Chapter 5
Energy Harvesting Models and Techniques for Green IoT: A Review

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ABSTRACT

Wireless sensor networks (WSNs) have been popular due to their wide range of applications in almost all walks of life including industry controls, environmental monitoring, health, transportation, military. Usually conventional sensor networks are dedicated, and private networks have little or no communication with the outside world; hence, when connected to the external world by using internet protocol (IP), they form a network of connected devices, sensors, and systems and form an internet of things (IoT). Due to rapid development of IoT infrastructures worldwide, energy demand has been increased significantly to meet the power requirements of billions of connected devices. Since WSN is a foundation of IoT; hence, IoT also inherited with the challenge of providing consistent energy and to maintain hazard-free environments. This chapter is the extension of "Energy Harvesting Models and Techniques: A Review," which focuses on possible energy sources available in ambient environment and the technological mechanism to harvest energy for WSN and IoT that promotes green energy concept.

INTRODUCTION

WSN was explored to a great extent by researchers in past three decades due to its wide use and significance in industry, environment monitoring, military and many other applications. It comprises spatially dispersed and dedicated sensors and has limited communication with external world as it is usually a private and dedicated network of sensors. In order to exchange information with the outside world that is generated by sensor network it is needed to have specific gateways in WSN. This is achieved by using internet Protocol (IP) to connect a particular WSN with internet (Vasseur, J-P. et al., 2010). Hence, sensor devices have their own IP addresses and can be linked to the outside world and form internet of connected systems. (Khan, Z.A. et al., 2016). This technical advancement in IT sector allow the integration of both

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physical and virtual in a new paradigm along with innovative and diversified applications in all walks of life and termed as internet of things (IoT). The term ”Internet of Things” was first coined by Kevin Ashton in 1998 (Ashton, K. 2009). Later In 2001, IoT vision was introduced by MIT Auto-ID center (Brock, D. 2001) and the International Telecommunication Union (ITU) formally used the term in 2005 (ITU, 2005). IoT is a worldwide network of interconnected devices, objects, machines and systems that can be identified by unique addresses. Technical advancements in last decade increases the number of devices and subscribers all over the world exponentially, According to (IHS Markit 2017) it is expected that by 2030 there will be 125 billion IoT devices worldwide. The entire IoT is built upon four Cs, that is connect, collect, compute and create new business models which requires tremendous amount of data processing and power consumption. The result is the great amount of carbon di oxide (CO2) emission that becomes an environmental and health hazard. Also the power resources of theses smart devices are battery depended and limited which have a great impact on their performance and usability (Jhanjhi, N. Z. et al., 2017), hence in order to overcome these problems green computing attracts the attention of many researchers. The standard IoT is an evolution of WSN and considered as a combination of Wireless Sensor Networks (WSNs) and Radio Frequency Identification Devices (RFID) (Khan, Z.A. et al., 2016). As energy and power consumption has been a major concern in WSN deployment from the beginning and since IoT is considered as the evolution of WSN hence the energy and the low power consumption is the inherited problem in IoT as well, and the demand rises with the exponential growth of digital society. The launch of recent 5G networks and the drastic increase in IoT devices along with many versatile applications imposes two major challenges to cope up with the increased demand of power consumption, maintenance in diversified and new IT infrastructures and networks such as 5G, another problem is the associated environmental risk of carbon emission (GSMA, 2015) and the electronic waste. One of the effective solution to address both the problems is to harvest environmental energy. Hence, the need of low power consumption and environmental friendly devices are the main triggers of green IoT.

Energy Harvesting

Harvesting energy from environment is not a new technology; it has been used since decades to scavenge energy from wind, sun and moving water. The new thing is to implement this idea in modern systems. It is a process of conversion of environmental energy into electrical energy. Energy is around us in many different forms such as sound, vibration, mechanical, thermal, chemical, electrical, solar, wind, RF etc. Figure1 (Hi-globe, n.d.) shows the ambient energy sources in the environment. There are many types of energy harvesters each offering differing degrees of usefulness depending on the application (Alippi C. et al., 2009).Energy harvesting or energy scavenging has an important application in areas where wiring is not practical or it is difficult to supply energy, hence it has great scope in wireless sensor networks to keep them operational for almost infinite time.

Wireless sensor networks are suitable to deploy in areas with harsh weather condition and flexible enough to embed with any system of interest. However, constant power supply is a big challenge to keep sensor node functional. To address power problem in WSN, we broadly have two solutions

Reduce Power Consumption By Using Low Power Networks

Low power consumption in WSN has been a popular research topic since past two decades for the sake of increasing sensor network life. Continuous research has been conducted to investigate and improve