaic cells which extract the electrical energy. This very difficult to implement and manage.

F. Electrical conduction method
In this method, during transfer energy through wires or conductors, when the voltage reaches the breakdown voltage, the surrounding medium start conducts, in this way the energy can be transferred through air medium. Though there are several methods available, in practical cases there is no device for transmitting power wirelessly with high energy capacity. But at low power transfer there are so many devices available in the market.

II. HISTORY OF WIRELESS POWER TRANSMISSION

- Nikola Tesla he is who invented radio and is referred to as “Father of Wireless”. Nikola Tesla is the one who first conceived the idea Wireless Power Transmission and demonstrated “the transmission of electrical energy without wires" that depends upon electrical conductivity as early as 1891[2].

- In 1893, Tesla demonstrated the illumination of vacuum bulbs without using wires for power transmission at the World Columbian Exposition in Chicago.

- The Wardenclyffe tower shown in Figure 1. was designed and constructed by Tesla mainly for wireless transmission of electrical power rather than telegraphy [3].

Fig. 1. Warden clyffe Tower, including the partially-complete cupola

- The world’s first fuel free airplane powered by microwave energy from ground was reported in 1987 at Canada. This system is called SHARP (Stationary High – Altitude Relay Platform) [5].

- A physics research group, led by Prof. Marin Soljacic, at the Massachusetts Institute of technology (MIT) demonstrated wireless powering of a 60W light bulb with 40% efficiency at a 2m (7ft) distance using two 60cm-diameter coils in 2007 [7].

- In 2008, Intel reproduced the MIT group's experiment by wirelessly powering a light bulb with 75% efficiency at a shorter distance.

- MIT team experimentally demonstrates wireless power transfer, potentially useful for powering laptops, cell phones without any cords.

- Imagine a future in which wireless power transfer is feasible: cell phones, household robots, mp3 players, laptop computers and other portable electronics capable of charging themselves without ever being plugged in, freeing us from that final, ubiquitous power wire. Some of these devices might not even need their bulky batteries to operate.

- A team from MIT's Department of Physics, Department of Electrical Engineering and Computer Science, and Institute for Soldier Nanotechnologies (ISN) has experimentally demonstrated an important step toward accomplishing this vision of the future. Realizing their recent theoretical prediction, they were able to light a 60W light bulb from a power source seven feet (more than two meters) away; there was no physical connection between the source and the appliance. The MIT team refers to its concept as "WiTricity" (as in wireless electricity).

Sony Corporation in 2009 announced the development of a highly efficient wireless power transfer system that eliminates the use of power cables from electronic products such as television sets. Using this

system, up to 60 Watts of electrical energy can be transferred over a distance of 50cm (at an efficiency of approximately 80%, approximately 60% including rectifier) [8]. This new wireless power transfer system incorporates a form of contactless electrical energy transmission technology based on magnetic resonance. With magnetic resonance, electromagnetic energy is only transferred to recipient devices that share the identical resonant frequencies as the energy source, so energy transfer efficiency is maintained, even when misalignment occurs. Furthermore, even if there are metal objects located between the transmitter and receiver, no heat induction occurs. With the growth in networked products, the number of cables used to connect these products has also increased. While data cables are rapidly being replaced with wireless communication systems such as Wi-Fi, the demand for wireless power transfer systems is also continuing to grow. Sony will proceed with its efforts to develop further technologies that meet customer needs for the wireless transfer of power across a wide range of products, distances and energy levels.

III. BASIC DESIGN AND IMPLEMENTATION OF WIRELESS POWER SYSTEM

The Figure 2a and 2b depicts high speed rectifier realizing high transfer efficiency relating to transmitter and receiver.

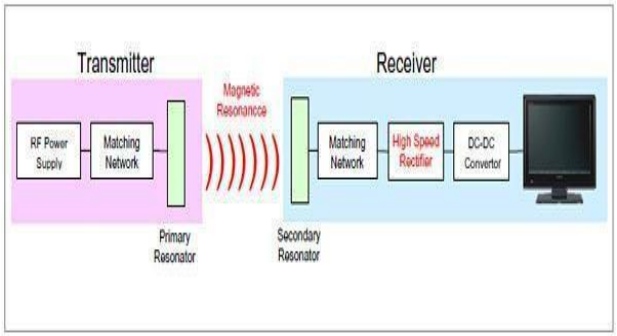

Figure 2 a. Wireless power system

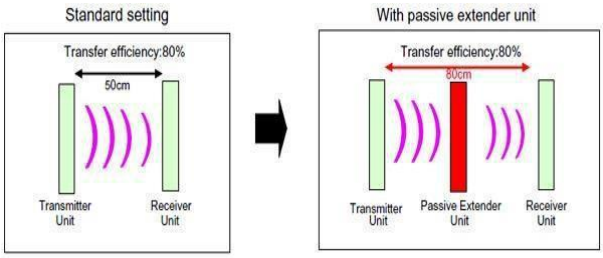

Figure 2 b. Wireless power system

William C. Brown, the pioneer in wireless power transmission technology, has designed, developed a unit and demonstrated to show how power can be transferred through free space by microwaves. The concept of Wireless Power Transmission System is explained with functional block diagram as shown in figure 3. In the transmission side, the microwave power source generates microwave power and the output power is controlled by electronic control circuits. The wave guide ferrite circulator which protects the microwave source from reflected power is connected with the microwave power source through the Coax – Waveguide Adaptor. The tuner matches the impedance between the transmitting antenna and the microwave source. The attenuated signals will be then separated based on the direction of signal propagation by Directional Coupler. The transmitting antenna radiates the power uniformly through free space to the rectenna.

In the receiving side, a rectenna receives the transmitted power and converts the microwave power into DC power. The impedance matching circuit and filter is provided to setting the output impedance of a signal source equal to the rectifying circuit. The rectifying circuit consists of Schottky barrier diodes converts the received microwave power into DC power. The Primary components of Wireless Power Transmission are Microwave Generator, Transmitting antenna and Receiving antenna (Rectenna).

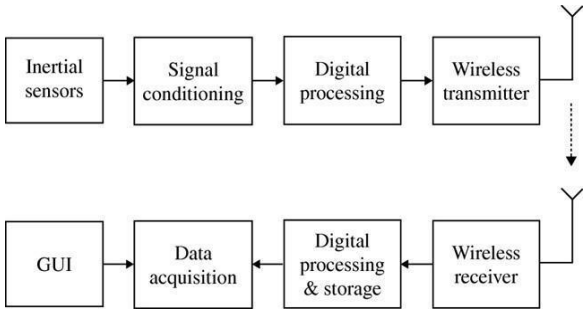

Figure 3. Flow and components of Wireless power System

The key for the present world is to save energy and related recourses in the organizations and as well as at home. Energy costs account for a huge portion of most companies operating expenses, so monitoring, controlling and conserving a building's lighting, heating and cooling, and other energy-hungry systems can lead to substantial savings. Several energy management vendors report that customers have shrunk their power bills by at least 30 percent. Saving energy also means lowering your carbon footprint, which could help reduce carbon taxes and

promote a green image, another plus for business. The figure 4 shows a typical energy wireless light controller device.

Figure 4. A typical wireless energy device interface

IV. MERITS

1. Various methods of transmitting power wirelessly have been known for centuries. Perhaps the best known example is electromagnetic radiation, such as radio waves. While such radiation is excellent for wireless transmission of information, it is not feasible to use it for power transmission. Since radiation spreads in all directions, a vast majority of power would end up being wasted into free space.

2. Wireless Power Transmission system would completely eliminates the existing high-tension power transmission line cables, towers and sub stations between the generating station and consumers and facilitates the interconnection of electrical generation plants on a global scale.

3. It has more freedom of choice of both receiver and transmitters. Even mobile transmitters and receivers can be chosen for the WPT system.
4.The power could be transmitted to the places where the

wired transmission is not possible. Loss of transmission is negligible level in the Wireless Power Transmission; therefore, the efficiency of this method is very much higher than the wired transmission.

5. Power is available at the rectenna as long as the WPT is operating. The power failure due to short circuit and fault on cables would never exist in the transmission and power theft would be not possible at all.

5. Less cost for cabling infrastructure and device

6. More user supported - cable device have limited slots whereas wireless does not.

VII. CONCLUSION

The concepts of Microwave Power transmission (MPT), Wireless Power Transmission history and basic implementation of Power System is discussed elaborately . Technological developments in Wireless Power Transmission (WPT), the merits, demerits, applications of WPT are also discussed in this paper. By this we are able to know the greater possibilities for transmitting power with negligible losses and ease of transmission in the years to come. It is envisaged that wireless energy would be really accomplished with a advantage of easy implementation and cost effective i.e., cost of transmission and distribution overhead would become less and moreover it is important that the cost of electrical energy to the consumer would also be reduced compared to existing systems.

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V. DEMERITS

1. Capital Cost for practical implementation of WPT to be very high.

2. The other disadvantage of the concept is interference of microwave with present communication systems.
3. Common belief fear the effect of microwave radiation.

4. But the studies in this domain repeatedly proves that the microwave radiation level would be never higher than the dose received while opening the microwave oven door, meaning it is slightly higher than the emissions created by cellular telephones [6].

VI. APPLICATIONS OF WPT AND IoT

1. Generating power by placing satellites with giant solar arrays in Geosynchronous Earth Orbit and transmitting the power as microwaves to the earth known as Solar Power Satellites (SPS) is the largest application of WPT and IoT.

2. Moving targets such as fuel free airplanes, fuel free electric vehicles, moving robots and fuel free rockets. The other applications of WPT are Ubiquitous Power Source (or) Wireless Power Source, Wireless sensors and RF Power Adaptive Rectifying Circuits (PARC).

3. Mobility - user device can be moved easily within the wireless range.
4. Neat and easy Installation - since no cable running here and there, just start up the wireless device and you're ready to rumble .

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