ENERGY EFFICIENT SLEEP SCHEDULING WITH QOS CONSIDERATION IN NEXT GENERATION WIRELESS NETWORKS

MR. A. Kalyanasundaram, Mr.S. Radhakrishnan
CSE Department,
DR,Pauls Engineering College,
VanurTaluk, Villupuram District – 605 109.
Affiliated to Anna University
kalyan03ak@hotmail.com, radki2003@yahoo.co.in

ABSTRACT

Next generation wireless networks are probably the most promising technology for next generation mobile communications. For mobile applications, continuous communications at the User Equipment's (UEs) over a long period of time, imposing stringent requirements on power saving. To manage power consumption, has defined the Discontinuous Reception (DRX) mechanism to allow UEs to turn off their radio interfaces and go to sleep in various patterns. Existing literature has paid much attention to evaluate the performance of DRX; however, how to tune DRX parameters to optimize energy cost is still left open. This work addresses the optimization problem of the DRX mechanism, by asking how to minimize the wake-up periods of the UEs while guarantee their QoS, especially on the aspects of traffic bit-rate, packet delay, and packet loss rate in mobile applications. Efficient schemes to optimize DRX parameters and schedule UEs' packets at the evolved NodeB (eNB) are proposed. The key idea of these schemes is to analyses and balances the impacts between QoS parameters and DRX configurations. Simulation results show that scheme can fully satisfy QoS requirements of the UEs while save considerable energy, compared to the existing schemes

IndexTerms—Long Term Evolution-Advanced(LTE-Advanced), Discontinuous Reception/Transmission (DRX/DTX), Power Saving, Quality of Service, Sleep Scheduling.

1. INTRODUCTION

The 3GPP LTE-Advanced (LTE-A), which is designed with wireless data communications is the most promising technology for IoT applications. For IoT application, such as video surveillance [1] and smart metering [2], devices need to report various events and streaming data to a central server over a long period of time in an efficient and robust way.

The joint optimization on energy saving and Quality of Services guarantee for next generation wireless networks is proposed in this method. To develop an efficient sleep scheduling scheme tooptimize the Discontinuous Reception mechanism which can fit all the packet delay probability models and effectively mitigate the packet loss issue and guarantee the traffic bit-rate requirements.

In addition, a Discontinuous Reception aware packet scheduling scheme is also proposed to well cooperate with the proposed sleep scheme to improve the performance on energy saving and Quality of Services satisfaction. Extensive simulations show that scheme can satisfy User Equipment's Quality of Services while incurring lower energy consumption as compared to existing results. Finally, through the simulation results, give a constructive summary to conclude the limitation of the current Discontinuous Reception mechanism in the standard for IoT applications and provide some suggestions for the devolvement of future standard

The Next generation wireless networks standard has defined several quality-of-service classes for different traffic characteristics on the aspects of traffic bit-rate, tolerable delay, and packet loss rate. To continuously report data over a long period of time, the requirements on power saving are more stringent. To save the energy of devices (also called user equipment's), the next generation wireless

networks standard has defined the Discontinuous Reception/Transmission(DRX/DTX) mechanism to allow devices to turn off their radio interfaces and go to sleep when no data needs to be received or transmitted from/to the base station (also called evolved NodeB, eNB).

2. EXISTING SYSTEM

The requirements on power saving are more stringent. To save the energy of devices (also called User Equipment), the next generation wireless networks standard has defined the Discontinuous Reception/Transmission (DRX/DTX) mechanism to allow devices to turn off their radio interfaces and go to sleep when no data needs to be received or transmitted from/to the base station (also called evolved NodeB, eNB). UEs can turn off their wireless transceivers during the non-wake-up period to save energy.

Each UE adopts a specific timer to prolong its wake-up period whenever it sees the data coming before the timer expires. Thus, somedata posing unexpected delay can still be received/transmitted after the regular wake-up periods. However, how to tune DRX/DTX parameters to minimize UEs' energy costs is still left as an open issue in LTE-A.

The DRX optimization problem[1] with the consideration of UEs' QoS requirements. The objective is to maximize UEs' sleep periods (i.e., non-wakeup periods) to save their energy while satisfy their QoS requirements in terms of traffic bit-rate, packet delay, and packet loss rate. We propose an efficient sleep schedulingscheme and a packet scheduling method to tackle this problem. The key idea of these schemes is to balance the impacts between QoS parameters and DRX configurations.

Disadvantages of Existing System

1) Each UE adopts a specific timer to prolong its wake-up period whenever it sees the data coming before the timer expires.

2) To tune DRX/DTX parameters to minimize UEs' energy costs is still left as an open issue in wireless network.

3) DRX brings only minor impact to the power consumption ratio.

3. RELATED WORK

Performance analyses of the DRX mechanism in LTE-A networks are conducted in [3] which all show that enabling DRX can significantly save UEs' energy. Reference [4] uses hierarchical cascaded power gating and multi-level clock gating to reduce the power consumption at the physical layer in DRX cycles. Reference [5] proposes a "light sleep" approach to turn off UEs' power amplifiers to further reduce the consumed power in wake-up periods.

In reference [6], a packet scheduling scheme is proposed for the eNB which prefers allocating resource to the UE whose "inactivity" timer is going to expire first. Thus, the selected UE is more likely to catch packets in time before sleeping, thus reducing its packet loss rate. To reduce UEs' power cost, [7] tries to derive the optimal number of active slots in a frame according to the physical structure when DRX operates. However, these studies [8] neglect the coordination between various traffic characteristics and DRX configurations. Reference [8] proposes a dynamic DRX scheme which continuously lengthens the DRX cycle and inactivity timer if no data needs to be received by UEs. However, it costs a large amount of signaling overheads to negotiate these adjustments between the eNB and UEs.

Reference [9] proposes an autonomous scheme incurring low signaling overheads which can adaptively adjust DRX cycles to capture the UE's incoming traffic characteristic to improve energy efficiency.

In [9], the channel quality identifier (CQI) is considered to adjust the DRX inactivity timer for UEs with different CQIs to improve system utility. However, both [8] and [9] do not consider the higher-level QoS features such as the traffic bit-rate and packet loss rate, which are mandatory in LTE-A network. These observations motivate us to address the DRX optimization problem.

4. THE PROPOSED SCHEME

To solve the challenges presented above, this paper proposes to maximize User Equipment's sleep periods (i.e., non-wakeup periods) to save their energy while satisfy their Quality of Services requirements in terms of traffic bit-rate, packet delay, and packet loss rate. That Discontinuous Reception optimization problem with the consideration of User Equipments Quality of Services requirements. An efficient sleep scheduling schema to optimize the Discontinuous Reception mechanism which can fit all the packet delay probability models and effectively mitigate the packet loss issue and other QoS parameters

A. QoS in LTE-A

A Guaranted-Bit-Rate (GBR) flow can support real-time services, such as conversational voice, video, and gaming applications, while a non-GBR flow can support non-real-time services, such as IMS signaling and TCP-based applications [10]. A GBR flow is associated with some QoS parameters such as

guaranteed-bit-rate and maximum-bit-rate. The former is the minimum reserved traffic rate (bits/s) guaranteed by the eNB. The latter is the maximum sustained traffic rate (bits/s) that the flow cannot exceed. All non-GBR flows share a common QoS parameter: aggregate-maximum-bit-rate, which is the amount of traffic rate (bits/s) shared by all non-GBR flows of a UE. In addition, each flow (including GBR and non-GBR flows) is further associated with a QoS profile including:

• **QoS Class Identifier**
• **Packet Delay Budget**
• **Packet Loss Rate**

The QoS Class Identifier (QCI) is a scalar identifier to describe the traffic characteristics in terms of packet delay budget and packet loss rate.

B. *Discontinuous Reception (DRX) Mechanism*

The DRX mechanism is managed by the Radio Resource Control (RRC). An eNB can initiate the DRX mechanism by sending a Command MAC control element to a UE. The DRX configurations are UE-specific. Each UE has its own configurations which are determined by the eNB.

4. SYSTEM MODEL

The proposed system model can be explained with the Next Generation Wireless Network using Discontinuous Reception is enabled, a UE wakes up and sleep with specific patterns, the basic unit of wakeup and sleeping duration is a subframe. When the DRX mechanism is activated, there are six parameters to be specified for each UE.in Figure 1.
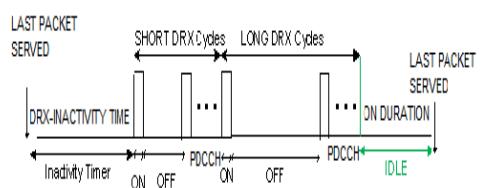

Figure 1.System Model

Discontinuous Reception is enabled, a UE wakes up and sleeps with specific patterns, as shown in Fig. 1. The basic unit of wakeup and sleeping durations is a subframe (i.e., 1 ms). When the DRX mechanism is activated, there are six parameters to be specified for each UE: shortDRX-Cycle, on-duration, drxStartOffset, drx-InactivityTimer, longDRX-Cycle, and drxShortCycleTimer. The shortDRX-Cycle and longDRXCycle are the basic operation periods (in

subframes) that the UE performs wake-up and sleep operations. Usually, the length of longDRX-Cycle is a multiple of the length of shortDRXCycle.

The on-duration is an interval (in subframes) in a cycle that the UE has to stay awake. During the wake-upperiod, the UE will monitor whether or not there is a Physical Downlink Control Channel (PDCCH) delivered from the eNB to indicate any downlink transmission to it. The DrxStartOffset indicates the subframe where the first on-duration starts. The drx-InactivityTimer is used for extending the wake-up period of the UE when finds any PDCCH delivered to it. Before drx- InactivityTimer expires, if the UE monitors a new PDCCH from the eNB, the drx-InactivityTimer resets and restarts to count down again. Once the drx-InactivityTimer expires, the UE will start drxShortCycleTimer and go to sleep (by turning off its interface).

During the UE's sleep period, all data for the UE will be buffered in the eNB until the next onduration comes. If no PDCCH is monitored by the UE during several shortDRX-Cycles, the drxShortCycleTimer will expire. Once the drxShortCycleTimer expires, the shortDRX-Cycle ends and the longDRX-Cycle follows. During the longDRXCycle, the UE behaves similarly as it works in the shortDRXCycle. Once the UE monitors the PDCCH, it terminates the longDRX-Cycle and starts the shortDRX-Cycle again.

5. PROPOSED TECHNIQUES

The proposed system consists of following techniques:

A. *Creation of Simulation environment for Next Generation Wireless Networks:*

The Next Generation Wireless Network is created. All the nodes are randomly deployed in the network area. The nodes are connected with wireless links and bandwidth is provided with the links. The properties like buffer, antenna, and energy are attached to the nodes. To check the connectivity among the nodes, a sample routing is performed.

B. *Three-Stage Schema to the DRX Optimization Problem:*

Stage1:

To reduces UEs unnecessary wake-up period incurred by resource competition using DRX cycle be an integer multiple to others and determining ShortDRX-Cycle (T_i^S) and LongDRX-Cycle (T_i^L).

Equation:

$$D_i^{min} = min\{D_j|flow_j\varepsilon\ U\ E_i\}$$

Stage2:

To help UEs to catch the packets posing unexpected delays and thus to meet their delay budgets. using optimize the drx-inactivityTimer.and determining On-duration(O_i,), Drx-InactivityTimer (Γ_i^I) and DrxShortCycleTimer (Γ_i^L)

Equation:

$$O_i= max\{\lceil \Sigma_{Dj}=T_i^s, \forall flow_j\varepsilon\ U\ E_iQ_j^{max}/c_i^{min}\ X\ \Omega\rceil,1\}$$

Stage3:

To Determining DrxStartOffset(L_i)of each UEi, i = 1..N, We first define the "crowded" degree for each cycle. Then, Weallow UEs to go to "deep" sleep when their service-request-response times are not violated.

C. Analysis of QoS in the network:

Data communication is enabled between nodes. Multimedia streaming is configured across the network is analyzed. All the nodes send and receive multimedia data packets. The nodes in the network continuously send the data to the base station over the network. The parameters like traffic, delay, throughput, packet loss are considered.

D. Performance analysis:

The performance is analyzed. Based on the analyzed results X-graphs are plotted is performed in this module. Throughput, delay, energy consumption, traffic, packet loss are the basic parameters considered here and X-graphs are plotted for these parameters.

E. Implementation of Sleep Scheduling mechanism:

Sleep scheduling method is implemented across the network to save the energy consumption of the nodes. Sleep and wakeup modules are configured and nodes are put into sleep / wakeup mode according to the algorithm configured.

F. Performance analysis and Result Comparison:

The performance of the proposed sleep scheduling method is analyzed. Based on the analyzed results X-graphs are plotted. Throughput, delay, energy consumption are the basic parameters considered here and X-graphs are plotted for these parameters. Finally, the results obtained from this module is compared with third module results and comparison X-graphs are plotted. Form the comparison result, final result is concluded.

6. PROPOSED MODEL EVALUATION

The performance report of the proposed model with the existing model is described in this section. The below figure describes the performance, packet loss rate and power consumption of the proposed model.
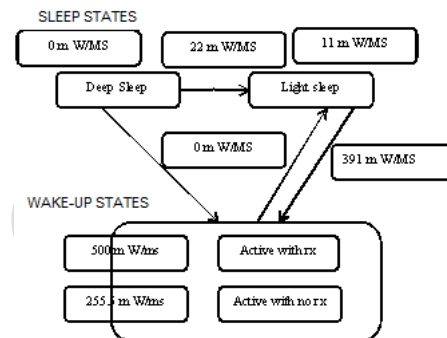

Figure 2 UE power consumption Model.

The system parameters of the simulatorare listed below. The frame duration is 10ms. The channel bandwidth is 10 MHz. Thus, we have = 100 RBs in each subframe. The first type of UEs adopts only one GBR flow. The second type of UEs adopts only one non-GBR flow. The third type of UEs adopts both one GBR and one non-GBR flows.

We compare our scheme against the Counter-Driven DRX(CDD) scheme and the Multiple-Threshold DRX (MTD) scheme which are the most relative schemes to the topic of this paper. The rationale of CDD scheme is to dynamically adjust each UE's cycle length to capture the UE's incoming traffic to improve energy efficiency and data receiving latency.

The rationale of MTD scheme is to dynamically adjust eachUE's InactivityTimer to accommodate different CQIs that the UE perceives to maintain energy efficiency while increasing the traffic rate satisfaction. Specifically, the CDD scheme adjusts each UE's cycle length based on two predefined counters and two thresholds. Thus, if the UE consecutively wakes up but does not receive the data delivered from the eNB, the first counter of the UE is increased

A. Packet Loss Rate:

The average packet loss rate under different numbers of UEs. The packet loss rate of most schemes increases when the number of UEs increases. This is because the network is getting saturated and it becomes difficult to serve all UEs' packets under the consideration of packet delay budgets.

The CDD scheme incurs the highest packet loss rate because it only adjusts DRX cycles for UEs but neglects to tune their InactivityTimers. Once the UE's packet delay budget

is used up at the middle of its cycle, the UE will fail to receive the packet. On the other hand, the MTD scheme has the lower packet loss rate because the UEs can adjust their InactivityTimers when they are under different channel conditions.

B. Sleep Scheduling Algorithm:

Sleep scheduling, which is putting some sensor nodes into sleep mode without harming network functionality. A common method to reduce energy consumption in dense wireless sensor networks.This paper proposes a distributed and energy efficient sleep scheduling and routing scheme The scheme can activate and deactivate the three basic units of a sensor node (sensing, processing, and communication units) independently

C. Power Consumption:

The average power consumption of all schemes under different numbers of UEs, where the UE's power consumption of our scheme increases when the number of UEs increases. This is because UEs need more wake-up time to receive their data to guarantee their QoS when the network resource is insufficient. On the other hand, the power consumption of the CDD scheme decreases when the number of UEs increases, because the UEs enlarge their cycle lengths without considering QoS. Finally, the power consumption of the MTD scheme is stable because this scheme adjusts InactivityTimers of UEs independent with the network traffic load.

D. Average Sleep Ratio:

The sleep ratio of our scheme decreases when the number of UEs grows, because our scheme extends UEs' wake-up periods to guarantee their QoS when the network traffic load becomes heavy. Contrarily, the sleep ratio of the CDD scheme increases when number of UEs increases. This is because CDD neglects the UEs' QoS satisfaction. Note that the MTD scheme has a lowest sleep ratio because this scheme adjusts InactivityTimers of UEs only based on UEs' CQI which is independent with the network traffic load

7. CONCLUSION

In this paper we developed a Discontinuous Reception optimization problem which considers the Quality of Services requirements in next generation wireless networks. In this scheme an efficient three-stage scheme and a Discontinuous Reception aware packet scheduling method are proposed to tackle the problem. . By balancing the impacts between Quality of Services parameters and Discontinuous Reception configurations, simulation results have verified this scheme. It has been shown that our schemes can fully guarantee User Equipment's Quality of Service requirements in terms of packet loss rate, packet delay, and traffic bit-rate while saving considerable power consumption of User Equipment.

REFERENCES

[1] L. Atzori, A. Iera, and G. Morabito, "The Internet of Things: A survey," Computer Networks, vol. 54, no. 4, pp. 2787–2805, 2010.

[2] D. Guinard, V. Trifa, S. Karnouskos, P. Spiess, and D. Savio, "Interacting with the SOA-Based Internet of Things: Discovery, query, selection, and on-demand provisioning of web services," IEEE Transactions on Services Computing, vol. 3, no. 3, pp. 223–235, 2010.

[3] L. Zhou, H. Xu, H. Tian, Y. Gao, L. Du, and L. Chen, "Performance analysis of power saving mechanism with adjustable DRX cycles in 3GPP LTE," IEEE Vehicular Technology Conference (VTC), pp. 1–5, 2008.

[4] G. S. Kim, Y. H. Je, and S. Kim, "An adjustable power management for optimal power saving in LTE terminal baseband modem," IEEE Transactions on Consumer Electronics, vol. 55, no. 4, pp. 1847–1853, 2009.

[5] K.-C. Ting, H.-C. Wang, C.-C. Tseng, and F.-C. Kuo, "Energy-efficient DRX scheduling for QoS traffic in LTE networks," IEEE International Symposium on Parallel and Distributed Processing with Applications (ISPA), pp. 213–218, 2011.

[6] B. Huang, H. Tian, L. Chen, and J. Zhu, "DRX-aware scheduling method for delay-sensitive traffic," IEEE Communications Letters, vol. 14, no. 12, pp. 1113–1115, 2010.

[7] R. Wang, J. S. Thompson, and H. Haas, "A novel time-domain sleep mode design for energy-efficient LTE," International Symposium on Communications, Control and Signal Processing (ISCCSP), pp. 1–4, 2010.

[8] H. Xu, H. Tian, B. Huang, and P. Zhang, "An improved dynamic user equipment power saving mechanism for LTE system and performance analysis," Science China Information Sciences, vol. 53, no. 10, pp. 2075– 2086, 2010.

[9] E. Liu, J. Zhang, and W. Ren, "Adaptive DRX scheme for beyond 3G mobile handsets," IEEE Global Telecommunications Conference (GLOBECOM), pp. 1–5, 2011.

[10] S. Gao, H. Tian, J. Zhu, and L. Chen, "A more power-efficient adaptive discontinuous reception mechanism in LTE," IEEE Vehicular Technology Conference (VTC), pp. 1–5, 2011.