Review on RF Energy Harvesting

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Abstract: **RF energy harvesting and transfer techniques have recently become alternative methods to power the next generation of wireless networks .Radio frequency energy transfer and harvesting techniques is one of alternative methods to power the next generation wireless networks. It is emerging technologies enable protective energy replacement of wireless device. It provides consistent efficient source to devices. RF energy harvesting systems are emerging as efficient solution to existing situations. It supports applications with quality of service requirements. This paper presents an overview of passive radio frequency energy overview of passive harvesting circuits for isolated communication and computing system locking access to primary power sources. RF technologies ranging from the directed communication signal repetition to dispersed ambient power harvesting provided.**

I INTRODUCTION

Energy harvesting is the process by which energy is derived from external sources. For example: solar power, thermal energy kinetic energy and wind energy. Energy harvesting is also called ambient energy or power harvesting. Energy harvesting provides a very small amount of power for low energy electronics. While the input fuel to some large-scale generation costs resources I.e oil, coal etc.The energy source of energy harvester is present as ambient background. For example temperature gradients exist from the operation of a engine and in urban areas. There is a large amount of electromagnetic energy in the environment because radio and television broadcasting. One of the earliest applications of ambient power collected from ambient electromagnetic radiation (EMR) is the crystal radio. The principal of energy harvesting from ambient EMR can be demonstrated with basic components i.e diode, capacitor, resistor etc. energy harvesting device composes of transducer, power conditioning and energy storage.[4] This technology work together to collect the energy and deliver the power of the device.

Energy device converting ambient energy into electrical energy have attracted much interest in both the military and both commercial sectors. Some systems convert motion, such as that of ocean waves into electricity to be used by oceanographic monitoring sensor for autonomous operation. Future application may include high power output device (i.e arrays for such devices) deployed at remote locations to serve as reailiable power stations for large system. Another application is in wearable electronics where energy harvesting device can power or recharge cell phones, mobile computers, and radio communication equipments.

II. RF ENERGY HARVESTING

RF energy harvesting is converts into RF signal energy into DC power. RF energy harvesting for wireless devices, It is also called power harvesting or energy scavenging. The ambient energy may come from stay electronics or magnetic fields or radio waves from nearby electrical equipment. Light thermal energy for kinetic energy such as vibration or motion of the device. In everyday technologies RF energy is available in wide range of frequency for example cell phone, radio tower, Wi-Fi routers, laptops. By RF energy harvesting little amount of energy can be harvested. It is even better for low power application example Wi-Fi router can transmit 50-100mw. It can be harvested up to 1.5milies. Recent advances in ultra-low power wireless communication and energy harvesting technologies have made self sustainable device feasible. The major concern for these devices is battery life and replacement. Applying energy harvesting techniques to these devices can significantly extend battery life and sometimes even eliminated the used for better.[6] Ambient energy is available in different forms I.e small vibration, light temperature gradients electromagnetic waves etc.The energy is around us can be converted to electrical energy with current technologies like solar cell, Pizeo electric device, thermal electric device or spatial antenna. This paper aims to discuss one of the available techniques i.e RF energy harvesting. Ambient energy in the form of man-made electromagnetic of the system location whether indoor or outdoor system.[4]

III. OVERVIEW OF RF ENERGY HARVESTING

A general architecture of RF energy harvesting network and device as shown in below fig 3.1.

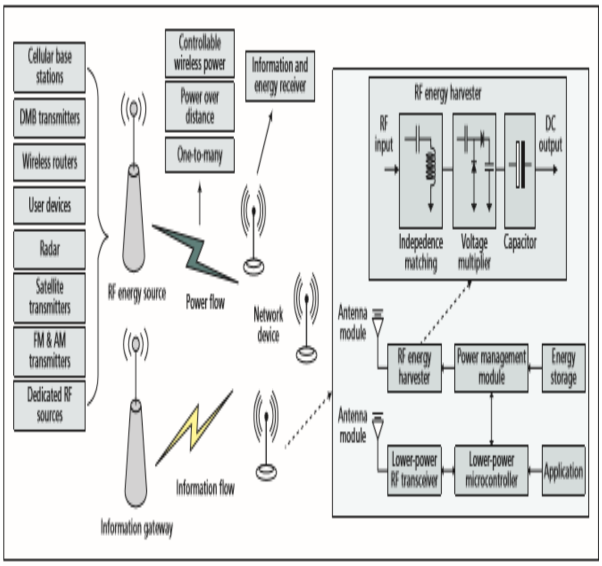

Fig 1: A general architecture of RF energy harvesting network and device.

A) A GENERAL ARCHITECTURE OF RF ENERGY HARVESTING NETWORK

A general architecture of RF energy harvesting network and device as shown in above fig 3.1.

The major components are

a) Information gateways

b) RF energy sources

c) Network nodes/devices

Information gateways are generally known as base station wireless routers and relays. The RF energy source can be either dedicated RF energy transmitter or ambient RF source for example towers. The network nodes are the user equipment that communicated with the information gateways. Typically the information gateways and RF energy source have continuous and fixed electric supply. While the network nodes harvest energy from RF sources to support their operations. The some case the information gateways and RF energy source ca be the same. The information gateway has an EH zone and an information transmission zone represented by the dashed curves as shown in figure. The device in the harvesting zone is able to harvest RF energy from the information gateway.[2] The device in the information transmission zone can successfully decode information transmitted from the gateway. Generally the operating power of the harvesting components is much higher than that of information decoding component. Therefore the energy harvesting zone is smaller than the information transmission zone. Note that the decentralized RFEHN also has a similar architecture to the figure except that network nodes communicate with each other directly.

B) A GENERAL ARCHITECTURE RF ENERGY HARVESTING DEVICE.

Fig 3.1 shows the block diagram of network done with RFEH capability. An RF energy harvesting node consists of the following major components are the application, A low power microcontroller, A low power RF power transceiver, A energy harvester, power management module, an energy storage or battery. The power management module can adapt two methods to control the incoming energy flow

1) Harvesting – use method

The harvesting energy is immediately used to power the network node. Therefore for the network node operates normally and the converted electricity has to constantly exceed the minimum energy demand of the network node otherwise the node will be disabled.

2) Harvesting store use method

The network node is implementing with energy storage that stores the converted electricity, whenever the harvested energy is more at the nodes. The excess energy will be stored for future use.

Figure also illustrates the block diagram of RF energy harvester. The antenna can be designed to work on either frequency or multiple frequency bands which the network node can harvest from a single or multiple sources. Simultaneously RF energy harvester typically operates over range of frequencies since energy density of RF signals in diverse in frequency. The impedance matching is resonator circuit operating at the designed frequency to maximize the power transfer between the antenna and multiplier. The efficiency of the impedance matching is high at the designed frequency. The main component of the voltage multiplier is diodes of the rectifying circuit which converts RF signals in nature into DC voltage. Generally higher conversion efficiency can be achieved by diodes with lower built in voltage. The capacitors deliver smoothly to the load. If RF energy is not available, the capacitor can also serve as are serving for a short distortion. The efficiency of the RF energy harvesting depends on efficiency of the antenna. The accuracy of the impedance matching between antenna and voltage multiplier. The power efficiency of the voltage multiplier converts received RF signals to DC voltage.

IV. WORK ON RF ENERGY HARVESTING IN INDIA

In India, the permanent RF source which enable RF harvesting commercially are TV broadcast, FM radio system, AM transmitter, mobile cellular handsets, Wi-Fi and cell tower transmission. Cell tower transmissions in India include technology I.e CDMA, GSM, WCDMA, BWA.

Table (1): Different technology bands using cell tower.

Technology	Frequency Band
Code Division Multiple Access (CDMA)	869-889 MHz paired with 824-844 MHz
Global System for Mobile communications (GSM)	GSM800: 890-915 MHz paired with 935-960 MHz GSM1800: 1710-1785 MHz paired with 1805-1880 MHz
Wideband Code Division Multiple Access (WCDMA) - 3G	WCDMA2100: 1920-1980 MHz paired with 2110-2170 MHz
Wideband Code Division Multiple Access (WCDMA) - 3G	2.3-2.4 GHz and 2.5-2.69 GHz

Globally is home for 7,47,917 base transreciever station (BTS) as of 30.06.2013 with 864.72 million wireless connections. These cell towers transmit 24hours every day all round the year. Hence it can be used as a continuous source of usable energy.

V. ISSUES IN RF ENERGY HARVESTING

An antenna is responsible for capturing RF signals decreases size and main aims are increases high antenna gain. For hardware implementation, these have been made for narrow band antenna and designs in a single band.

- Matching network: matching network is to reduce the transmission loss from an antenna to rectifier circuit and increases the input voltage of a rectifier circuit.
- Rectifier: rectifier is convert input RF signal captured by antenna into DC voltage. Rectifier design is generate a battery like voltage from input RF power.
- Receiver architecture design

✓ Separated receiver switching: it also known antenna switching and it is implemented energy harvester and information receiver with independent antenna and it is decoding independlty.

✓ co- located receiver architecture: it is implemented in energy harvesting and information receiver and share the same antenna single antenna can be adopted. This co-located receiver architecture is similar size compared to separated receiver architecture. It can be 2 modes are used –time switching architecture, power splitting architecture

- Single-hope RF-EHN's:

✓ Multi-user scheduling: The multi-user scheduling goals are to achieve the best utilization of resources for example RF energy and frequency bands and among through different users and some QOS criteria.

✓ Receiver operation policy: It can require for wireless devices and sharing the same antenna or antenna array for information reception and RF energy harvesting. This policy is based on time switching or power switching.

- Multi-antenna network with RF energy harvesting

✓ SWPT beam forming optimization without secure communication requirements: Beam forming is explored in a 3 nodes are MIMO network with one transmitter, one energy harvester and one information receiver. It can be transfer between information rate and the amount of RF energy.

✓ SWPT beam forming optimization with Secure communication requirement:
Beamforming schemes for secure communication in MISO downlink system. It is targeted information receiver and energy harvester. It design of transmit beamforming vector and power allocation with different objectives.

V. CONCLUSION

RF energy harvesting will play an important role in powering the next generation of wireless network. In these articles we presented an overview of RF energy harvesting including the network architecture and devices. Significant amount of research is being conducted in the area of energy harvesting. There are various ways of harvesting the ambient energy. Power is harvested from electromagnetic radiation coming from major broadcasting systems like mobile phones, TV radio. The major application for EH at the moment is the creation of wireless sensor networks is depends on truly autonomous device. Such integrated RF energy harvesting systems have been researched and implemented for various applications worldwide and urgent need for it is seen in India. We have provided an overview of RF Energy harvesting with the focus on the architecture.

VII. REFERENCE

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