International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

MINIMIZE THE TOTAL POWER CONSUMPTION OF A 5G HETEROGENEOUS NETWORK

Neha Bhakoriya[1], Jaya Dipti Lal[2], S.V. Charhate[3]

[1,2,3]Department of Electronics and Telecommunication

Shri Govindram Seksaria Institute of Technology, Indore (M.P.)

ABSTRACT

Data traffic in cellular network is increasing rapidly, therefore power consumption is very essential. To improve the efficiency of a network we use a two tier heterogeneous network as we move to the 5G cellular network. 5G network are intended to provide significantly high data rate access and guaranteed quality-of-service. So when the data traffic in a Heterogenous network is high we use data offloading. Data offloading means when macro cell base station (MBS) is upsurge of data traffic then small cell base station (SBS) is used to offload the data. To reduce the total power consumption of a Heterogeneous network, we dynamically change the operation states (on and off) of the SBS while keeping the MBS on to avoid any service failure. We also studied about the various technique used for power consumption such as Base Station Switching and Cell Zooming. Cell zooming adaptively adjusts the cell size to solve the problem of traffic imbalance which reduce the power consumption. BS sleeping is used to save power by switching BSs between on or off.

Keywords : Base station switching, Cell zooming, Heterogeneous network, Mobile data offloading, Macro cell, Small cell.

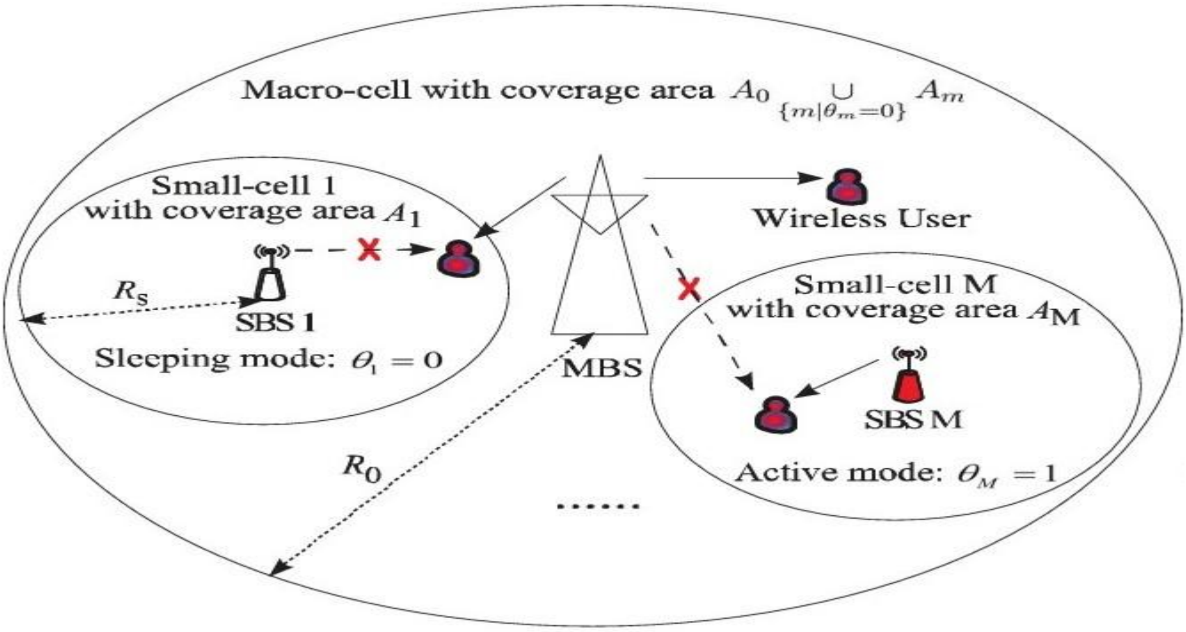
I. INTRODUCTION

With the explosive growth of mobile internet application, mobile users are also increased. Therefore services provided to these user also need to improved. Wide area coverage, hot-spot high capacity, low power consumption is the main motive of the new generation (5G). Single tier cellular network architecture is not adequate to meet these requirement thus Heterogeneous network (HetNet) is used. Heterogeneous network is used to increase the spectral efficiency's so we move to the 5G cellular network. HetNet is a two tier network which include Macro cell Base Station (MBS) and Small cell Base Station (SBS) [1]. The deployment of massive small-cell in the macro-cell can increase the total power consumption of a 5G heterogeneous network. Different transmission power is used for different BS of HetNet (related to coverage and capacity) so total operational power work on different frequency bands. Thus it is more challenging to make entire system energy efficient because the degree of controllability increases. Traffic load is never constant it always fluctuate according to the user demand. It showed that Macro cell with excellent signal strength may suffer from heavy load or have less effective bandwidth thus reducing the effective rate it can serve at. So offloading the traffic load from Macro cell Base station to small cell base station can maximize the rate coverage and increase the user's QoS requirement[2]. Data offloading from the MBS to SBSs thus helps save the MBS power

International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

consumption but requires more SBSs to be tuned on and increases the total power consumption of the SBSs. But still the total power consumption of small cell base station is high, so to reduce the total power consumption of a HetNet we use dynamic adaptation of the small cell base station operation modes (on/off) strategies. The MBSs and the SBSs are dynamically operated over different spatial and time scales. So it important to jointly manage the power consumption of macro-cells and small-cell. Turning on or off an MSB take several minutes while a SBS can be quickly turned on or off in seconds. Therefore we are using two major approach : Cell zooming and Base station (BS) sleeping. Cell zooming adaptively adjusts the cell size to solve the problem of traffic imbalance which reduce the power consumption[4]. BS sleeping is used to save power by switching BSs between on or off.. So the main purpose of this paper is to increase the percentage of powering saving in 5G Heterogeneous network. And to assure high QoS for all the users who access the HetNet.

II. SYSTEM MODEL



F

ig (1) – The HetNet system model with one Macro-cell and M Small-cells

In this fig(1) we consider a two-tier HetNet. Where small-cell are deployed in a macro-cell. The MSBSs dynamically adjust their on/off operations to serve the offloaded traffic from the MBS.

Here : R_0 and R_s = Radius of the MSB and SBS where $R_0 > R_s > 0$.

MBS is located at the origin o, given by (0,0).

A_1 to A_M = Area coverage of the various small-cell.

The operation mode of SBS are :

$\theta_m = 1$ (Active mode)

$\theta_m = 0$ (Sleeping mode)

The operation modes of all SBSs are given by :-

$\theta = [\theta_1, \theta_2, \ldots, \theta_M]$ MBS is always active to avoid any service failure.

International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

III. INDENTATION AND EQUATION

In fig(1) we can see that a single macro cell consist of various small cell base station. Where R_S is the radius coverage of small cell and R_O is the radius coverage of macro cell base station. Small cell have two operation mode the active mode and the sleeping mode. When the small cell are ON they are called as active cell and when the small cell are OFF they are called as sleeping mode. Macro cell base station is always keep active to avoid any service failure. The power consumption of MSB is shown in equation (1). In this we have M number of small cell so each cell have there own state either ON or OFF. For a particular area when the traffic load is low we turned off its base station. So our power consumption is getting reduced shown by equation (2).
Total power consumption is given in equation (3).

- Each SBS can either be active or in sleeping mode.

  $\theta_m \in \{0,1\}$

- MBS is always keeping active to avoid any service failure.
- MBS operates over a different spectrum band from the SBSs, to avoid the interference between the MBS and the SBS.
- There are one macro cell and M small cells in the network

  R_o = coverage radius of MBS

  R_s = coverage radius of SBS

  Where $R_o > R_s > 0$

- MSB located at origin o, (0,0)

Mode of SBS:-

$\theta = [\theta_1, \ldots\ldots, \theta_m]$

$\theta_m = 1$ (SBS = active mode)

$\theta_m = 0$ (SBS = sleeping mode)

- Power consumption for the MBS

$$P = \underline{P} + \mu P^t(\theta) \tag{1}$$

- Power consumption for each SBSs

$$p_m = \begin{cases} p_t = p + vp^t, & if\ \theta_m = 1(active/on) \\ p_0, & if\ \theta_m = 0(sleeping/off) \end{cases} \tag{2}$$

- Total power consumption in the HetNet is

International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

$$P^{H_{st}}(\theta) = P + uP^{t}(\theta) + Mp_0 + H(\theta)\Delta p \quad (3)$$

Where:-

$\underline{P}$ = Power consumption starts from a base level $\underline{P} > 0$

P^{t} = Transmitted power

θ = SBSs operation modes

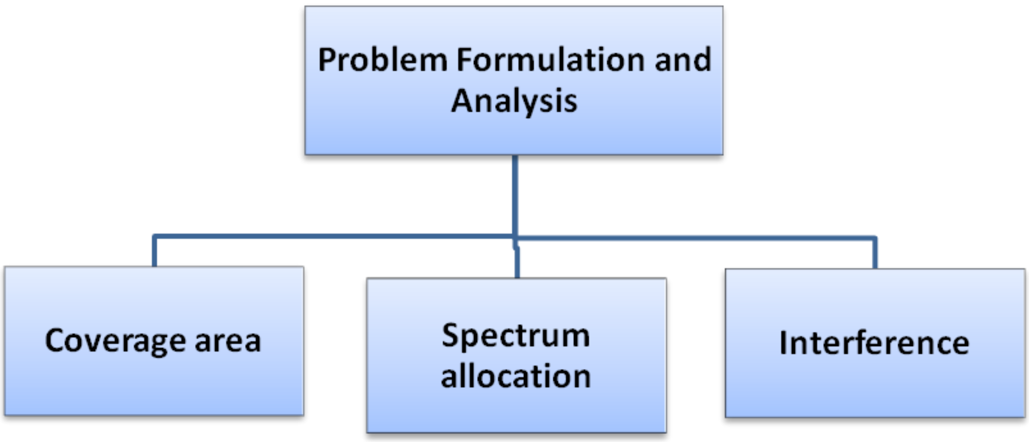
μ = Power utilization

$P^{\wedge}t(\theta)$ = Transmitted Power with SBS operation mode

(After data offloading)

IV. PROBLEM FORMULATION AND ANALYSIS

- It showed that offloading the mobile user in a two-tier wireless heterogeneous network from macro cell to small cell can lead to maximize the rate coverage which in term is dependent on user's QoS requirement.
- We investigate the dynamic base station (BS) switching to reduce energy consumption. In which dynamic adaptation of the SBSs operation modes on/off (active or deactive) take place.
- The Cell zooming concept is used to reduce the power consumption. According to traffic load fluctuation cell zooming adaptively adjusts the cell size which solves the problem of traffic imbalance and also reduces the power consumption.
- **I**t showed that how to avoid the Inter-cell Interference between the various SBS



1. We have to decide the proper coverage area which provides the highest efficiency of the cellular network.

2. To properly serve the user we adopt the separate carrier models such that MBS operates over a different spectrum band from the SBSs.

3. All active SBSs operate over same spectrum band; therefore inter-cell interference is generated between active SBSs.

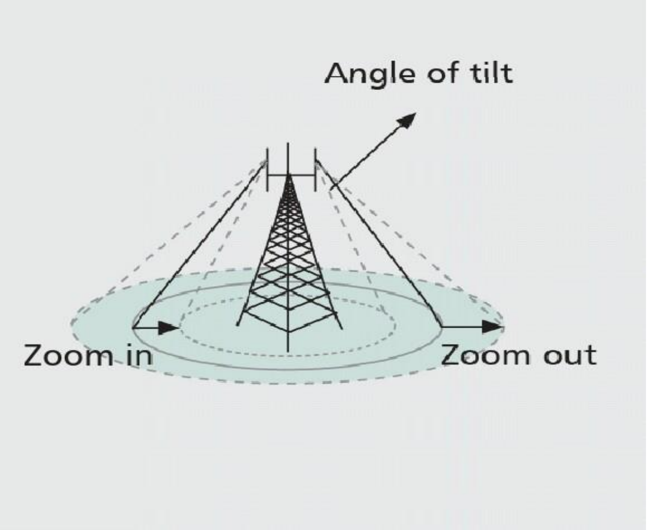
International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

Proposed Methodology

The proposed methodology for the power consumption of 5G heterogeneous network is mainly depend on two technique that is Cell Zooming and BS sleeping.

(A) Cell zooming

Cell zooming adaptively adjusts the cell size according to traffic load, user requirements and channel conditions. Cell zooming has the potential to balance the traffic load and reduce the power consumption. Traffic load in cellular network can have significant spatial and temporal fluctuations due to user mobility and busty nature of many application. Some cells under light load while others are under heavy load so some MUs will be unable to get services, so we use Load balancing schemes.

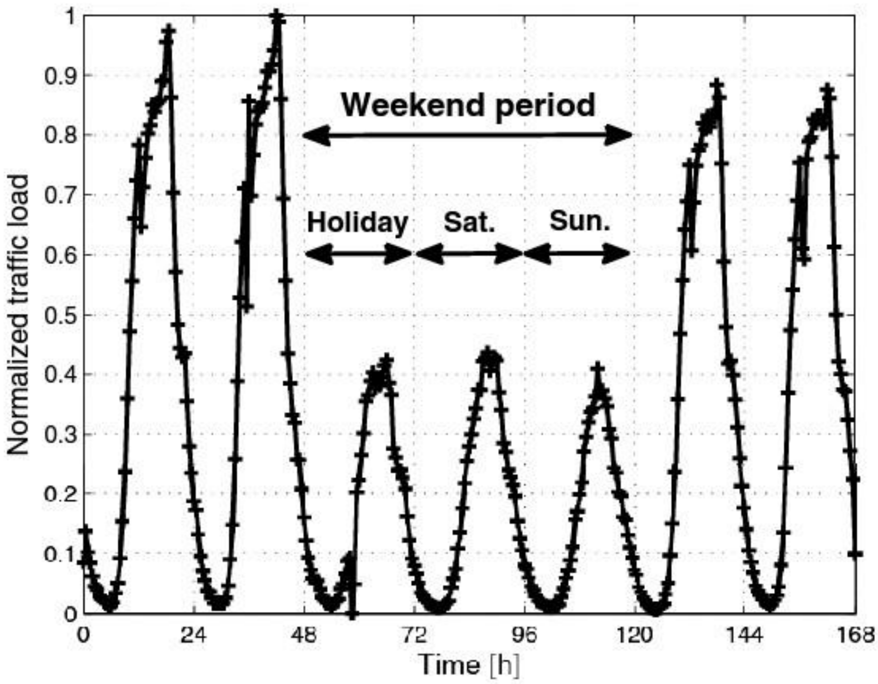


Fig(2) - Cell zoom in or Cell zoom out

When some MUs move into central cell and make it congested, the central cell can zoom in to reduce the cell size. And when MUs moves out of the central cell and make neighbouring cells congested then central cell is zoom out.

(A) BS Sleeping

When a BS is working in sleep mode, the air-conditioner and other power consuming equipments can be switched off thus reduce the power consumption in a cellular network. It also saves power by switching BS between the SBSs operation modes on and off i.e. active and deactive.



Fig(3) - Normalized traffic load during one week

As the traffic profile of the BS is not always similar (for ex. in night time it is much lower than daytime or the difference between the normal week days and weekends) so we proposed a practically implementable switching on/off based energy saving (SWES) algorithm. By SWES algorithm we estimate up to 50% potential saving based on the real traffic profile implementable switching on/off based energy saving (SWES) algorithm.

V. CONCLUSION

With the increasing volume of mobile data traffic, it is required to adopt such innovative solutions for the power consumption. Data offloading and dynamic BS switching are working together to reduce the power consumption.In [5] showed that 25-30 % of the total power consumption can be saved by reducing the number of active cell when the traffic is low. In this we also provided a detailed of cell zooming concept with different traffic scenarios. The cell zooming techniques provides the solution for traffic load imbalance as well as reduces the energy consumption in the cellular network. It is of highest interest to extend the current single macro-cell scenario to the general multi-macro-cell scenario by further taking the interference from neighbouring macro-cells into account. A future extension may consider the ‘shared spectrum’ model where macro-cell and small-cell operate over the same spectrum band.

REFERENCE

[1]. Shijie Cai, Yueling Che, “Green 5G Heterogeneous network Through dynamic small-cell operation” IEEE journal vol.34, No. 5 may 2016

[2]. S.singh, H.S. Dhillon, and, J.G. Andrews, “Offloading in HetNet: Modeling, analysis, and design insights,” IEEE Trans. Wireless Commun. Vol. 12

International Journal of Electrical and Electronics Engineers
Vol. No. 9, Issue No. 01, January-June 2017
ISSN (O) 2321-2055
ISSN (P) 2321-2045

[3]. E.Oh, K.Son, and R.Zhang. Dynamic base station switching on/off strategies for green cellular network." IEEE Trans. Commun. Vol 61

[4]. Z. Niu, Y.Wu, J.Gong, and Z.Yang, "Cell zooming for cost efficiency green cellular network," IEEE Commun. Mag., vol.48

[5]. Y.S. SOH, T.Q.S Quek, M.K countouris, and H.Shin, "Energy efficient heterogenous cellular network", IEEE J.Sel. Areas commun, vol.31

[6]. I Ashraf, F.Boccardi, and L.Ho, "SLEEP mode techniques for small cell deployments," IEEE Commun. Vol.49

[7] M.Hossain, K.Munasinghe, and A.Jamalipour, 'Distributed inter-BS cooperation aided energy efficient load balancing for cellular network', IEEE Trans. Wireless commun. Vol 12, No. 11

[8]. C. kosta, B. hunt, A. Quaddus, and R. Tafazolli, "On interference avoidance through inter-cell interference coordination (ICICI) Based on OFDM mobile systems," IEEE Proc. Commun. Vol. 15

[9]. D. cao, S.Zhou and Z.Niu. "Improving the energy efficiency of two-tier heterogenous cellular network through partial specrum reuse," IEEE Trans. Wireless Comm. Vol 12