International Journal of Advance Research in Science and Engineering
Volume No.06, Issue No. 10, October 2017
www.ijarse.com
IJARSE
ISSN: 2319-8354

An Improvement in Energy Efficiency Using Green Cell Planning for Small Cell Network Deployment

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ABSTRACT

Green cellular communication is today's main design paradigm for future cellular networks and upcoming research aims at enabling sustainable growth for broadband wireless network. There are numerous solutions which have been proposed till now for enhancing the reduction in energy consumption and hence increasing the efficiency of Green small networks. Based on low-power Access Points (APs) and reasonable cost small cells are promising solution to reduce power emission and enhance the energy efficiency. By adapting network parameters to load variations dynamic radio resource management can avoid energy wastage while maintaining quality constraints. This paper summarized a literature survey of the models proposed earlier for the same.

Keywords: Green communications, Base Station, Symbiocity.

I. INTRODUCTION

An urban area is a financial, commercial, social, and cultural hub with a diversified ecosystem of built infrastructure and citizen services. IDC has a broad meaning of a city which can be a district, city, town, county, municipal, and metropolitan area. The meaning of a Smart City, in our view, is an entity with its own authority to govern it, that is more local than national although city states with no local government (e.g., Singapore and Hong Kong) are included and which uses a specific set of technologies to achieve its goals of a higher quality of living and sustainable urban development. In previous time, cellular mobile networks have revolutionized the way user access communication links, but require a huge effort of the operators for the development of a wireless cellular infrastructure which must be designed considering the cost for deployment with universal coverage and to maintain the service quality targets. The basic traditional Base Stations (macro) that are been used till now, came out to be inefficient due to it's operational costs and mostly due to their high energy consumption hence poor energy efficiency.

II. BACKGROUND

Urbanization brought several issues to the forefront for city leaders, including increasing pressure for the optimal management of the city's operations and services. Cities are challenged to develop in economical and environmental sustainable municipal entities anchored on the parameters of competitiveness, economic progress, growth, security, social cohesion, and innovation. With the integration of technology across various functions, Smart Cities can overcome these challenges to deliver on the goals of economic development, sustainability, innovation, and citizen engagement, all while utilizing a diversified ecosystem to fundamentally change and enhance the quality of life for residents, businesses, and visitors.

A smart city means a city which deals in a suitable and intelligent way, by collaborating all its infrastructures and services into a single commodity by using intelligent devices for control and monitoring purpose, to ensure sustainability and efficiency. In a world where population numbers are constantly rising, significantly driving the consumption of resources causing resource extinction and climatic changes, the incentive for improvised and innovative solutions is evident. Urban or civilized areas specifically, are responsible for the major portion of resource degradation, adding to an increasing need to create much better and smarter infrastructures, in search for greener and more energy efficient urban dynamics. Solutions to these issues comprise of improvements to a majority of components of urban dynamics, as illustrated in Fig.1.1.

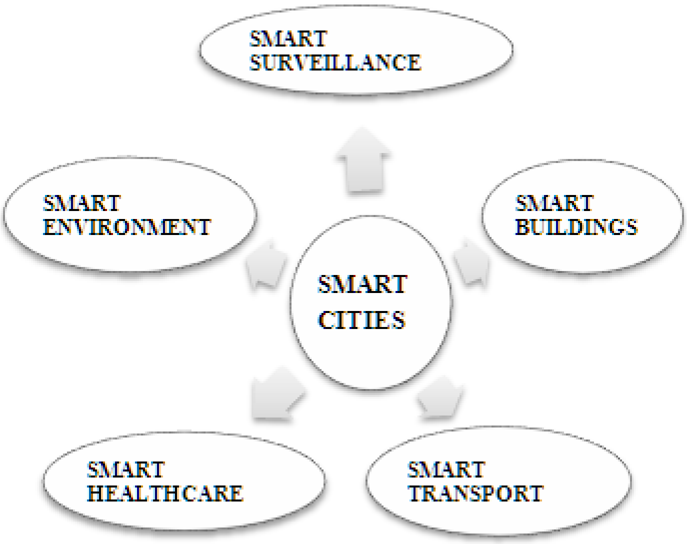

Fig.1. Sensing in smart cities

It is predicted and expected that the global economy will be disproportionate due to the growth of cities, supported with the forecasts that by 2050 more than a 6 billion people will live in urban areas. This growth will demolish and degrade the further existing energy and climate related challenges. To solve the above mentioned challenges, cities which are more equipped with resources, efficient and technology driven, are necessary. Sensing is the art of smart infrastructures, by which they monitor themselves and act on by themselves in a more appropriate and intelligent way. Based on the data collected by these sensors, it monitors public infrastructures, like bridges, roads and buildings and provides awareness that enables more efficient and better use of resources. Real-time monitoring removes the need for regularly prescribed inspections, therefore decaying cost. Measuring energy usage in households allows accurate load forecasting and sensors used in roads for traffic controlling and monitoring collects data which is necessarily used for the implementation of intelligent transportation systems (ITS).

III. LITERATURE SURVEY

L. Zhou et.al [1] modeled numerous traffic patterns using a stochastic geometry approach and proposed a scheme which is energy-efficient, used to deploy and to plan small cells in accordance with the prevailing traffic pattern. The simulation results indicated that his scheme can meet the dynamic traffic needs with optimized deployment of small cells and improves the energy efficiency of the system without degrading on quality-of-service (QoS) requirements. In addition, the scheme could achieve better or close performance compared to the leading optimization solver CPLEX and finds solution in very much less computational times than CPLEX. E. Oh et.al [2] focused on green cellular process. Using real data traces, derived a first-order calculation of the percentage of power saving one can assume by turning base stations off, during low traffic instance while maintaining coverage. They also discussed a number of appropriate challenges and solutions, maintaining coverage, enabling cooperation between operators, and providing E911 service. M. Ismail et.al [3] designed network cooperation for energy conservation on two scales: Large scale- it is a network with overlapped coverage by switching their BSs in accordance to the long-term traffic load fluctuations; Small scale- in this active BSs switch it's channels in accordance to temporary load fluctuations. Satisfactory service quality in terms of call blocking and large one hundredth of energy saving, confirm radio coverage. Service quality constraints can be extended to: minimum achieved quantity for data applications and delay and delay-jitter for video streaming applications Experienced cost: synchronization overhead require. Y.S Soh et.al [4] investigated and enquired the design of energy efficient cellular networks by the service of base station to be in sleep mode plans as well as small cells, it also considered the trade-off issues with the mentioned techniques. Future work can include the addition of the above model to the case where base stations have various antennas and may complete principle user choice. It would also be attention to explore how random spatial situations of base stations that model repulsion or hang-up affect the results in respect of quantity and energy efficiency. To finish, the reduction in energy consumption and it's efficiency metric studied there is only depend on the power ingestion and the coverage within the network, and does not take into accordance to the infrastructure cost and backhaul overhead associated with implementing small cell networks. The developed an imaginary (and also practical) framework for BS energy saving that contains both dynamic BS operation technique and user association. The authors formulated a total cost cut off and minimization problem that allows for flexible trade off in the medium of flow-level presentation and energy ingestion. K. Son et.al [5] showed numerical results for the developed real BS topologies under practical formations. The authors showed that the proposed technique that is, energy-efficient user association and BS operation algorithms technique can theatrically reduce the total energy consumption by up to 70-80%. N. Saxena et.al [6] proposed an information theoretic approach used in capturing the dynamics and the uncertainty of network traffic in a 4G LTE system with eNBs. The authors in this paper showed an online stochastic theoretic algorithm which also have been proposed to communicate among eNBs to themselves for optimize traffic awareness. The LTE eNBs uses the present traffic data's to build further future traffic estimations. So with that past and present data's of active mobile phone traffic condition of each eNBs, the further future traffic profile could be predicted with all the probabilistic analyses and accordingly for minimum network traffic durations. The BS could be made to safe mode or power saving mode to optimize the power. The accurate, efficient estimation of the provided uncertain network traffic has to play an important role in power optimization of cellular network. M. Aykutyigitel et.al [7] proposed a model with an innovative nonlinear programming in order to find the best possible network topology to reduce the power consumption and enhance the efficiency of the network without compromising the grade of service. The authors solved it by proposing an algorithm for the green dynamic BS planning. They have considered crowded urban areas where there are numerous BS which are the best appropriate places for greener dynamics BS planning problem, by comparing a suburban or rural area. They have marked crowded urban area in to four regions for greener dynamic BS planning problem to be implemented as- Town centers (business), Residential areas, Town centers (entertainment) and Seasonal tourism centers. E. Oh et.al [8] provided a proposal of an algorithm called SWES, which could be practically implemented in distributed manner with less computational complication to switch BS on/off. The important principal to design this algorithm is for turning off BS one after the other that will negligibly affect the network by using a freshly presented concept of network-impact, which considers the additional load increments carried by its neighboring BSs when a BS is in power saver mode. In respect in further reducing the signaling and implementation overhead they also offered three other versions of this heuristic SWES algorithm over the air and the backhaul, which use the estimated values for the network-impact as their decision metrics. Since this algorithm is online distributed it could be operated without any central control. The result predicts that by the algorithm eighty percentage of power saving is possible. Y.L Chung et.al [9] proposed a efficient power-saving transmission method which saves power for the two-tier LTE macro - femtocell network by vigorously managing the transceivers at femtocell BSs (FBSs) to enhance and improve the energy-saving criteria. The proposed method allows a flexibility of clustered FBSs to quickly switch on/off according to the uncertain prevailing traffic loads, and reports the problem of energy minimization for the transceivers at both MBSs and FBSs, while retaining a pre-determined data rate. To measure the uncertain prevailing network traffic a methodology can be included in this work. R.K Jha et.al [10] analyzed power optimization methods in wireless mobile network on the bases of three case study. They showed critically interims of relative transmission power the FRS (Fixed Relay Station) has important role to play in power minimization. This work did not mentioned regarding the capacity of a relay station that is how, many MS can be associated to a RS at the maximum. To detect the number and value of MS associated to a BS or RS an online network traffic estimation method is required. The power source for RS mentioned in this paper by the author is battery it makes more complex system as the battery must be charged frequently. This proposal needs more investigation for Handoff strategies and QoS parameters. Z. Abbas et.al [11] analyzed and proposed a method for power consumption estimation for user equipment in a hybrid Rely-aided wireless mobile network. The power usage or consumption of the mobile stations (MSs) are examined with respect to the quantity of data transferred and the operation time of the Mobile station’s battery. Even though with this method the time of battery operation for UE can be found out for various ranges of uplink and the downlink paths for the MS/RS from and to the Internet, the mobility factors and the modulation technique has not considered in this work and the paper. H. Holtkamp et.al [12] proposed a Resource Allocation and Power including Sleep method associated resource sharing, Power Control, and Discontinuous Transmission, such that downlink power consumption is lessened. Unlike conservative approaches with objective to reduce transmit power, in this work the BS total power supply is selected as the appropriate metric. Based on a linear power model, which records a certain

IJARSE
ISSN: 2319-8354

transmit power to the required mains supply power, the authors compute the limits of PRAIS in terms of reachable BS power savings. The central limits are mathematically calculated on link level for 4 sets of BS power model factors illustrative of envisaged future hardware developments. Depending on the rate, target per link that is PRAIS provides 63% to 34% energy savings over the conventional resource allocation schemes and techniques. T. Han et.al [13] introduced the GEP (Green Energy Provisioning) problem which aims at minimizing the capital amount of deploying greener energy systems in BSs while maintaining the Quality of Service (QoS) requirements of cellular mobile networks. The author also proposed a greener energy provisioning solution, for the provision-cost aware and effective traffic load balancing algorithm and the binary energy system sizing algorithm to resolve the sub-problems by subsequently solving the GEP problem. D. Liu et.al [14] proposed a joint user association and greener energy allocation algorithms which aims to graphically minimize the on grid energy usage and consumption in HetNets, where all the base stations (BSs) are assumed to be in power mode by both the power grid and renewable energy sources in play. The optimization problem involved both the user association optimization in space dimension, and the greener energy allocation in time dimension. Simulation results indicated that the proposal of the algorithm significantly saves on-grid energy as well as reduces peak-to average energy consumption ratio on-grid. However the proposal by them required an efficient enegy estimation method for network traffic to lead to better performance which is not precisely mentioned by the authors.Y. Chen et.al [15] proposed few important tradeoffs to establish in the skeleton of the framework. In day to day systems, the trade off relatives regularly apart from the simple monotonic curves which have been derived from Shannon's formula, mostly for the present literature mainly focused on the point-to-point single cell case. The visions, like how to progress the trade off curves as a complete an how to change the process point on the curve in balancing the specific system requirements, has to be estimated to guide the practical system designs towards green evolution. The proposed framework impacts the green design of future systems.L. Saker et.al [16] presented a proposal of two sleep mechanisms namely for 2G and HSPA base station to shut down a number of system resources in light or small traffic scenarios i.e. dynamic way and semistatic way. In dynamical way, resources are activated (on) or deactivated (off) in real-time as a function of the instantaneous load or traffic of the system proposed. Further in a semi-static way resources are kept unchanged as constant during longer time intervals, in the order of one hour. The authors showed that the dynamics one achieves larger energy reductions and more conservation while the semi-static has an acceptable performance with low complexity. E. Altman et.al [17] discussed a mechanism called as a sleep mode mechanism for base stations in OFDMA cellular networks called Orthogonal Frequency-Division Multiple Access, where the least loaded base stations are turned off randomly, while achieving explicit expressions for the effect of the impact of switching off base stations for the total expected power consumption, on the coverage, and on the amount of radiation to the human's body. The author assumes that the distribution in the base station to form a homogeneous Poisson point process and the radio interference is said to be negligible. P. Kolios et.al [18] proposed a method to turn off the low utilization or least loaded level base stations based on the technique of store carry and process forward relaying paradigm. The scheme formulated a routing and scheduling problem and exploits and degrades the mobility of relay nodes in migrating traffic from the base stations of very low utilization to the neighboring base stations, allowing that the respecting sites are to be switched off. The authors concluded that from their numerical investigations report the significant amount of the energy gains and efficiency are attained using their scheme for switching off base stations. E. Oh et.al [19] discussed dynamic operations to switch on and off some redundant base stations during periods of low traffic such as at night to provide significant energy savings. The authors estimated the percentage power savings by a first-order equation analysis based on real cellular traffic pattern and found a promising savings. L. Ewe et.al [20] discussed that the base station handover optimization scheme in self organized networks. The role of self organized networks having the handover optimization scheme, for the overall radio network have a significant performance. From the results obtained by simulations done by the authors of handover optimization procedure which has been characterized by heterogeneous radio conditions between the neighboring cells, the authors showed and predicted that their procedure was more stable and efficient from the initial suboptimal parameter settings towards the optimum values of the handover key performance indicators. K. Samdanis et.al [21] introduced few algorithms for partitioning energy in accordance with network elements to power the system on and power off base stations in order to save energy with the objective of matching offered capacity with the traffic demand in a flexible manner. These algorithms achieved network-level energy saving and rely on shared knowledge of load and coverage information to enable an appropriate cell reconfiguration. The authors analyzed the performance of the centralized and the distributed algorithms under different network topologies and traffic conditions through simulation evaluation. Z. Niu et.al [22] discussed cell zooming to just balance the traffic load, and reducing the consumption of energy. The authors implemented few cell zooming algorithms namely the centralized and the distributed algorithm. In centralized algorithms there are two main goals, namely resource allocation and cell zooming operations are deployed in a centralized way depending on the requirements of the user in the network by the central system. In the other i.e. distributed algorithm each mobile equipment selects that base station to be associated, based on the information being broadcasted by the base stations. The author's simulation results showed that with cell zooming the energy usage and consumption can be greatly reduced. H. Zhang et.al [23] surveyed the challenges as associated with coexisting Wi-Fi network systems and hetnets the heterogeneous cellular networks sharing the unlicensed spectrum. The authors introduced the network architectures for LTE and LTE-A small cells to exploit and degrade the unlicensed spectrum already used by Wi-Fi systems. The abs mechanism with an interference avoidance scheme has been presented by the authors to mitigate the interference between Wi-Fi and LTE and LTE-A systems when both are in the same transmitting unlicensed spectrum. Simulation results by the authors shown that with proper use of abs mechanism discussed here and interference avoidance techniques, hetnets and small cell networks can improve the capacity by the use of the unlicensed spectrum. F. Chiariotti et.al [24] proposed a fresh and new vision where technology and the Smart City services were designed to take advantage of each other, in a manner called symbiotic. According to the new paradigm proposed, which we pronounce as SymbioCity, the wealth of sensing and measurements available through smart city are exploited and degraded to provide better connectivity services, and to optimize the overall delivery of communication services. As one of the major components, the smart cities have the intelligent transportation system. The authors showcased SymbioCity vision by analyzing the vehicle traffic data and utilizing such analytics to add to the improvement of the performance for the machine or vehicular communications within the 4G/LTE network. While considering both human-and vehicle-generated data traffic patterns, the authors showed how the smart city data can be used for optimal configuration and the design communication protocols and architecture. L. Zhou et.al [25] proposed an energy efficient small cell planning scheme for dynamic traffic states in small cell networks. In this proposed work the authors adopted a heuristic to turn offs-BSs and update BS-UE connections in iterative way. Finally the authors obtained a solution using the least number of s-BSs without reducing efficiency of the spectrum and connectivity quality service. The simulation results of the authors showed that the dynamic cell planning scheme approach can achieve a significant improvement in energy efficiency while attaining the QoS requirements.

IV. SUMMARY

In the section, mentioned above are few papers has been taken to provide a literature survey of some research papers which deals with the past and some present trends for cellular network deployment. It comprises of how to increase the potential of a cellular mobile network and to maintain the quality of services for all the users. All the authors mentioned in the literature survey discussed about new techniques to improve the potential of a cellular network comparing it with old techniques. This is all about in the summary for the same provided in the above section.

VI. CONCLUSIONS

In smart cities, cellular mobile network plays a crucial role to support connectivity anywhere and anytime. However, the communication demand brought by applications and services is hard to predict. Traffic in cellular networks might fluctuate heavily over time to time, which causes burden and waste under different traffic states. Recently, new technique i.e. small cell is proposed to enhance and upgrade spectrum efficiency and energy efficiency in cellular mobile networks. However, how green the small cell network could be is still a question because of the accompanying the interference. To meet the above challenge, new green technologies should be developed and implemented. A new technique can be proposed which should be green small cell planning scheme with consideration of the dynamic traffic states. Firstly, it should define a set of users locations for base stations (BSs) in a given geographical area and generate a graph of connection, which contains all the possible connections between Base Stations and user equipments (UEs). Then it may adopt a heuristic to turn off the small cell BSs (s-BSs) and provide an update BS-UE connections iteratively. Finally obtained can be a cell planning solution with a better energy efficiency without reducing the spectrum efficiency and enhancing the quality-of-service (QoS) requirements. The simulation results could be provided, that the technique of dynamic small cell planning scheme has low computational complexity and achieves better improvement in energy efficiency as compared with the static cell planning scheme.

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