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DESIGNING A HORN ANTENNA AND FEMTO CELL NETWORK TO REDUCE THE CO2 AND ELECTROMAGNETIC POLLUTION USING GREEN MOBILE COMMUNICATION

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ABSTRACT:

This article proposes an energy-efficient deployment of the cells where the femtocell base stations are arranged around the edge of the reference macrocell, and the deployment is referred to as femto-on-edge (FOE) deployment. For macrocell it needs maximum transmit power to serve cell edge mobile users, increase in transmit power also increases the energy consumption which leads to more CO_2 emission. The proposed deployment ensures an increase in the network spectral and energy efficiency by facilitating cell edge mobile users with femtocell.FOE deployment guarantees reduction of CO_2 emission and electromagnetic pollution by using directional antenna instead of omnidirectional antenna. Simulationresults quantify the improvements in CO_2 emissionsand transmit power of the proposed FOE deployment compared to macro-onlynetworks and typical small cell deploymentstrategies where small cells are randomlydeployed within a given macro cell.

***Keywords*: Electromagnetic pollution, CO_2 emission, heterogeneous network, femto cell, macro cell.**

1. INTRODUCTION

Mobile communications are expected to be the major worldwide cause of energy consumption within a few years, with a devastating impact in terms of electromagnetic pollution and co_2 emission. Over the last decade global warming has become an increasingly important item on the global political agenda. In this regard, information and communication technologies (ICTs) have been identified to be a major future contributor to overall greenhouse gas emissions, having a share of more than 2% already in 2007 with a strong trend to increase[1].some have concluded that at the end of 2011,total worldwide mobile subscription have grown to 5.9 million and mobile internet subscription to 2.5 million over the worldwide population of 7 billion and these are expected to increase up to two times within five years. The increase in mobile subscription increases the growth of base station, which means that more BSs would have to be deployed to support the ever growing increase in mobile users. However, given that mobile communication systems rely on radiofrequency (RF) waves to operate, the iniquitousness of mobile communication systems raises the level of electromagnetic (EM) radiation exposure to the public.

To decrease the energy consumption, one of the proposed solutions is improving base station deployment strategies. Therefore, acceptable performance in the form of spectral efficiency and coverage can be provided by consuming less energy. To decrease the energy consumption by a deployment strategy, Badic et al. emphasize on effects of cell sizes on energy consumption. They stated that bringing the base station closer to users increase the energy efficiency. Then they create a case study to calculate the effect of cell sizes which is a classical hexagonal deployment. Firstly, they calculate the power consumption of a 1000 meter range of a base station. Then they reduce the range of a single base station by replacing a big cell with smaller cells. They found that the performance gets better with a short range between the base station and users which indicates that small cell deployment is more preferable for energy efficiency. On the other hand, they do not consider the embodied energy which is a very significant value of the total base station energy consumption.

A. Basis for EM Radiation and exposure Limits

.There have been many public debates about the siting of BSs as well as the short and long-term implications of exposure to EM emissions from these BSs on humans and animals.The most reoccurring questions focus on the EM radiation exposure levels within the vicinity of the BSs, effects of increased and indiscriminate deployment of BSs and EM regulatory compliance of BS antennas. Although several reports suggest that EM radiation from BSs are too low to produce any health risks (as long as there is no direct contact with the antennas), there are still concerns about the long-term effects of such exposure. A 2011 report by the international agency for research on cancer (IARC) of the world health organization (WHO) concluded that EM radiation is possibly carcinogenic to humans and classified it as Group 2B, a category used when there is limited evidence of carcinogenicity in humans [8]. As a result of this, several international and national EM radiation exposure guidelines and limits have been introduced and adopted by relevant regulatory bodies.

B. Co_2 Emission and exposure Limits.

In November 2012, the World Bank has published a report to remind us of the environmental and humanitarian crisis brought by climate change and global warming.If nothing is done, the world will be warmed by 4 degrees Celsius by the end of this century. The warmer climate will present a significant threat to our economic development and human life. Global warming and climate change are caused by heat-trapping carbon dioxide (CO2) in the atmosphere. We can reduce CO2 emission by reducing our power consumption.

2. RELATED WORK

In this paper [2] using cell-on-edge (COE) deployment and by employing adaptive uplink power control the reduction in carbon footprint is achieved. The advantage is an increasing flexibility and direct channel access. The disadvantage is only 60% of reduction is achieved. The effectiveness of small-cell based future mobile communication systems in terms of energy efficiency as well as the reduction of EMP for 'True' Green Mobile Communications is analysed in this paper [3]. They concluded that by reducing size of the cell the reduction in electromagnetic pollution and co2 emission can be achieved and also it increases system capacity and battery life.

The main aim of this paper [4] is proposing and analysing a new efficiency for future wireless communication, called dynamic efficiency which combines both green communication and cognitive radio. By using dynamic efficiency they achieved proper utilization of spectrum and elucidation of energy consumption and greenhouse gas emissions. Possible techniques which are all used for reducing EM radiation exposure in mobile communication systems are discussed in this paper [5]. By using those techniques the reduction in electromagnetic pollution is achieved and also those techniques increase the throughput of the network and reduce the energy consumption. This paper [6]integrates the femto and macro cellular networks and thereby reducingCO2 emissions, operational and capital expenditures (OPEX and CAPEX) whilst enhancing the area spectral efficiency (ASE) of the network.Enhancing the area spectral efficiency (ASE) of the network saves the energy and reduces the co-channel interference. The main aim of this paper[7]is Model, measure, monitor and manage EMP using a key attribute called electromagnetic pollution index (EPI).EPI is the product of normalized polluted area and polluting energy in a cell. Minimizing this ratio can reduce electromagnetic pollution.

3. CURRENT MOBILE COMMUNICATION

In current mobile communication base stations are served by unidirectional antenna which radiates equally in all direction. The radiation in all direction increases unwanted radiation it further increases concentration of electromagnetic pollution causes harm full effects and requires high power consumption. Fig.1 shows the direction of radiation in both the Omni directional and directional antenna.

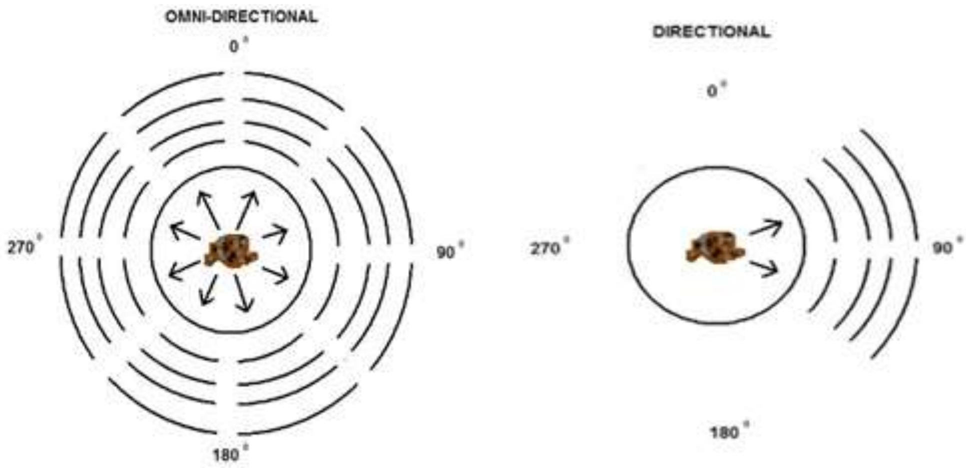

Fig.1. Direction of omnidirectional and directional antenna

In this paper we are going to reduce the density of electromagnetic radiation by replacing omnidirectional antenna by directional antenna which radiates only in particular direction. Relevant data (Fig. 2) show that the number of BSs worldwide has approximately doubled from 2007 to 2012, and the number of BSs today has reached more than 4 million. The increase in base station increases energy consumption of mobile communication. In current mobile communication base stations are operated by bio fuels which emits greenhouse gases which causes harmful effect on human beings. The growth in base station increases the amount of percentage of CO_2 emission. Mobile communication has more disadvantages but compared with others CO2 emission is the most considerable effect which causes harmful effect on both human beings, plants and animals.

Green mobile communication is a practice of selecting energy efficient networking technologies and products for reduce worldwide Co_2 emission and minimizing resource use whenever possible. Green mobile computing with the aim of reducing energy costs and co_2 emission as well as protecting environments is becoming a potential research focus for many next generation communications and network's designers.

4. HETEROGENEOUS NETWORK

A heterogeneous network is a network connecting computers and other devices with different operating systems or protocols. The word heterogeneous network is also used in wireless networks using different access technologies. For example, a wireless network which provides a service through a wireless LAN and is able to maintain the service when switching to a cellular network is called a wireless heterogeneous network.

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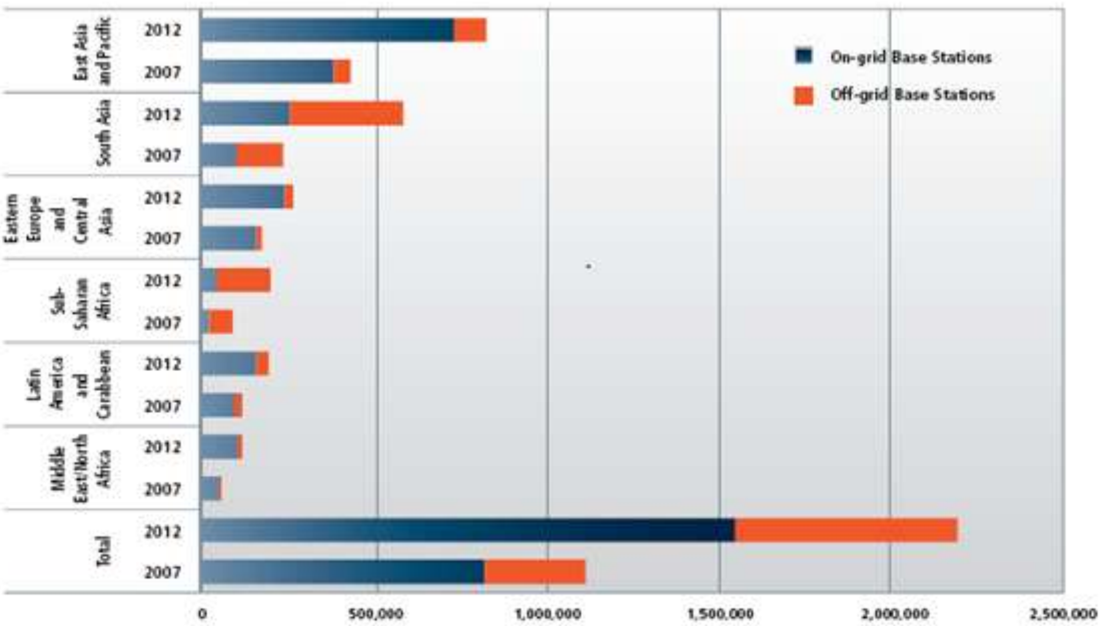

Fig.2. Growth in the number of BSs (©GSM Association 1999–2015).

In existing system they have proposed cell on edge deployment where small cell base stations are arranged around reference Macro cell base station but they does not specify any size of the cell. Here we propose FOE deployment in which the femto cell BSs are arranged around the edge of the reference macro cell. The deployment is referred to as The first tier of the considered heterogeneous network comprises of circular macrocell each of radius *Rm*[m] with a BS *Bm*deployed at the center and equipped with directional antenna. Each macrocell is assumed to have *H* mobile users uniformly distributed over the region bounded by *R*0 and *Rm*, where *R*0 denotes the minimum distance between the macrocell mobile user and its serving BS. The second tier of the heterogeneous network comprises of *N* circular femtocells each of radius *Rn*[m] with low power low-cost user deployed femto BSs *Bn*located at the center.

$$P^{tx} = \min\,[P_{max,} P_0\, r^{\propto}(1 + \mathrm{r/g})^{\beta}/\mathrm{k}]$$

In existing system they have deployed cell on edge deployment using small cell base station to reduce maximum transmit of macro cell base station by reducing distance between cell edge mobile user and macro cell base station. By using cell on edge deployment and uplink power adaptation they achieved 60% of reduction in CO_2 emission. For cell on edge deployment two slope path loss model is used with the value of 2 for both the additional and basic path loss exponent. In proposed system we have designed femto on edge deployment by using MATLAB software. By using graphical user interface we have plotted map which has some number of femto cell base station, femto cell user and macro cell user. Users are connected to corresponding base station. The transmit power of femto cell base station is calculated by using following formula.

The calculated transmit power of femto cell base station is compared with transmit power of macro cell and small cell base station. From that we have analyzed that to reach target SINR femto cell needs low transmit power compared with macro and small cell base station.

The amount of energy that femto cell base station consumed is calculated by using following formula

$$\text{Energy}=\text{Power}*\phi(t)*\text{No.of Days/year}$$

5. SIMULATION RESULTS

Figure.4, shows the variation of gain when the aperture diameter changes from that the gain of the horn antenna increases when the aperture diameter increases. In figure x-axis indicates aperture diameter and y-axis indicates gain. Figure.5, shows the variation of directivity when the aperture diameter of the horn antenna changes. The directivity of the horn antenna increases when the aperture diameter of front end of the horn antenna increases. Here x-axis indicates the values of directivity and y-axis indicates the values of aperture diameter.

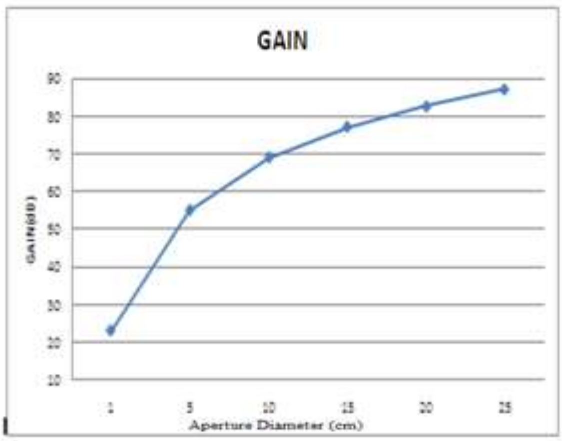

Fig.4.Gain graph

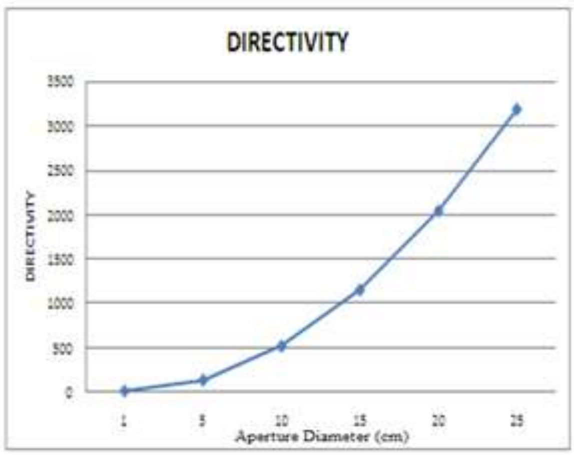

Fig.5. Directivity Graph

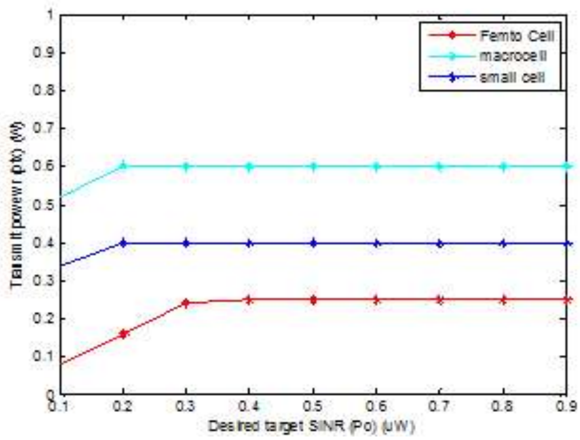

Fig.6. Comparison of transmit power of various cell

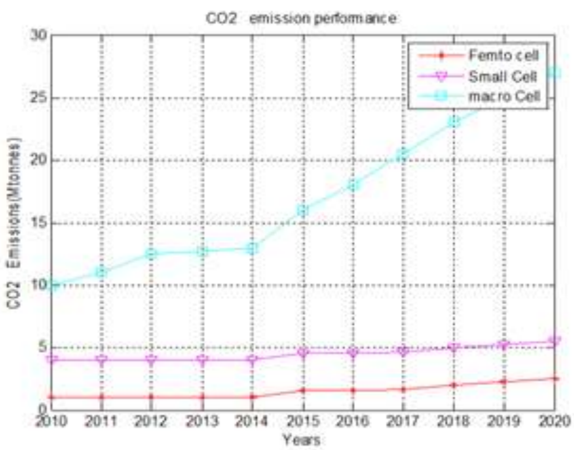

Fig.7. Comparison of CO_2 emission of various cell

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