An Energy Efficient Sleep and Wake-up Scheduling Approach in Heterogeneous Networks

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Abstract: In current years, there is an sudden increase of wireless data Traffic which has resulted in a huge scale dense deployment of small cells, with which the increasing cost of energy has concerned a set of research interest. I present the wireless network which consists of distributed sensor nodes. The function of distributed sensor nodes is to manage the physical condition and to generate the traffic system. Each and every nodes in WSN will sends and receives the packet ensuing in depletion of bandwidth. However, bandwidth sensor nodes are not an productive by saving the energy. Thus, sleep/wake-up scheduling is one of the vital problems in the wireless sensor network. Because, they are fixed and it cannot be recharge again. An energy efficient sleep/wake-up scheduling approach is proposed. The aim of this approach is to save the energy of each nodes and to increase their lifetimes.

Keywords: Distributed sensor nodes, Bandwidth sensor nodes, sleep/wake-up scheduling, self-adaptive sleep/wake-up scheduling.

1. Introduction

A network which connects computer and other devices with the different operating system and protocols is called as heterogeneous network. Local area network is an example which can connect the Microsoft windows and Linux based PC with Apple Macintosh computers. By using distinct connection technologies, the heterogeneous networks are also used in wireless networks. Wireless networks is an example, which provides a service through the wireless LAN and it is about to continue the service when it switching to the cellular network is called as wireless heterogeneous network. With the aim of additional characteristics, the “Heterogeneous networks” comes from the mixture of different telecommunication technologies. Because of heterogeneous networks, users can transport the connection between different access points of different types. Moreover, the heterogeneous networks represent the good solution for decreasing congestion on mobile networks by sharing with distinct access technologies with the higher flows. In this, I focus only on mobile and satellite heterogeneous networks. Because it has quick and expressive deployment and mobile networks will consists of set of heterogeneous systems. The heterogeneous networks can influenced by different operators and formed of specific access networks. During the communication, mobile terminals will be network multi-interfaces which enables them to move from one system to another system transparently. The user connection with the heterogeneous network should occur transparently without interruption and without reduction in service when the user can change from one network to another network. Networks is based on existing framework, by linking the networks which is already disposed. Thus, in 3\textsuperscript{rd} generation networks, telecommunication networks have invested a great deal and it choose the variety types of network. This network suggests a new model for existing backbone providers of...
mobile networks such as MANET, UMTS, WiMAX and satellite among others. In wireless network, HetNet will frequently indicate the use of various types of access nodes.

A huge area network can use the picocells, microcells, femtocells in order to provide wireless coverage in an environment to office and underground areas. Mobile skillful network with the ambitious interruption among macrocell, small cell and in wifi network used to enumerate a coverage, with the handoff capacity among network elements. It decides the service quality across the overall network, inorder to automate the reconstruction of its operation and to accommodate the flexible adequate to by changing the user needs, business goals and subscriber attitude.

2. Related Work

A appropriate description of small cell formation will come in limited packages in cellular networks. Small cells have a big role in arranging a cellular network that can exceed the volatile mobile traffic and increases at little cost to the network operator. Thus, small cell deployment can increases the network energy consumption with the capable ecological and economic implications. In this paper, I propose the energy-efficient SLEEP mode algorithms for small cell base stations in order to decrease the cellular networks power consumption. The hardware components in the base station to be switched off in the idle conditions. so, that the energy consumption is switched over the changes in the traffic load[1]. 3GPP LTE- advanced has newly been probing heterogeneous network (HetNet) distribution as a cost effective way to deal with the constant traffic demand. HetNets consists of combine of macrocells, remote radio heads, and low-power nodes .In this it consists of femtocells, picocells and relays. It can expand the proximity between the access network and the end users, by holding this network topology. It provides the next performance in wireless networks by increasing the spatial spectrum reuse and also to increase the indoor coverage. However, the formation of huge number of small cells covering the macrocells is not without new technical challenges [2].

2.1. Existing System

In this paper, I present a small cell activation method for HetNets, which allows the energy saving gains acquired based on the amount of traffic load off-loaded from the macro cell to small cells, while skipping UE QoS rejection. The main aim is to decrease the total energy consumption of the network. The structure is calculated using LTE-Advanced HetNets system as well as user throughput[3]. In this method, I use an energy-saving small cell sleeping mechanism in a HetNet. In this, the distance of small cells to the macrocell is smaller than Z is all pushed into the sleeping mode. The function of energy-saving small cell sleeping mechanism is to regulate the remaining small cells by using cell range expansion technique (CRE). It is noted that as the UEs inside the dashed circle are close to the macrocell, I make the assumption that all the UEs from the sleeping cells within the dashed circle can only be offloaded to the macrocell. I also use the eICIC(enhanced inter-cell interference coordination) technique is to improve the QOS of UEs in the edge of small cells. The macrocell can mute its downlink transmissions in specific subframes is called as almost blank subframes(ABSs).

![Fig.1 System Model](image_url)

In this paper, I assume that ABSs are allocated only to UEs in the small area to avoid the interference from the macrocell. The UEs placed close to the small cells and in the coverage of the macrocell are awaited with normal subframes. In existing works, the only switched off small cells close to the macrocell and handover to the associated
UEs to the macrocell. However, I notice that the network power saving of this kind of approach is not significant, because of many small cells in the area far from the macrocell are still active. The propose is to combine the adaptive small cell expansion and small cell sleeping mechanism. More specifically, propose to use range expanded small cells to cover the traffic system from nearby sleeping small cells in the edge area of the macrocell in order to save more power. This is different from the existing small cell sleeping mechanism, where all the traffic of a sleeping small cell would be handed over to the macrocell to decrease the network power consumption.

Furthermore, eICIC technique is applied in conjunction with cell range expansion to guarantee the QoS of UEs in the edge area of small cells. In this, the small cell sleeping mechanism is to provide a cleared analysis of the resulting inter-cell interference. I consider the fact that under the repulsive sleeping mechanism, in this it consists of almost all the small cells close to the macrocell are turned off and excluded from the set of the interferers. This analysis is more accurate than that in [19], where the small cell density is assumed to be uniformly decreased across the whole area in the interference analysis I jointly optimize the cell range bias factor (B2), small cell density, and switching off radius (r) to reduces the network power consumption for a given UE density. A genetic algorithm (GA) is used to solve the joint optimization problem in order to reduce the computational complexity. For a given traffic profile, we show that our proposed small cell sleeping mechanism achieves a much lower network power consumption compared with random and conventional ones, especially in a high UE density scenario.

2.1.1 Cell Range Expansion Technique
From the surrounding macro network, small nodes are oftenly increase with the cause of off-loading traffic. Thus, the Off-loading traffic provides greater throughputs to the users that are Off-loaded, while permitting other macro users to enjoy an enormous share of the acquirable macro resources. Traditionally, in connected mode, a UE will be handed over to the cell with the potentially acquired common pilot signal, that is, the perfect downlink. Yet, in heterogeneous networks, it cannot at all the times be the frame that existing allocated from the cell with the perfect downlink which is precise from a system and user routine aspects. The area with the small cell common pilot level is greater than the macro common pilot level which is represented in the inner circle around the small cell node. Yet, there is a broader area around the small cell node within which the small cell downlink common pilot level is maximally 6dB bad than the macro level. If UEs in this area are allocated from the small cell node, they will practice a lower per TTI throughput than if they would be allocated from the macro. Yet, the small cell node will divides its resources among smaller UEs than the macro node, and hence the UEs can strongly be allocated more often and practice an upgraded user throughput. Moreover, it allocates the UEs which would be off-load the macro and upgrade the practice of other macro users from the small cells.

3. Proposed System
The HetNet can be found as ambient conventional macro radio access network (RAN) functions with the RAN moving ability, small cells and Wi-Fi functionality, that are continuously existing constructed and transported in an operational environment where the distance of control includes data centre resources affiliated with the measure, networking and storage. In this structure, self-optimizing network (SON) functionality is important to allow the order-of-magnitude network reinforcing with the small cells. Self-configuration or 'plug and play' changes the time and cost of arrangement, while self-optimization provides the network auto-tunes itself for greatest productivity as conditions change. Traffic requires the user movements and service combine will all enlarge double time, and the network needs to accommodate to keep speed. These upgraded SON capabilities will hence want to take into account the expanding user needs, business goals and subscriber attitude. Essentially, functions combined with the HetNet operations and management in order to attain earlier SON(self-optimizing network) capability that may have only gone to aimed at a single domain or technology, and increase it to transport automated service quality management through the whole HetNet.
In proposed system, an Energy Efficient Sleep and Wake-up Scheduling Approach is used in order to save the energy and to prolong a network lifetime. The nodes will adapt their sleep and wake-up time in each and every period. Self-Adaptive sleep/wake-up scheduling approach is used as proposed method. The time is exactly splits into time slots. In each time slot, an individual node individually decides to sleep or wake-up. Thus, in the proposed approach, there is no ‘cycle’ and each time slot is independent. Each and every node will achieves a packet at the creation of individual time slot based on the predefined feasibility. At that time, the state of a node is determined by the number of packets in its buffer, the packet generation feasibility will exactly damages the state of individual node.

### 3.1 System Parameters

| Macro/ small cell / UE distribution | Hexagon /PPP / uniform distributed |
|------------------------------------|-------------------------------------|
| Density of UEs(sq.m)               | 0.0002*[1,2,........,10]            |
| Bandwidth allocation(MHz)          | 20                                  |
| Number of antennas                 | 1                                   |
| Macro/ small cells path loss exponent | 4                               |
| Data rate requirement (U) [Mbps]   | -0.64                               |
| Macrocell size (apothem of hexagon) [m] | 500                               |

### 4. Flow of Work

In this method, sleep/wake-up scheduling is used. The objectives of sleep and wake-up scheduling approach is to decrease the unwanted listening time and it is one of the fundamental problems in WSNs.

Especially, sleep/wake-up scheduling investigate to adapt the ratio between sleeping time and attentive time of individual sensor in individual period. When a sensor is alive, it is in an useless listening state and it can collect and transfer the packets.

If no packets are collected or transferred yet during the unwanted listening time, the energy used as unwanted listening time which is wasted. With the aim of sleep/wake-up scheduling, such wastages of energy should be minimized by adjusting their wake time of sensors. In current times, many sleep/wake-up scheduling approach have been matured. In this method, a self-adaptive sleep/wake-up scheduling approach is proposed, which takes both energy saving and packet delivery delay into account. Therefore, this approach does not need the technique of duty cycling. Thus, the tradeoff between energy saving and packet delivery delay can be avoided. In maximum existing duty cycling based sleep/wake-up scheduling approaches, the time axis is splits into periods, individual of which consists of different time slots. In individual period, the nodes will adjust their sleep/wake-up time. In the proposed,
self-adaptive sleep/wake-up scheduling approach, the time axis is exactly splits into time slots. Thus, in the proposed approach, there is no 'cycle' and each time slot is independent. The proposed approach is not arranged to organize a definite packet routing protocol. This is because if the sleep/wake-up scheduling approach is designed incorporation with a specific packet routing protocol, the scheduling approach may work well only with that routing protocol but may work less efficiently with the other routing protocols. The sleep/wake-up scheduling approach is an example which arranged inorder to organize with a packet routing protocol. Their scheduling approach uses staggered wake-up schedule creates unidirectional delivery paths for data propagation to significantly decrease the delay of data collection process. Their approach works definitely if packets are expressed in the nominated direction, but it is not an adequate when packets are expressed in another direction.

Fig.3 Flow Chart

The contributions of this paper are as follows:
1. This approach is the first which does not use the technique of duty cycling. Hence the trade off among energy saving and packet delivery delay, which is obtained by duty cycling, can be escaped. This approach can decrease both energy consumption and packet delivery packet
2. This approach can also attain greater packet delivery ratios in different prospects compared to the benchmark approaches.
3. Unlike modern forecasting- based approaches where nodes have to transfer the information between one and all, this approach facilitates the nodes to estimate their neighbours situation beyond the demanding information from these neighbours. Thus, the enormous amount of energy used for information transfer can be saved.

4.1 Implementation:
Node deployment is a major problem to be determined in Wireless Sensor Networks (WSN).
A convenient node deployment scheme can decrease the complication of problems in WSNs. And moreover, it can broaden the lifetime of WSNs by reducing energy consumption.

![FIG.4 NODE DEPLOYMENT](image)

### 4.2 Graphical Representation:

The delay is the time which takes the packet to attain the target after it leaves the basis. The graph depicts the number of nodes versus its average delay. There are 72 nodes with which the existing system has 0.4msec which is high when compared to the proposed system with 0.27 msec.

![FIG.5 DELAY](image)
Energy is referred as the capability to do something. A WSN consists of several sensor nodes which intellect physical phenomena or assemble data from an environment. The energy consumption is one of the most fundamental issues in the wireless sensor network which does not emerge in more traditional wired sensor network. The graph depicts the number of nodes versus its energy consumed in joules. The existing system has 3 joules which is high when compared to the proposed system with 2 joules with 72 nodes.

Network lifetime is the amount of time that a Wireless Sensor Network would be completely working. The graph depicts no. of nodes versus lifetime in terms of years. The existing system has 5 years which is less when compared to the proposed system with 8 years with 72 nodes.

4.3 Comparison Table:

| PARAMETERS            | EXISTING SYSTEM | PROPOSED SYSTEM |
|-----------------------|-----------------|-----------------|
| DELAY                 | 0.4 msec        | 0.27msec        |
| ENERGY CONSUMPTION    | 3 joules        | 2 joules        |
| NETWORK LIFETIME      | 5 years         | 8 years         |
5. Conclusion:
In this paper, an energy efficient sleep/wake-up scheduling approach is introduced. This approach despots the technique of duty cycling. Rather, it splits the time axis into different time slots and an individual node will choose individually to sleep, listen or transfer in a time slot. At that time, each and every node will make a arrangement based on its current situation and an similarity of its neighbours situations, where such similarity does not need the communication with the neighbours. The achievements of the proposed approach exceed the other related approaches. In the proposed method, packet retransmission by reducing packet loss is addressed by considering buffer space, channel state and remaining energy. Later, the simultaneous scheme for a overall schedule is achieved by considering flexible listening using the length of the sending queue.

6. Future Scope:
From the simulation analysis with the metrics, Retransmission energy Consumption, Overall Energy consumption, shows the better results when compared to the other existing algorithms. As a future, the utilization of improved energy efficient sensor nodes in state of art real-time applications in the Internet of Things domain can be used.

References
[1]. I. Hwang, B. Song, and S. S. Soliman, “A holistic view on hyperdense heterogeneous and small cell networks,” IEEE Communications Magazine, vol. 51, no. 6, pp. 20–27, 2013.
[2]. G. Fettweis and E. Zimmermann, “Ict energy consumption-trends and challenges,” in Proceedings of the 11th international symposium on wireless personal multimedia communications, vol. 2, no. 4. (Lapland, 2008, p. 6).
[3]. A. Felske, G. Fettweis, J. Malmodon, and G. Biczok, “The global footprint of mobile communications: The ecological and economic perspective,” IEEE Communications Magazine, vol. 49, no. 8, 2011.
[4]. T. Langeden, “Reducing the carbon footprint of ict devices, platforms and networks,” GreenTouch, Amsterdam, The Netherlands, Nov. 2012.
[5]. L. Belkhir and A. Elmeligi, “Assessing ict global emissions footprint: Trends to 2040 & recommendations,” Journal of Cleaner Production, vol. 177, pp. 448–463, 2018.
[6]. A.S. Andrae and T. Edler, “On global electricity usage of communication technology: trends to 2030,” Challenges, vol. 6, no. 1, pp. 117–157, 2015.
[7]. Ashraf, F. Boccardi, and L. Ho, “Sleep mode techniques for small cell deployments,” Communications Magazine, IEEE, vol. 49, no. 8, pp. 72–79, 2011.
[8]. Z. Niu, “Tango: Traffic-aware network planning and green operation,” IEEE Wireless Communications, vol. 18, no. 5, 2011.
[9]. M. A. Marsan, L. Chiaraviglio, D. Ciullo, and M. Meo, “Optimal energy savings in cellular access networks,” in Communications Workshops, 2009. ICC Workshops 2009. IEEE International Conference on. IEEE, 2009, pp. 1–5.
[10]. E. Oh, K. Son, and B. Krishnamachari, “Dynamic base station switching off strategies for green cellular networks,” IEEE transactions on wireless communications, vol. 12, no. 5, pp. 2126–2136, 2013.
[11]. W. Guo and T. O’Farrell, “Dynamic cell expansion with self-organizing cooperation,” IEEE Journal on Selected Areas in Communications, vol. 31, no. 5, pp. 851–860, 2013.
[12]. F. Han, Z. Safar, and K. R. Liu, “Energy-efficient base-station cooperative operation with guaranteed qos.” Communications, IEEE Transactions on, vol. 61, no. 8, pp. 3505–3517, 2013.
[13]. T. Bousia, A. Antonopoulos, L. Alonso, and C. Verikoukis, “Green” distance-aware base station sleeping algorithm in lte-advanced,” in Communications (ICC), 2012 IEEE International Conference on. IEEE, 2012, pp. 1347–1351.
[14]. D. Tsilimantos, J.-M. Gorce, and E. Altman, “Stochastic analysis of energy savings with sleep mode in ofdma wireless networks,” in INFOCOM, 2013 Proceedings IEEE. IEEE, 2013, pp. 1097–1105.
[15]. Y. Li, H. Celebi, M. Daneshmand, C. Wang, and W. Zhao, “Energy-efficient femtocell networks: Challenges and opportunities,” IEEE Wireless Communications, vol. 20, no. 6, pp. 99–105, 2013.
[16]. S. Wang and W. Guo, “Energy and cost implications of a traffic aware and quality-of-service constrained sleep mode mechanism,” *IET Communications*, vol. 7, no. 18, pp. 2092–2101, 2013.

[17]. E. Mugume and D. K. So, “Spectral and energy efficiency analysis of dense small cell networks,” in *Vehicular Technology Conference (VTC Spring)*, 2015 IEEE 81st. IEEE, 2015, pp. 1–5.

[18]. L. Saker, S.-E. Elayoubi, R. Combes, and T. Chahed, “Optimal control of wake up mechanisms of femtocells in heterogeneous networks,” *IEEE Journal on Selected Areas in Communications*, vol. 30, no. 3, pp. 664–672, 2012.

[19]. S.-r. Cho and W. Choi, “Energy-efficient repulsive cell activation for heterogeneous cellular networks,” *IEEE Journal on Selected Areas in Communications*, vol. 31, no. 5, pp. 870–882, 2013.