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IMPACT OF PATH LOSS AND ENERGY EFFICIENCY ON MOBILE NETWORK

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ABSTRACT

Network operators are increasingly focused on improving the energy efficiency of long-term evolution (LTE) cellular communication networks to cut down on both operating costs and environmental impacts. In LTE cellular networks, base stations may use as much as 95% of the network power, depending on the network's design, configuration, radio technology, and data rates. Controlling the output power of transmitters in cellular wireless networks, such as eNodeBs in the downlink and UEs in the uplink, is known as power control. On the uplink, LTE uses either Open Loop Power Control (OLPC) or Closed Loop Power Control (CLPC). To account for longterm channel changes like route loss and shadowing, the UE may conduct uplink OLPC in accordance with the eNodeB setup. To counteract the rapid channel decay that results from multipath fading, the uplink CLPC method employs a power compensation scheme.

KEYWORDS: Path Loss, Energy Efficiency, Mobile Network, long-term evolution, Network operators, Open Loop Power Control, Closed Loop Power Control.

INTRODUCTION

Reducing the uplink transmission power of user equipment in LTE is discussed on the basis of employing Okumura-Hata propagation models. To reduce UE power consumption and improve UE experience, the thesis focuses on uplink transmission power control parameters for UEs. This has led to the development of the following areas of study:

• To learn how the height of the base station (hbs), the path loss compensation factor (), and the sensitivity of the eNodeB (Po) affect the amount of energy used by the user equipment.

• To calculate the To Analyze the performance of Various Path Loss Models with factors of Distance and Frequency, the thesis makes use of an Open Loop Power Control (OLPC) approach for LTE uplink using the Okumura-Hata propagation model.

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• Examine the connection between the transmit power [dBm] from the user equipment and the distance [km] from the base station in rural, urban, and suburban settings with varying base station heights of 10m, 35m, 50m, and 75m.

MOBILE COMMUNICATION GENERATIONS

Manufacturers of mobile wireless devices have been at the forefront of technical innovation and advancement since the 1970s. To far, there have been five generations of mobile wireless technology introduced, starting with 0G or PreCellular technology and ending with 4G or Fourth-Generation technology. Bandwidth, data rate, radio access, and switching mechanism are the four pillars upon which the cellular generation rests. The introduction of the cellular concept in 1G technology paved the way for mobile wireless communication. Depending on the kind of system and services provided, 1G cellular networks' bandwidth may be anywhere from 10 to 30 KHz, and its maximum data transfer rate is 10 kbps. FDMA was used as the radio access method, and all switching was circuit-based. 1G was only compatible with voice services. In 2G technology, digital communication has replaced analogue communication to improve system quality. With a bandwidth of 200 kHz, a packet and circuit switching mechanism, and TDMA and FDMA radio access, the 2G system's first phase had a data rate of 9.6 kbps, while the second phase increased that to more than (300 kbps).

In addition to voice calls, 3G technology also allows for the transmission of data. The data rate peaked at 2 Mbps in the first phase and climbed to 50 Mbps throughout the course of the remaining phases, all while maintaining a constant wide bandwidth of 5 MHz. CDMA was used for radio access, while circuit switching with packets was used for data transmission. There was significant concern about packet switching when the 3.5 G system with the HSDPA technology was originally launched. 4G technology used sophisticated radio interfaces such orthogonal frequency division multiple access (OFDM) and multiple-input multiple-output (MIMO). 4G wireless networks may provide data rates of up to 1 Gbps for users with limited mobility and up to 100 Mbps for those with high mobility. The evaluation of the wireless communication system is presently underway, and scientists are actively planning for 5G wireless technologies.

1. 0G

It wasn't until after WWII that 0G wireless telephones were widely available. The mobile operator at the time only allowed talks to take place on a small number of channels, and

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phones did not have a changeover function, thus users were stuck on a single channel frequency. Precellular mobile phone technology was referred to as 0G back in 1970.Before cellular phones were commonplace, people often used radio telephones while driving. Then the mobile radio telephone system came along and evolved into today's cellular networks. 0G makes use of a wide variety of technologies, including PTT, OLT, MTS, IMTS, AMTS, and MTD.

2. 0.5G

In comparison to 0G technology, 0.5G is a significant improvement. Unlike earlier closed radio telephone systems, 0.5G mobile phone technologies are offered to the public as a paid service. The transceiver would be mounted in the trunk and connected to the top of the trunk, while the handset would be kept close to the driv- -way radio dealers, WCCs, and RCCs. Real estate agents, famous individuals, and the wealthy made up the bulk of this generation's customer base.

3. 1G

In 1979, NTT introduced the first commercially deployed cellular network (1G) in Japan, and since then, the company's network has grown to cover the whole nation.In 1981, the NMT system was introduced to Sweden, Denmark, Norway, and Finland.When it comes to mobile phone networks, NMT was one of the first to provide roaming across borders. With a bandwidth of 10-30 KHz, a frequency range of 824-894 MHz, and a data rate of 1 Mbps (10kbps), the 1G is an analogue system that employs FDMA as the radio technology to offer voice service[9].

4. 2G

In 1991, the GSM network launched the first commercial 2G cellular system, whose principal function is to digitally encrypt communications. Secondgeneration mobile data services launch with short-form message service (SMS) and texting. [9] . Mobile phone networks provide access to a wide variety of services, including texting, multimedia calling, and picture messaging. Using digital encryption, 2G technology ensures that only the intended recipient may read the contents of a text message. 2G technologies are categorized as either TDMA-based or CDMA-based depending on the multiplexing scheme used. The most common 2G technologies are IS-95 (based on CDMA), iDEN (based on TDMA), GSM (based on TDMA), IS-136 (based on TDMA), and PDC.[9] .The 850–1900 MHz range is used by GSM. It uses 2G technology with its expansion to deploy the generation, which consists of 2.5G (GPRS) and 2.75G (GPRS) (EDGE) on the full rate channel at a total data rate of (22.8kbps).

5. 3G

The third generation (3G) of mobile phone standards and technology is seen as one of the most exciting developments in wireless communications since the year 2000.Combining IP with lightning-fast wireless data transfer speeds. 3G technology is distinguished by its enhanced speed, larger storage capacity, and high-end network services including wireless web access, email, video conferencing, and multimedia. [21] .IMT-2000 suggests the most important improvements to the UMTS and WCDMA. Depending on the user's speed and mobility, 3G systems may provide data transfer rates of up to 2 Mbps on channel-carrier widths of 5 MHz while making efficient use of the radio spectrum. Using the 1.8-2.5 GHz frequency band, 3G networks provide varying data speeds based on the user's location: 2 Mbps for indoor and low-range outdoor use, 384 kbps for urban outdoor use, and 2 Mbps for sat-lite and rural outdoor use [9].

6. 4G

Long Term Evolution (LTE) is a trademark for the 3GPP 4th generation technology development effort, which is also known as the fourth generation of wireless systems. Smartphones, wireless modems, laptops, and other mobile devices may all get access to the internet through 4G systems in the same way that they could previously use 3G services. 4G uses include IP telephony, HD mobile TV, gaming services, 3D TV, video conferencing, and cloud computing. The mobile WiMAX standard, first used in South Korea in 2007, and the first release LTE standard, first used in Sweden, Stockholm, and Norway in 2011, are both commercially accessible 4G systems. (2009).

POWER MODEL

To further quantify energy savings on individual components and boost network energy efficiency, the BS power model is developed with the aim of reaching equilibrium between components and at the system level. The BS type greatly affects the implemented components because of output power, cost, and space constraints.

Base Station Power Consumption

Each transmit antenna element on a BS is serviced by a transceiver (TRX) in the BS. A TRX includes an AC-DC unit (mains supply) for grid connection, an active cooling system, a DCDC power supply, a power amplifier (PA), a radio frequency (RF) small-signal TRX module, a baseband engine with reception (uplink) and transmitter (downlink) sections, and a baseband engine. This setup might be useful for any size of BS, from macro to micro to pico to femto.

1. Antenna Interface (AI)

The impact of power efficiency in antenna types is represented by a set of losses including the feeder, antenna bandpass filters, duplexers, and matching b components. The use of a remote radio head (RRH) has the potential to reduce feeder loss in macro BS. Connecting the operator radio control panel to the RRH.

2. Power Amplifier (PA)

Maximum output power is the most efficient operating position for a power amplifier. Unfortunately, the power amplifier has to operate in a more linear mode due to nonlinear effects and OFDM modulation with non-constant envelope signals. As a result of the nonlinear distortions, the receiver's performance will not degrade and adjacent channel interference (ACI) will be suppressed. Nonetheless, the poor power efficiency etaPA that comes with such a high operating cost will lead to increased power consumption. It is widely agreed that both macro and micro BSs need extra input for predistortion and signal processing. Given that the PA only accounts for a negligible amount of the overall power used by the BS, it might be considered wasteful in smaller BS designs; moreover, the low proportion of power used by the PA can be used to rationalize a less efficient PA.

3. RF Transceiver (RF-TRX)

The RF architecture is affected by the BS type, which in turn affects the linearity and blocking requirements of an RF module. For macro/micro BSs, super heterodyne designs or low IF topologies are suggested.

4. Baseband unit (BB)

Signal detection (synchronization, channel estimation, equalization, correction of RF non-ideals), modulation demodulation, digital predistortion (only for large BS types), and channel cod-management and medium access are all examples of digital signal processing. The efficiency of the BB's power consumption is affected not only by the technology itself, but also by the signal bandwidth, the number of antennas, and the suitable signal processing algorithms.

CELL DISCONTINUOUS TRANSMISSION (CELL-DTX)

The base stations (BSs) in a typical cellular network account for around 80% of the total energy consumption. During transmission time intervals (TTIs) with no traffic, Cell-DTX enables BS to operate in sleep mode. This means the transmitter is only turned on when absolutely necessary, saving energy. This technique accelerates network low-power states by deactivating hardware components. A simple model for power consumption per cell is shown in Figure (Illustration of the power consumption model used in the implementation), along with the fact that several cells may be serviced from a single location. There is a linear correlation between PA use and the increase in cell power consumption. In most cases, the stable energy consumption element (C) follows the variable energy consumption portion (V) in the listing. One may "switch off" or "sleep" a cell. Transmission (DTX) mode is utilized when the energy consumption is reduced to a value (D) below a certain threshold. There are two distinct types of cell DTX, fast cell DTX and long cell DTX. Some examples of fast cell DTX include cell micro DTX and MBSFN-based DTX, both of which function at the slot/sub frame level. When there is no user data to transmit in the cell, the radio enters DTX, also known as micro DTX or micro sleep, in between transmissions of the Cell specific Reference Signal (CRS). In contrast, CRS is not transmitted in MBSFN sub frames, therefore users of MBSFN-based DTX (Multicast transmitted-Single Frequency Network) may take advantage of extended sleep periods made possible by sub frames. Both cell micro DTX and DTX based on MBSFNs are feasible in LTE Release-8 networks. The opposite of rapid cell DTX is long cell DTX, which occurs on a slower time scale and describes a condition of low activity inside a cell. Because it is based on a more in-depth sleep state than the low power state outlined in the quick cell DTX, it uses less energy and may be thought of as a kind of cellular sleep.

CONCLUSION

We have completed our study and found that the antenna's height (hbs), the route loss compensation factor (), and the sensitivity of the eNodeB (Po) all play important roles in determining the network's coverage. For optimal performance while reducing UE uplink transmit power (-96.5 dBm to -106.5 dBm), the network requires antenna height and eNodeB sensitivity to be high. Maximizing the route loss compensation factor is desirable. Numerous common route loss models for urban, suburban, and rural areas compose the Okumura-Hata model. This group includes densely populated areas with multistory buildings and homes, as well as more rural settings with many, towering trees. In the suburbs: Tree- and house-scattered villages or highways close to the UE fall into this type. This class includes farmland, rice paddies, and wide fields that are 200-400 meters in length and have no tall trees or buildings in the propagation path. Different Frequency and other parameters are used to make comparisons between the various Path Loss models, and the results are graphed. Additional route Loss models might be included to the investigation.Figure 76 (highest value) and Figure 75 (lowest value) show the minimum and maximum values, respectively, from the data. The following summary information is based on the study conducted, and it indicates the minimum and maximum values of path loss for the different path loss models. For transmissions between 2 and 6 kilometers in length, the minimum Path LossValue in dB may be calculated using the Free Space Model at 900 MHz, while the maximum can be calculated using the COST 231 Model at 3300 MHz. It demonstrates that route loss grows with distance.

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