Overview of Power Optimization in LTE Network

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ABSTRACT
Power in any cellular network is a key degree of freedom in management of connectivity, energy factors, speed etc. As the Network evolved, a new-generation technology for mobile communication was specially created to fulfill the need of bandwidth ravenous user’s viz. LTE, WCDMA, UMTS, but this technology demand more power. So Power control in uplink and downlink has been major concern in cellular network (LTE) because of limited resources in user equipment (UE). So save power at different level of network are discussed.

General Terms
LTE (Long term evolution), SIMO (Single input multiple output), DTX (Discontinuous transmission), DRX (Discontinuous reception), eNB (evolve node)

Keywords
Power saving, LTE, DRX, EARTH and DTX

1. INTRODUCTION
Long Term Evolution (LTE), a new-generation technology for mobile communication was specially created to fulfil the need of bandwidth ravenous users. With aims to entitle users with a new smartphone experience, providing higher data rates and lower latencies that could transform the overall industry into a new wireless ecosystem of smartphone devices and applications. LTE render remarkable improvements over older cellular communication standards like GPRS, EDGE and WCDMA, and because of this outstanding improvement it is called as 4G (fourth generation) technology. LTE architecture is based on Internet Protocol (IP) distinct from other cellular Internet protocols, the 4G-LTE supports browsing Web sites, VoIP and other IP-based services as well. LTE was proposed to achieve theoretically download rate of 300Mbps or more based on experimental trials. In practical the rates vary on actual network bandwidth accessible to an individual LTE subscriber sharing the service provider's network (ISP) with other customers is significantly less [10]. Most of the commercially established LTE networks are optimized for USB data dongles where the power consumption is not a crucial concern. With the inception of LTE, power consumption has become a major problem to the end user using smartphones and tablets and other handheld LTE device. So power efficiency can be increased at Network architecture and protocol level, OFDM access, SC-FDMA and MIMO diversity.

Different method that has becoming popular is Discontinuous reception [13], Discontinuous transmission [1],[2],[4], Green communication and Power Management through MIMO [3].

This paper has been divided in three main sections LTE architecture, Different Power efficient technique and Conclusion.

2. LTE ARCHITECTURE

Figure 1: LTE Utran Architecture

Figure 1 depicts the essential design of LTE. The radio network architecture projected by the 3GPP LTE consists of evolved NodeB (eNodeB). The eNodeB provides a link between the user instrumentality and core network. As shown in Figure 1, eNodeB is connected to the core network via the S1 interface, and every eNodeB is interconnected via the X2 interface. The eNodeB is responsible for the bulk of the radio resource management (RRM) functions like packet programing. Both mobility management entity (MME) and serving gateway (S-GW) are a part of the core networks. The MME is responsible for paging and user instrumentality (UE/UI) quality in idle mode inside the network, whereas the S-GW node is responsible for routing user information packets and handling alternative user requests, as an example handover. LTE uses orthogonal frequency division multiple access (OFDMA) as a radio interface. OFDMA divides the bandwidth into subcarriers and assigns them to the users depending on the present demand of service. Every subcarrier carries information at low rate, however exploitation of multiple subcarriers at once to produce high information rates.
3. DIFFERENT POWER EFFICIENT TECHNIQUE

3.1 MISO-OFDM SYSTEM

Multi Input Single Output (MISO) or Multi Input Multi Output (MIMO) and Orthogonal frequency division Multiplex is mainly found in LTE systems. However power saving leads to degrade Quality of service such as system throughput and delay. MISO-OFDM communication system is illustrated in Figure 2. The evolve Node is integrated with multiple antennas and every user terminal just is integrated with one antenna. There are K users and a evolve Node distributed into a MISO-OFDM communication system. In this communication system, all orthogonal sub carriers are regrouped into N or less N sub channels by the OFDM scheme. The total bandwidth of communication system is assumed as B. Every chosen user is allocated a sub channel for transmitting data. User scheduling algorithm accounting for the QoS of sub channels is employed. Received signal can be given as Hk is channel vector, no is Gaussian noise and Pn is power allocation of nth sub channel [3].

\[
P_{\text{min}} - P_{\text{total}} \geq P_{\text{min}} - C_{\text{min}}
\]

\[
\sum_{n=1}^{N} P_n = P_{\text{total}} P_n = \left( \frac{\|H_{k,n}\|^2}{P_{\text{min}} - P_{\text{total}}} \right) \quad (1)
\]

\[
C_{\text{min}} = \frac{B}{N} \log_2 \left[ 1 + \frac{P_{\text{min}} \sqrt{\sigma}}{N_0} \left( \frac{\|H_{k,n}\|^2}{P_{\text{min}}} \right) \right]
\]

\[
Y_{k,n} = \sqrt{\frac{P_n}{M_t}} H_{k,n} S_k + n_i
\]

But even MISO-OFDM doesn’t have any significant impact User Equipment power saving factor.

3.2 Discontinuous Transmission (DTX)

Discontinuous transmission (DTX) is employed for reduction of energy utilization in a radio base station that is evolve node (eNB). LTE can save near about 61% of the energy in a realistic traffic scenario [13] [8], by turning off the eNB base station. The Cell Base Station (eNB) monitors for traffic statistic, if it is found that no traffic is there then the Cell go in sleep mode which is also called as DTX mode. Assuming that the cell can enter in sleep mode with zero time delay while going back from a sleep mode to the active transmission mode requires a certain delay and a certain amount of energy which both depend on the sleep state. In the longest sleep state the power use can be arbitrarily close to zero Watt. However to wake up from this low power mode may require some 10-20 seconds or more. In a more short sleep mode, only some well selected parts of the cell hardware may be inactivated and the activation process is much faster, however, at the expense of somewhat reduced power savings [13]. The DTX algorithm depends on micro cycle of DTX, Short DTX traffic and DTR cell power, where micro DTX and Short DTX is duration of switching off BS.

Before going in DTX mode the Cell BS (eNB) send a ping to UE so that user can also go in inactive mode but it has to monitor the channel. In DTX there is a lot of chances that QoS get degraded and Power On transient loss also a measure concern.

3.3 Discontinuous Reception (DRX)

LTE has two Radio Resource Control (RRC) states, RRC CONNECTED and RRC IDLE [10,17], as shown in Figure 3. At RRC CONNECTED state, User Equipment (UE) can be in one of the three modes: Continuous Reception, Short DRX, and Long DRX. The transition from one state to another depends on the traffic activity. Network runs an inactivity timer referred as RRC Inactivity timer to push the device to Idle mode. When there is no packet activity for a long duration (equal to RRC Inactivity Timer), UE is moved to Idle state from Connected state. RRC Inactivity timer is reset with any uplink or downlink data activity. In LTE, UE may be configured with a DRX mechanism by radio resource control (RRC) in both Connected and Idle states [14]. However, the functionality and configuration parameters of DRX are different in these LTE states. Since data traffic mainly take place in connected state. DRX can be configured by RRC on per UE basis to control UE’s Physical DL Control Channel (PDCCH) monitoring activity in order to save UE’s battery power. Network runs an inactivity timer called DRX Inactivity timer for the connected UEs to push them to DRX mode. When there is no packet activity for duration of DRX Inactivity timer, UE stays in connected state but moves to DRX mode. DRX Inactivity timer is also reset with any uplink or downlink data activity. RRC Inactivity timer is used to move the UEs to Idle and DRX Inactivity timer is used to move the UEs into DRX mode while still staying in Connected. In current LTE deployments, RRC Inactivity timer is larger than DRX Inactivity timer.

The parameters on which the DRX Algorithm depends are DRX cycle, DRX inactivity timer, DRX retransmission timer. Other includes parameter long cycle and short cycle is duration of switching off UE.

3.4 Other Methodology

Other method are likely cognitive radio which is beneficial for leveraging intricate trade-offs among energy efficiency.
performance and practicality [1]. Secondly Distance-Aware Base Station Sleeping Algorithm which use the knowledge of the distance between the User Equipment’s (UEs) and their associated BS[4]. Thirdly network controlled uplink transmission power parameters [5], [6], [8], [9], [11] and also control has been made in downlink with continuous traffic and non-real time traffic even in sensitive and non-sensitive with QoS.

4. CONCLUSION

An LTE is one of the most popular technology among user because of improved system capacity and coverage. High peak data rates, Low latency, and Multi-antenna support. But the problem which LTE suffers is from high power utilization which is overcome by DRX and DTX with proper power allocation in OFDMA. However, DTX, DRX, Scheduling algorithm and MIMO-OFDMA power allocation doesn’t make any significant impact on “Network” individually but if few of these methods are combine viz. DRX and DTX can make a greater impact on eNB BS side and also end user (UE).

Considering an DRX in UE make an best suited option for power utilization but for proper QoS and efficient trade-off between latency and energy consumption need to done. Furthermore there need to find solution for low power consumption in User equipment as the battery constraint is limited. Whereas the power utilization of evolve node is concern there is still need of research work apart from sleep scheduling or DTX.

5. REFERENCES


