Chapter 79
Power Consumption in Wireless Access Networks

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ABSTRACT

Power consumption of mobile devices is a great concern in the current mobile communication systems. Recent analysis by manufacturers and network operators has shown that current wireless networks are not very energy efficient. Power consumption is directly related to the coverage area of the base station. So in this chapter, the authors analyze and compare the total power consumption, power consumption per covered area and ranges of the macrocell, microcell and femtocell base stations for Mobile WiMAX, fixed WiMAX, UMTS, HSPA, LTE for 1x1 SISO systems and mobile WiMAX, HSPA, and LTE will be considered for 2x2 MIMO system. The numerical example will be illustrated with help of simulation results. This chapter enables the reader for knowledge of power consumption in existing wireless access networks technology with current and future trends of research.

INTRODUCTION

Early wireless systems consisted of a base station with a high-power transmitter and served a large geographic area having less number of users. The systems were isolated from each other and only a few of them communicated with the public switched telephone networks. Today, the cellular systems consist of a cluster of base stations with low-power radio transmitters. Each base station serves a small cell within a large geographic area. The total number of users served is increased because of channel reuse and also larger frequency bandwidth. The cellular systems connected with each other via mobile switching center and directly access the public switched telephone networks. The most advertised advantage of wireless communication systems is that a mobile user can make a phone call anywhere and anytime.

The power consumption of ICT is approximately 4% of the annual energy production and it is expected that this number will double within the next 10 to 15 years. Internet traffic has a compound annual growth rate of 40%, which is an increase in two fold in every two years. The wireless world research forum (WWRF) has a vision of 7 trillion wireless devices serving 7 billion users by 2017 (Deruyck et

al., (2011)). This indicates that the power consumption of wireless access networks become an important and crucial issue in the coming years. Earlier work also showed that the radio access network is a large contributor to CO2 emissions. Particularly, the base stations are responsible for roughly two-thirds of the CO2 emissions of these radio access networks. NTT DoCoMo states that the daily energy consumption per customer is 0.83 Wh for a terminal and 120 Wh for the mobile network, which is a consumption ratio of terminal versus networks of about 1:150 (Jimaa et al., (2011)). The energy consumption of the terminals is thus negligible with respect to the energy consumption of the networks. Several studies indicate that within communication networks, the wireless access networks are high power consumers. Especially the base stations (BSs) are responsible for a significant part of the power consumption caused by wireless access networks. Therefore, it is clear that we should focus on the base stations in the wireless access networks in order to reduce the power consumption.

This chapter provides an overview and comparison of the power consumption of some of existing technologies of wireless access network and suggests the optimum technology for a specific area on the basis of power consumption per covered area. The recent significant literature and some frontier of this area are also included in this chapter.

BACKGROUND

The power consumption and energy efficiency of telecommunications networks become more and more important. For wireless access networks, most studies focus on energy-efficient deployments of wireless access networks. These studies shows that the user try to reduce the number of base stations in the network by switching them off during periods of low traffic which is a very promising method for energy savings. These studies in combination with a realistic power consumption model for base stations will enable to quantify the actual power savings in the network.

Jain, (2007), presented a description of the different Path Loss models. He gathered information from various IEEE and ITU standards. In Deruyck et al. (2014), authors presented the power consumption model for macrocell and microcell base stations and energy efficiency of three different wireless technologies (mobile WiMAX, LTE, and HSPA) has been compared. In Alshami et al. (2011), authors presented a comprehensive study of frequency analysis for different path loss on mobile WIMAX. They discussed and implemented Okumura, Hata, Cost-231, Ericsson, Erceg, Walfish, Ecc-33, Lee and the simplified free space path loss models. In Deruyck et al. (2011), authors calculated the power consumption of base stations for mobile WiMAX, fixed WiMAX, UMTS, HSPA, and LTE. They introduced a new metric, the power consumption per covered area PCarea and investigated the influence of MIMO. In Deruyck et al. (2012), they categorized the base stations as macrocell, microcell, and femtocell base stations and compared the power consumption for each base station. In Sharma et al. (2012), they presented the calculation of path loss, link budgets etc, which are in the part of wireless system designing. Arif et al. (2013), presented a hybrid deployment model of a LTE-femtocell for a residential suburban scenario. In their model they placed the femtocell in a fix grid to calculate path loss for each femtocell. In Ho et al. (2013), they proposed the Quality of Service (QoS) supporting video streaming system with minimum data service cost over heterogeneous wireless networks. They determined that, one of the critical problems is power consumption at the mobile devices due to limited battery capability.

Although some researchers calculated the total power consumption and coverage range for two or three technologies using only one or two PathLoss models, but this seems to be missing in the literature

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