Energy Competence of Base Station in cellular Network

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ABSTRACT Energy efficiency is the key concept of wireless communication to achieve green network. Green networking is the process that reduces consumption of energy as well for conserving bandwidth and also for any other process that will ultimately reduce energy use and, indirectly, the expense. With the rapid growth of technologies in wireless network and rapid increase of mobile users the problem of spectrum usage as well as energy consumption plays a vital role. As there is an exponential increase in the deployment of base station every year the power consumed by base station is the significant theme of intrigue. The increase in the number of base stations also leads to environment impact of CO₂ emission which is normally due to powering up the base station which is located in remote areas as these off-grid sites are powered by diesel generators. It is been predicted that if this trend continues then the energy consumed by cellular network in future will lead to a serious problem. Thus, there has to be a tradeoff between the quantity of subscribers and the quantity of base station or otherwise it will affect the system throughput. In this paper a brief review of methods that have been used recently to improve the energy consumed by the base station is analyzed.

Keywords: Energy Efficiency, Base station, CO₂, Sleep mode, Optimization, Genetic Algorithm

I. INTRODUCTION
The exponential increase in mobile users every year and the expectation for fast information transmission led enormous growth in cell arrange. In the year 2017 the quantity of versatile subscribers achieved 4.77 billion. The quantity of cell phone subscribers on the planet is relied upon to develop to five billion by 2019. And also the deployment of base station has doubled between 2012-2017 and is expected to get increased by more than four million by 2018[1]. With all this statistics it is clear that as these increase in number of mobile users there is a increase in the number of base station so as to mitigate the increasing data traffic. In a cell arrange the base station is the one which utilizes 58% of total energy consumed. It is important to concentrate on the energy consumed by base station to conserve world economic condition and likewise to decrease the natural impacts. During 2002 the amount of carbon-dioxide emitted due to information and communication technology was found to be 151 MtCO₂ of which 43% is due to mobile sector. This is expected to increase by 349 MtCO₂ of which 50% will be due to mobile sector [2]. Thus keeping all these aspects into mind we have to concentrate on both economic and environmental effects.

It is evident from the Fig.1 that 58% of the power is devoured by base station from the overall power consumption of cellular network.

In this paper we give a broad overview of energy consumed by base station in a cellular network form the past to present scenario for example , cell zooming , cell switching, heterogeneous networks, and the with features on the standards of operation, energy savings, LTE technology with GA (geneticalgorithm) and shortcomings of each technique.

II. METHODS TO REDUCE BASE STATION POWER CONSUMPTION

Fig 1. Power consumption in cellular network

![Fig 1. Power consumption in cellular network](image1)

Fig 2. Basic block diagram of base station

![Fig 2. Basic block diagram of base station](image2)

The major components of major cellular base station are Antenna, Signal transmitter, signal Receiver, Encoder, Decoder, Power amplifier, the control unit, main power supply, and interfaces as shown in fig 2. Base station which is also known as Base Transceiver Station (BTS) acts as an interface between subscriber device and telecom operator network. A typical base station consists of Transceiver (TRX) which performs transmission and reception of signals, a combiner which combines signals from several TRX such that they are sent out through a single antenna which reduces the number of antennas to be installed, a duplexer which separates the sending and reception of...
For this reason, the battery life of UE is been extended. The light cell indicates the small cell. Second one is the core network controlled by station. The two states are READY state and SLEEP state. Sleep state is nothing but introducing low power state in which the UE controls the sleep mode. Initially the small cell, if it is in SS has the capacity to receive wake up signal from UE. At this stage whenever it receives a wake-up signal it transits to RS. With these three sleep mode mechanism they have achieved the range which between 10-60% of energy savings in the network when compared to the network which doesn’t have small cell sleep mode mechanism. This technique greatly reduces the transmitter and receiver distance which in turn reduces transmission power and also the battery life of UE is been extended. Some of the sleep techniques in base station is been completely provided in [8] as a comprehensive survey.

III. SLEEP MODE MECHANISM FOR BASE STATION ENERGY CONSUMPTION

In [7] sleep mode mechanism for small cells is been discussed since small cells plays a vital role where there is heavy mobile traffic with low cost. Small cells like femto, Pico and micro cells [20] provide high data through put and improved coverage for office and home use. An advantage factor of deploying small cells is that when integrated with advanced sleep mode techniques it significantly reduces the energy consumption. Small cells are basically used to provide efficient and superior cellular coverage for home use, hotspot outdoor environments and enterprises. Here the hardware components consist of microprocessor for managing radio protocol stack, random access memory connected to microprocessor used for data handling and system boot up, field programmable gate array (FPGA) responsible for information encryption, equipment validation and system time convention, a RF power amplifier which transmits signal to transmitting antenna whose power is high. Sleep state is nothing but introducing low power state in the hardware equipment of the network design. Imran Ashrametal.deplcts sleep mode procedures in small cell as these small resides in any one of the states at random time. The two states are READY state (RS) and SLEEP state (SS). RS is one were all the hardware components are switched on. SS is one where some of the hardware components are switched off completely or allowed to operate in low power mode. In this paper three sleep mode mechanisms has been discussed. They are small cell controlled sleep mode where an active call from user equipment (UE) can be detected by a low power sniffer in the small cell. Second one is the core network controlled sleep mode; here a wake up message is used to transit from SS to RS which is controlled by core network through backhaul network. The third one is the UE controlled sleep mode where the UE controls the sleep mode. Initially the small cell, if it is in SS has the capacity to receive wake up signal from UE. At this stage whenever it receives a wake-up signal it transits to RS. With these three sleep mode mechanism they have achieved the range which between 10-60% of energy savings in the network when compared to the network which doesn’t have small cell sleep mode mechanism. This technique greatly reduces the transmitter and receiver distance which in turn reduces transmission power and also the battery life of UE is been extended. Some of the sleep techniques in base station is been completely provided in [8] as a comprehensive survey.

![Fig 3. Base station sleeping patterns](image)

Table 1. Parameters used in base station power reduction
The above discussed sleep mode mechanism is some of the techniques through which we can diminish the power devoured by base station.

IV. OPTIMIZATION TECHNIQUES OF BASESTATION FOR EFFICIENT ENERGY CONSUMPTION

Optimization technique is another interesting method to lessen the energy utilization in base station of a cellular network. In this section the different ways of optimizing the energy consumed in base station is thus discussed. The key concept of [12] is that having large number of smaller micro cells improves energy than having smaller number of high-power macro cell. The advantage here in [12] is that it uses random distribution of users. [12] Concentrateson downlink transmission which dominates most of the radio frequency (RF) transmission of base station. The main problem discussed here is to find the ideal number of base station and what's more, to position the base station in the proper locale. The above said problem is same as that of facility location problem and there are so many ways to solve the same which is discussed in [13] [14]. Tayeb Lemlouma et al. introduce PCNM which is nothing but a new way for cellular network measurements. Here it compares the theoretical data with the real measurement of cellular environment by using prediction methods which helps in cellular network maintenance and performance evaluation. In PCNM platform [15] the two main nodes come into play. one is the mobile node which is like sensor for cellular network and other is the central node which monitors the mobile node and also it stores the static information of the network. The results in [15] showed the evaluation of network performance measurements which was based on optimal and quick genetic algorithm. Also, PCNM experiments give a wide knowledge about the cellular network characteristics. Next category is to locate the base station in Long term Evolution (LTE). It is necessary to optimize base station in LTE since promising it is a technology where the size of the cell is reduced. When the cell size is reduced, more number of base station can be deployed, and if more number of base station is deployed more power will be consumed by the base station. Consequently, there is a need to decrease the power in LTE base station and therefore advancing transmission control [16] in LTE base station plays a very important role in cellular network. For base station location models, the application of genetic algorithm (GA) plays an important role [17-19].

| Title of the Paper | Parameters Used |
|--------------------|----------------|
| Minimizing Base Station Power Consumption | Objective: minimizing base station power consumption |
| | No of users: 10 |
| | Maximum transmission power: 46dBm |
| | Number of receive antennas: 2 |
| | Reduction in power consumption: -25% -40% |
| SLEEP Mode Techniques for Small Cell Deployments | Objective: power reduction in small cell base station by sleep mode algorithm |
| | Type of cell deployed: 1. pico cell, 2. macro cell |
| | Total number of mobile subscribers: 40000 |
| | For outdoor: 10000 users, For indoor: 50000 users |
| | Power consumed by macro cell: 1.3kW, Power consumed by pico cell: 5W |
| | Power saving: -10 to 60% |
| Energy Saving of Base Stations Sleep Scheduling for Multi-Hop Vehicular Networks | Objective: sleep mode strategy for moving vehicle |
| | Distance between adjacent base station: 800m |
| | Total cost of base station for turning it on and off: 10 J |
| | Base station power in sleep mode: 1kw |
| Base Station Location Optimization for Minimal Energy Consumption in Wireless Networks | Objective: -167 m |
| | Cell radius: 167 m |
| | Base station location: 13 numbers |
| | Number of users: 30 |
| | Power consumed: 13.3dB |
| | Power reduction: -96% for the given example scenario |
| PCNM: A New Platform for Cellular Networks Measurements | Objective: connects theoretical calculation with real |
| | Test area: 50km x 50km |
| | Two types of nodes |
| | Genetic algorithm - used to reduce nodes |
V. CONCLUSION

Cellular network assumes indispensable job in wireless communication since every single day there is an expansion in number of mobile subscribers. As there is an exponential increase in mobile subscribers eventually there is an increase in deployment of base station. At the point when the quantity of base stations is increased the power consumed by the base station increases exponentially. Thus, there is an urgent need to decrease the power devoured by the cellular network considering both the cost and environmental factor. In this paper we have focused on the power utilization of base station since a large portion of the vitality is been devoured by base station. In this paper an examination of intensity utilization of base station is been done and the various ways by which the power devoured by base station is been diminished is been talked about.

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