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A STUDY OF POWER CONSUMPTION WITH SAVING ENERGY IN LTE USER EQUIPMENT

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ABSTRACT

The eNodeB delivers CLPC-encoded Transmit Power Control (TPC) signals to the UE in order to control the UE's transmit power.In this thesis, the Okumura-Hata propagation route loss model is used to determine the uplink transmit power management parameters for User Equipment (UE) in an effort to lower UE energy consumption. This thesis uses the Okumura-Hata propagation route loss modestimation to analyze the necessary power levels for connecting the UE to distant base stations, which takes more power than connecting to nearby base stations. This thesis examines the Okumura-Hata propagation route loss in urban, suburban, and rural areas using a variety of receiver antenna heights (hbs), path loss compensation factors (), and eNodeB sensitivity (Po).

KEYWORDS: Power Consumption, LTE User Equipment, Transmit Power Control, User Equipment.

INTRODUCTION

Green communication in cellular networks is explored, along with energy-saving tips for end-user devices. Energy efficiency in wireless systems is of paramount importance because of its bearing on running expenses and global carbon footprint. The rapid development of ICT has led to a shocking surge in energy consumption. Increases in both environmental impact and operational costs might result from the exponential growth in energy consumption associated with wireless communications. The gap between the energy provided by UE and what is required widens annually. Therefore, energy-saving methods like discontinuous reception are included into the 3GPP Long Term Evolution (3GPP LTE) standard. Unfortunately, no current solutions come close to filling the hole, thus new approaches are being investigated to further reduce energy use.

LTE Power Consumption Model

In LTE, the overall power consumption model of a BS is broken down into two categories: (1) idle power consumption (the amount of power used by the BS even when it's not transmitting, or Ptx= 0), and (2) traffic load. The number of transceivers, represented by NTRX, and the transmit power, denoted by Ptx. Power consumption associated with active site cooling and signal processing is denoted by P0, whereas power consumption dependent on transmit power due to feeder losses and power amplifier is denoted by p. Even when there is no one in the cell, the traditional BS uses quite a bit of energy. Cell- DTX enables the BSs to turn down unused subsystems during the idle Transmission Time Intervals (TTIs). According to the cell DTX timing, it is thought to prevent a short sleep in LTE cells (max 0.2 ms) by doing which of the following? (Psleep =NTRX P0, where 0 1).

5G Power Consumption Model

This thesis uses a 5G power consumption model based on. The power amplifier (PA) efficiency is defined as where Ns are the number of sectors at each site and N is the total number of RF chains. The power consumption for each antenna branch, denoted by Pc, is higher than the power consumption for each sector, denoted by PB. is the amount of electricity being transmitted per sector. A system with N RF chains uses 2N dual-polarized antenna components. One of the advantages of power harvesting during idle mode was shown to be an improvement in the efficacy of Cell-DTX in 5G networks. Otherwise, the 5G system consumes more energy when activated.

Area Power Consumption on a Daily Basis

An example of an energy performance indicator is the daily average area power consumption (DAAPC), which is calculated by dividing the daily total network power consumption (in W) by the network area (A) in W/km2. The resource consumption of BS i in hour t may be inferred from the network load in the aforementioned system feasible load model, where NBS signifies the total number of BSs in the network, and reflects the probability that BS i is transmitting during the given hour t. In the equation, Pactive and Psleep stand for the active and passive power consumption of a BS, respectively. In conjunction with the LTE and 5G power consumption model, the following values may be substituted for Pactive and Psleep in LTE networks and 5G networks (with cell DTX capacity), respectively.

The following stages are outlined to help illustrate the process of mapping the daily traffic profile delivered by the network to the daily average area power consumption of the network:

• In the rural situation, peak-hour traffic demand is used to construct a daily traffic profile, which is then compared to the daily traffic fluctuation profile.

• The hourly network served traffic is mapped to the hourly network usage profile based on the outcome of system-level performance assessment.

• The hourly area power consumption of this mapping is calculated using a function derived from the power consumption models, which in turn is based on an area power consumption model taken from the long-term traffic model and updated using the E3F. Session 2 will include a more in-depth discussion of rural long-term traffic modeling.

• The assessed network's daily average area power consumption is calculated by averaging the area power consumption throughout 24 hours.

UE Model Design

Each every power-hungry UE physical layer component is analyzed. The objective is to determine which factors contribute to overall power usage. parameters of the UE model, and its constituent parts The UE model will be affected by the Rx and Tx power levels, the uplink and downlink data rates, and the RRC mode. The figure's parts are shown in the following subsections to examine their sensitivity to the aforementioned variables. The primary function of the LTE transmit baseband (BB) is to apply Forward Error Correction (FEC) turbo encoding to user data. Turbo coding is a method of encoding data that employs conventional methods to generate a bitstream with a 1/3 code rate. The Transport Block Size (TBS) or UL data rate determines how much data has to be encoded, but the UL Tx power has no bearing on how challenging turbo coding will be. Changing the modulation format has an effect on the Peak to Average Power Ratio (PAPR), but the UL data rate has no effect on the Radio Frequency (RF) itself. To conform to these regulations, the Power Amplifier (PA) will adjust its output accordingly. For instance, the Adjacent Channel Leakage Ratio (ACLR) could affect energy consumption. The Tx RF is the obvious recipient of the UL Tx power. Since there is only one PA output power level where it is most energy efficient, researchers are looking for ways to improve efficiency across the board. Bias and voltage switching for multiple power amplifiers are two such applications.

Power Added Efficiency (PEF) is expected to rise linearly with input power when each method is put into practice. Although the RX RF power consumption shouldn't change depending on the DL data rate, it will be affected by the DL Rx power level. As the Analog to Digital Converter (ADC) requires a certain signal level, the RF includes Gain Controls (GA) and Low Noise Amplifiers (LOA) to accomplish this. To save energy, the gain in these circuits may be lowered or even turned off if the DL Rx power level is too high. Baseband Reception: Most BB processing tasks, such channel estimation and equalization, are computationally intensive and unaffected by the DL data rate. The UE uses turbo coding to decode the user's input, which is an iterative approach and the most computationally demanding process in the digital BB. LTE's high data throughput necessitates a highly parallelized turbo decoder design. The complexity and thus the energy consumption grows linearly with the DL data rate.

Power versus Energy

The current drawn by the UE does not go over a certain threshold, the battery voltage may decrease, and the UE's Power Management Unit (PMU) may shut it down to prevent dangerous operation. The PMU may implement a power ON sequence if the current demand is high when many components are turned on simultaneously. Once this need is satisfied, the designer may start optimizing the components to get the intended outcome. It's in your best interest to tolerate a high peak power drain and bat drop-off. The longer OFF time may be made up for by switching to a power-saving sleep mode. This may happen, for instance, if there is just one planned data transmission. In the case when the power consumption increases linearly with the data rate, the area of each block represents the total energy required for transporting the stated amount of data. If the data rate is low and the transfer time is lengthy, the same amount of energy is used and bits are communicated as if the data rates were high and the transfer time was short. Energy consumption, as the former may need to be increased in order to reach the latter's goals. The battery life of the UE will be shortened if it has low power consumption but poor performance because of the longer periods of time it is ON. Clearly, after the data transmission is complete, the UE should adopt a very low power mode to avoid this argumentative chain.

ENERGY EFFICIENCY AND GREEN CELLULAR NETWORKS

Green communication is an emerging field of study that aims to improve the energy and resource efficiency of wireless communication without compromising on the quality of service provided to end users. It's beneficial for the world's ecosystem and the bottom lines of telecom businesses everywhere. Our approach to creating eco-friendly cellular networks is shown in the figure by a taxonomy graph. In recent years, several eco-friendly cellular network technologies have emerged with the aim of reducing the network's base stations' energy footprint. The mobile sector is struggling with a critical problem related to energy efficiency. There will be more mobile devices (11.6 billion) than personal computers (3.5 billion) by the end of 2020. The energy consumption of the auxiliary machinery is affected by this. In the meanwhile, data volume in the network is expected to expand by a factor of 10 every five years, leading to a 20% increase in energy consumption. Therefore, there is a serious problem with energy consumption that threatens the long-term growth of the mobile industry.

BS ENERGY CONSUMPTION REDUCTION

Energy consumption might be reduced by improving the BS design and incorporating more software and system capabilities. In order to lessen PA, it is crucial to think about the Power Amplifier's efficiency in BS design. The power amplifier in a base station uses the most electricity, and its efficiency is sensitive to factors including frequency range, modulation, and operational circumstances.

1. Enhancements to the Power Amplifier

The three most crucial parts of a BS are the radio, the baseband, and the feeder. More than 80% of a base station's power consumption goes toward the radio, with the power amplifier being responsible for more than half of it. Because of this, flexible power amplifiers need to be created so that the amplifier may be better adapted to the required output power. The search for more energy-efficient practices is widespread.

2. Protocols for conserving Power

In the current WCDMA/HSPA cellular network architecture, BS and mobile terminals are needed to continuously deliver pilot signals. LTE, LTE-A, and worldwide interoperability for microwave access (WiMAX) are some of the newer standards that have evolved to fulfill the growing need for high-speed data traffic. Even if improvements in hardware (such as Multiple-Input Multiple-Output (MIMO) antennas) boost spectral efficiency, allowing for high-speed data networks, the energy consumption of BS and Mobile Units (MUs) must be minimized because to the increasing volume of data they process. One simple way to save power is to turn off the transceivers whenever they are not needed for sending or receiving data. Future wireless standards must take use of base stations' potential energy savings by developing protocols to allow sleep modes in base stations. Turning off certain base stations during low traffic times might significantly reduce the network's energy consumption.

3. Energy-Aware Cooperative BS Power Management

The traffic load in cellular networks changes dramatically in both space and time for a number of reasons, including user mobility and behavior. The converse is true at night, when office districts have more traffic than nearby residential areas. Thus, certain cells will often be under little load, while others may be subject to heavy traffic stress. Therefore, a static cell size deployment is suboptimal when traffic conditions change. Such variations may pose a serious threat to microcell, picocell, and femtocell-based next-generation cellular networks. When a cell is overloaded or experiencing interference, it may breathe by decreasing its power output and handing over mobile users to other cells. To better distribute data traffic while reducing power consumption, "cell zooming" enables base stations to adjust cell size in response to changes in network or traffic circumstances.

MOBILE USER EQUIPMENT FOR GREEN COMMUNICATION

Furthermore, from the perspective of UE usage reduction, little research has been done despite recent initiatives. Most recent studies concentrate on discovering new ways to reduce power consumption in UEs, such as by enabling standby mode or integrating smart mobile applications. The LTE standard for uplink power management incorporates both an on-load power control and a carrier-level power control. Using data and measurements gleaned from the BS signals, the UE in the OLPC adjusts the transmit power. There is currently no way to influence the amount of energy used. balancing out the channel's frequent oscillations. To function, CLPC requires the BS to communicate information back to the UE so that it may alter the UE's transmit power.

CONCLUSION

LTE's uplink power management is adaptable, straightforward, and reliable. It consisting of a closed-loop component working in conjunction with an open-loop reference that may be tuned through parameters. In this thesis, the uplink transmit power management parameters of the UE were optimized to reduce the UE's energy consumption by using the Okumura-Hata propagation route loss model. Minimizing system interference via careful management of UE and eNodeB transmit power is one method that may be used to decrease cluster size. In actual LTE and cellular personal communication systems, the serving eNodeB is in charge of regulating the amount of power sent to each subscriber unit. This is done to ensure that each UE sends the minimum amount of power necessary to keep the reverse channel connection in good working order. Based on the results, adjustments may be made to the parameters base station height (hbs), route loss compensation factor (), and eNodeB sensitivity (Po) to locate the sweet spot between cell performance and outage. An UE may reduce its transmission power by using function compensation of path loss instead of full path loss compensation.

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