Chapter 83
Energy Conservation in the Era of Ubiquitous Computing

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ABSTRACT

Widespread availability and affordability of devices and easy accessibility of internet has accelerated the pace of ubiquitous computing. Connectivity to the internet has resulted in an exponential growth in terms of content and traffic available on the internet. When the barriers such as type of devices, location, time, and format have become meaningless in the era of ubiquitous computing; the issue of energy consumption and resultant carbon emission is a matter of concern. Energy consumption is an issue in ubiquitous computing, as the majority of the devices involved will be mobile devices that depend on the limited power offered by the battery inside the device. Carbon emission is a concern due to the combined impact made by the devices hooked over to the internet. This chapter discusses the issues related to energy consumption for various activities when the services offered by the internet are availed. The chapter also discusses the challenges to be overcome to achieve conservation of energy consumed by the internet and devices.

INTRODUCTION

The widespread availability of computing devices and easy access to the Internet has revolutionized the way people use computers. Computers and computing devices became so common and popular among the people of all walks of life. Advances in the technology pave way to computing devices that can be carried with users wherever they are – hence paving a new era called as "ubiquitous computing". The barriers such as type of devices, location, time and format has become meaningless in this era (Mark, 1999). Other terminologies used for ubiquitous computing include pervasive computing, ambient intelligence (Hansmann, Merk, Nicklous, & Stober, 2003), ambient media (Artur, Thomas, Bjoern, Kari, & Juha, 2009) or everyware (Adam 2006).

Ubiquitous computing resulted in a paradigm shift from the hitherto computing called desktop computing: (i) the traditional wired networks had to be extended to include wireless networks, and (ii) the

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concept of anywhere computing was materialized with the introduction of devices that are mobile and wireless. The extension of traditional wired network into wireless network resulted in a lot of challenges due to the reason that existing protocols and supporting software had to be extended to include wireless arena also. The introduction of wireless mobile devices also demanded a lot from the research and developer community for their smooth existence and interactions within a network.

When the facility of anywhere computing becomes the rule of the day, one of the main issues it raises is energy consumption. This is due to the following reasons: (i) majority of the devices engaged in ubiquitous computing are mobile wireless devices, (ii) mobile wireless devices depend on the attached battery for their power requirements, (iii) the challenge of "packing" energy with the limited "real estate" available with a hand held device, and (iv) even if significant improvements have been achieved in the battery technology, the pace of development is not in par with the developments in the microprocessor design (Christopher 2014).

Due to the inherent deficiencies of battery power, devices engaged in ubiquitous computing have further headaches concerning their battery power. The energy consumed by the devices is depending on many factors such as the type of gadgets used in the assembly/make of the device, type of usage of the device (mobile or fixed), type of applications and networks onto which the device is getting connected (Internet Users, 2015).

In this chapter, the scope is limited to the energy consumption issues related to the web connectivity. This is due to the fact that Internet is the most viable and readily available infrastructure to hook the entire world into a web. In the era of ubiquitous computing, the majority of the users are getting connected to the Internet for their heterogeneous types of needs and applications. As of July 2016, the total number of Internet users in the world crossed three and half billion – 4% of the world's population (Internet Users, 2016).

BACKGROUND

Main cause of energy consumption especially in hand held devices are usage of Internet. In this section a brief account of the internet usage and energy consumption is outlined.

INTERNET USAGE

The popularity of smart devices used in the ubiquitous computing continues to grow at an exponential rate. This is due to the affordability of devices and availability of 3G, 4G and 5G networks. Currently there are as many mobile devices all over the world, as there are computers. The availability of smart phones is also increasing to the extent that global smart phone activations outnumber global child births by three to one (Tom, 2014). Trends reveal that smart phone customers are expected to reach 2.08 billion by 2016 (Statistia, 2016).

This tremendous growth of devices (smart phones and feature phones with Internet connectivity) has its impact over the Internet traffic also. The Internet traffic is steadily increasing at the rate of 66% per year (Internet Live Stats, 2015). In the past five years Internet traffic has quintupled (World Wide Web, 2016). It is estimated that monthly global mobile data traffic will surpass 15 exabytes by 2018 (Cisco, 2016). Internet offers a bunch of services to the users at an affordable cost. The popularity of