REVIEW OF WIRELESS POWERED COMMUNICATION NETWORKS

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Abstract: Current wireless and cellular systems are ordained to experience a significant change in the progress to the next generations of the network technology. The well known wireless powered communication networks are becoming more predominant technology for obtaining the performance goals of the future networks. In this technique the nodes in wireless powered communication network are equipped with a hardware which can harvest energy from the received signals that is, their battery can be loaded without any physical connection. Recent innovations in the harvesting and energy transfer technology reveal the same thing, especially for low power devices. The future research will be more on the WPCN. This paper gives the review of all WPCN techniques, it gives details about the basic technique of WPCN, discussion on on going techniques and it also provide major research issues. In more specific, overview will be given first then some advanced techniques will be discussed to enhance the performance of future WPCN. We discuss implementation models and tools of WPCN. Finally we stress the research problems for WPCN.

Keywords: WPCN, Wireless energy transfer, energy harvesting

INTRODUCTION:

In the present wireless communication system battery plays very important role, the performance of the system totally depends on the power backup capacity of the used battery. Instead of totally depending on the reliability of the battery, we try to recharge the battery from the signals received by the device during its normal functioning. This idea will bring revolutionary changes in the field of wireless communications. The main challenge in the 5th generation technology is to find the solution for the increase of energy efficiency of the wireless communication networks. The ecological economical and functional sustainability of 5G network totally depend on this parameter. Same thing can be applicable for end portable devices. As the technology progresses next generation expect better power efficient devices compared to the existing electronic gadgets. The next generation wireless communication requires two important energy related performance challenges first one, the overall energy consumption of the future 5th generation technology should not exceed more than 20 percent of the present usage. Second, much longer battery life for wireless devices, that is at least one week for the smart phone and up to 20 years for a low machine type communication device, is required [1].

Several researchers proposed different methodologies to fulfill the above mentioned goals among that one technology based on radio frequency(RF) energy harvesting and transfer is the best, which gave best results[2]. By this method there is a possibility of future electronic mobile are capable of harvesting energy from signals delivered by different sources. This makes the possible use of wireless powered communication network by different users and fixed stations, started harvesting energy from the transmitted signals without any physical connection.

WPCN has some different and interesting characteristics compared to other harvesting techniques like wind, solar and vibration, the efficiency of this system depends not only on the randomness of the available energy, but also on the distance between the source and the harvesting user. The position of the power source and the movement of the harvesting unit will make high impact on the efficiency. Novel vision and research challenges related to the design, analysis and optimization of architecture and protocol arise [3]. Thus, there are many techniques and solutions to the problems developed for wireless communication networks with or without using the different harvesting techniques need to be reviewed to make them useful for wireless powered communication networks.

Organization of this paper is divided in to four sections section I initially reviews all the available techniques in the field of wireless energy transfer, then section II discusses about applications, architecture and standards of WPCN, and then section III explains about different advanced approaches and implementations of RF energy transfer and harvesting system.

First we consider most useful technique for smart use and reuse of energy by power efficient networks well known by battery less devices known as back scatter communication with energy harvesting. In this all the nodes transmit and receive data with certain quality of service requirements while harvesting energy from the environment. we use the advantage of this technique for the design of future wireless networks i.e; wireless body area networks(WBAN), instead of efficient energy usage it is better to go for energy management to generate the lifetime of the networks consist of low power devices, such as internet of things (IOT) and sensor networks. In this context, energy management mechanisms depending on duty cycles for WPCN are considered as the most reliable solutions because of this reason, we discuss about system architecture and implementation details of the technique when used in IOT and sensor networks. We try to focus on energy transfer and receive capabilities of the each node. We try to design a best transceiver algorithm for the improvement of efficiency of energy transfer and to reduce the consumption of energy for each wireless node in the WPCN. In specific, we first explain the concept of self sustainable communications and then discuss about best transceiver design for realization. We then give an overview of all the techniques available for the effective implementation of RF energy transfer and harvesting system. Finally we conclude with research problems in the area of WPCN.

Architectures of wireless powered communication networks:

The use of WPCN introduces many advantages to the user in many applications, the major benefits are user friendliness and battery charging without any physical connection. This can certainly improve the servicing and maintenance of the many battery powered devices used in current and future wireless networks.

Wireless Energy Harvesting Technologies:

With the use of WPCN user can get more flexibility in term of energy provisioning techniques. In general, for the energy transfer and harvesting to the end wireless user following two techniques are used in WPCN

(I) Radiative wireless charging

(II) Non Radiative wireless charging

Radiative wireless charging can also be called as RF energy transfer, and Non Radiative wireless charging can be further classified in to inductive coupling and magnetic resonant coupling [5]. These Radiative and non Radiative wireless charging can be combinely classified in to three categories.

(i) RF energy transfer

(ii) Inductive coupling

(iii) Magnetic resonant coupling

(i) RF energy transfer: This context mainly depend on the technique of transmission of the radio waves to the far field region, it can allow a propagation distance of several meters to the kilometers. This technique is suitable for the wireless devices which not in a near proximity to the transmitter.

(ii) Inductive coupling: This is mainly depends on magnetic field induction and can be used for transfer of electrical energy from millimeters to several centimeters. The transmitter's and receiver's are inbuilt with the coils. The transmit coil generates a magnetic field across the receive coil, thus inducing voltage and current at the receiver. The efficiency of this near-field energy transfer depends on the wave frequency.

(iii) Magnetic Resonant Coupling:

This technique is based on evanescent wave coupling. In this the near-field energy transfer is performed by making two separate coils resonate at the same frequency. As a result, the two coils are strongly coupled. Magnetic resonant coupling achieves transfer efficiency ranging from 30 percent to around 90 percent for distances between the transmitter and the receiver between 0.75 m and 2.25 m. This is better useful for the applications such as electric vehicles and cell phone charging[4].

The Non Radiative coupling is best suited for short distance applications as it is capable of high power high efficient transfer of wireless energy. where as Radiative coupling is mostly used for long distance propagation because it uses electromagnetic waves for the transfer of energy, it operates in the frequency range 3KHz to 300 GHz. It is divided in to RF energy spatial multiplexing and non directive RF power transfer. Due to the safety concern the Radiative wireless charging is operated under low power region.

Directions for Network Architecture and Standard Development:

The wireless power communication network is infrastructure with base stations are access points providing connections to the nodes powered by by wireless dedicated energy sources. In some applications the network can be infrastructure less and communication and energy transfer takes place between devices to device. Recent developments in the field of energy transfer had made mandatory for the standardization of rules and specifications for the future WPCN. The three main standard techniques till now are 1) Qi 2) Power Master Aliance (PMA) 3) Alliance for wireless power (A4WP) [2]. Qi depends on inductive coupling and was first proposed by the Wireless Power Consortium (WPC), an open-participation participation of Asian, European, and American manufacturers aiming at creating a worldwide standard for inductive charging technology. It works at the frequencies of 110– 205 kHz and 80– 300 kHz and defines specifications for interoperable wireless power transfer and in-band data communication between a wireless charger and a chargeable device within the scope of 4 cm. The received protocol empowers a charger to alter its power output to take care of the vitality demand of a chargeable device and to interrupt the power transfer when the charging is finished. Along comparative lines, PMA is likewise in light of inductive coupling and in this manner shares a similar center technology as Qi. Be that as it may, it works at the frequencies of 277– 357 kHz and further varies from Qi regarding control power management and communication protocols, the last aiming at certainly creating a work of wireless charging points. Then again, A4WP is based on magnetic resonant coupling and has been intended to be more adaptable than its partners in light of inductive coupling. All the more particularly, it neither necessities exact arrangement nor free-of-snags line of sight links amongst transmit and receive coils. Actually, A4WP works at the recurrence of 6.78 MHz, though charging control operations are performed out-of-band on the 2.4 GHz Industrial Scientific Medical (ISM) band. As a rule, it can bolster a level of coil separation up to a barely any meters, enabling multiple-device charging and better transfer range through layers, e.g., materials for example, books and clothes, and work in the nearness of other metallic items [6].

Advanced Approaches and Implementation Perspectives for Wireless Powered Communications Networks:

Architectural and standardization related viewpoints are certainly principal for the future improvement and organization of WPCN. Nevertheless, their significance is ostensibly dominated by the technological challenges that describe transceiver operations and design in these situations. Truth be told, from a commonsense point of view, the viability and possibility of WPCN operations can be ensured just if a near ideal interplay between energy supply and management is accomplished[7]. In a perfect world, such interplay ought to be improved at both the algorithmic and hardware levels. Research toward this path is still at a rather beginning period, albeit a few promising arrangements have already been proposed. In the remainder of the area we will particularly center on three methodologies and talk about their capability to further push the cutting edge of WPCN. The area will be then finished up by an introduction of general usage points of view for testing and developing arrangements and calculations for deploying 5G-ready WPCN[8].

Open Research Issues in Wireless Powered Communication Networks:

In spite of the consistently growing research endeavors made by both the industrial and academic communities in the a decade ago, powerful answers for a few important open issues complicating the useful monstrous arrangement of WPCN presently can't seem to be found. In this respect, three main research regions can be distinguished.

Interference management:

Indeed, RF-based energy transfer can cause hurtful co-channel interference to the nodes in the same or diverse networks. Therefore, interference management strategies for WPCN need to be created to guarantee their consistent integration with prior networks. Conceivable answers for this issue include, for instance, complex and adaptive transmit power control mechanisms on the off chance that the issue is tended to at the physical layer, or then again, dynamic multiple access approaches for information and energy sources if the issue is tended to at the MAC layer. All the more decisively, appropriate adaptive transmit power control mechanisms for WPCN ought to advance not just the throughput of the data transmission yet in addition the energy transfer efficiency, at the same time accounting for interference temperature constraints forced by the nearness of other nodes in the same or unique networks. In this context, customary power control optimization details may do the trick, gave that extra constraints on energy consumption, energy supply, and interference are accounted for and satisfied. Switching our concentration to MAC-arranged approaches, dynamic multiple access strategies can be embraced to plan data transmission and energy transfer for various nodes to such an extent that interference, that is, collision, can be adequately kept away from. Prior methodologies could then be altered according to the quality of service (QoS) necessities of the two data transmission and energy transfer[9].

Joint Radio and Energy Resource Optimization:

Energy consumption and management is a critical matter in WPCN. The dynamics regulating factors, for example, energy accessibility/supply, battery state information, wireless channel conditions, and the quantity of nodes in the WPCN and their QoS prerequisites, should be painstakingly considered in the design of ideal energy/asset management calculations. In other words, pertinent framework parameters should be set according to dynamic methodologies accounting for the stochastic nature of both energy prerequisites and ecological conditions rather than to existing opening focused ones. For instance, the energy gathered by low energy devices may not generally be totally utilized during the present space and may should be put away in the energy stockpiling device, e.g., a super capacitor, for later utilize, depending on the channel dynamics and area of devices. Two main research headings are as per the following. To start with, ideal long haul strategies for the wireless energy transfer mechanism, e.g., transmission powers, transmission length, and measure of transferred energy, rather than the existing space situated one, ought to be concocted to yield a powerful utilization of the put away energy. A decent case is the transient energy advancement model and calculation design approach portrayed before. Second, cross-layer approaches taking into account parameters and information
accessible at the physical, MAC, and system layers, ought to be advantaged. This could certainly
make it conceivable to distinguish ideal strategies, both framework insightful and per-client, to jointly control data scheduling/transmission and energy transfer.

Implementation and Deployment Cost Minimization:

While WPCN can decrease arrangement and maintenance costs due to the gave adaptable and simple energy renewal abilities, their usage cost can be higher because of the requirement for the
reception of unique electronic components and for critical investments for novel hardware advancement. Three main ways to deal with decrease such costs can be distinguished. Initial, a superior understanding of the mathematical models underlying the harvesting operations at the hardware level should be attained. A decent illustration is the current appropriation of more exact non-linear models for describing the operations performed by a rectifier in the RF energy harvesting domain, instead of the exemplary linear models. This approach already uncovered a surprising potential for noteworthy framework optimizations. Capitalizing on this more refined understanding, novel calculations and protocols could be created to improve the execution of concurrent information and power transfer applications and increase wireless energy transfer at a more affordable algorithmic level. Second, the design of integrated energy harvesting and information processing transceivers is by all accounts principal to accomplish non-irrelevant execution cost savings. The ensuing and fitting acknowledgment of self-sustainable communications between concurrent information and energy sources and end devices may further contribute to mid-to-long haul net arrangement cost diminishment. Finally, to test the design, hardware for various innovations, for example, energy beam forming and high-efficiency rectenna must be created. We the advancement of future wireless energy transfer and harvesting applications ought to

ensure a consistent integration with the core advances of future age networks. The perfect objective would be to guarantee the previously mentioned integration and to misuse the quirks and highlights of emerging methods and approaches for increasing the adequacy of wireless energy transfer and harvesting. Presently change our consideration regarding four emerging innovations and approaches for WPCN. Surprisingly, these devices can be utilized by researchers and framework engineers from both industry and the scholarly community to design and send WPCN in future 5G networks and have been chosen for their adaptability and timeliness. In this context, we will particularly allude to state-of the- craftsmanship applications and prerequisites with a specific end goal to guarantee the importance of the examined approaches as for the research regions and challenges outlined in this area.

conclusion:

Wireless power communication networks (WPCN) are a promising worldview to design sustainable and energy proficient answers for future communication arrange technology. Specifically, they can demonstrate useful to some low-power applications including device-to-device (D2D) and machine-to-machine (M2M) communications, sensor networks, and Internet of Things (IoT). In this article, we first given a general outline of the central parts of WPCN. In this context, we talked about the three main sorts of wireless energy transfer methods, and outlined potential application situations, design, and standards for WPCN. Then we talked about three progressed approaches, i.e., keen energy (re)use, ideal energy management, and energy-harvesting mindful calculation and transceiver design, and delineated general usage points of view for validating algorithmic arrangements with off-the-rack components and designing RF energy transfer and harvesting frameworks. Finally, we outlined prominent research bearings and open issues for future WPCN arrangement.

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