Energy Conservation in the Era of Ubiquitous Computing

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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 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 the services offered by the Internet is an indicative to the degree of the obsession the users across the world have developed with the Internet.

World wide web (WWW) is the foremost service offered by the Internet. The ease of use, easy access to the WWW and wide popularity of devices which can be used to access the Internet caused an exponential growth in terms of number of users logged on, devices used and data shared over the websites. WWW, one of the biggest repository of information in the world, is getting expanded in terms of its variety, veracity, velocity and volume - from just one web site in 1991 to 1 billion web pages in 2014 (World Wide Web, 2016).

When there is a variety of information available at WWW, the process of finding the required web pages will also increase. Search engines are widely used to locate the pages of one's interest. It is estimated that Google processes over 40,000 search queries every second on average - over 3.5 billion searches per day and 1.2 trillion searches per year worldwide (Google Search Statistics, 2015). The types of queries being fired are unique in the sense that 16% to 20% of queries that get asked every day have never been asked before (Mitchell, 2012). Queries made using mobile devices are also increasing day by day. It is found that the time spent on Internet using mobile devices in USA exceeds the time spent using desktop PCs during February 2013 and January 2014 (Rebecca 2014). Studies reveal that more than 90 percent of Internet users will access online content through their phones in 2017 (Internet Usage Statistics, 2015).

The evolution of web technology from read-only static pages to readily updatable dynamic pages has contributed a lot to the increased traffic over Internet – this evolution gave birth to a class of web sites known as social media. Social media is being effectively used as a platform for many innovative ideas and needs such as political campaigns, job applications, business promotion and networking, religious campaigns, educational purposes, and customer services. One of the reasons behind the popular use of WWW is the emergence of social media.

As of July 2014, there are 106,000,000 active social media users in India. However this is not a big number considering the fact that out of the 1.25 billion people in India, only one-fifth of the people use Internet and only 50% of these are using social media (Bhavya, 2014). But when the worldwide activities are considered, the statistics are astonishing. Number of postings made by the users on Facebook reached nearly 2.5 million. Contents uploaded to YouTube amounts to 72 hours of content. Number of tweets on Twitter crossed 277,000, Vine users shared 8,333 clips, WhatsApp users share 347,222 photos, and Instagram users share 216,000 new photos per minute (Kimberlee, 2014). In addition to this people also make use of WWW for their needs such as shopping, attending seminars and online courses.

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