International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 01, January-2016

Inter-Cell Interference Reduction in Green Cellular Networks using Improved Hand Offs Techniques

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***Abstract*— The concept of green networking is to minimize the utilization of energy. The base stations within the cellular networks utilize more than 80 percentage of the net energy available in the network. With the motive of reducing the power utilization, the cell zooming technique is incorporated. But the cell zooming technique leads to inter-cell interference and coverage holes problems. Hence a new technique with handoff is effectively proposed to overcome the limitations within the cell zooming, thereby providing the efficient energy conservation within the cellular networks.**

Keywords*— Cell Zooming, Green Cellular Networks, Hard Handoff Technique, Efficient Handoff Techniques.

I. INTRODUCTION

A Cellular Network is defined as a Network, where the final Link is said to Wireless. The Cell is the terminology for defining the Network which is spread over the entire landscape. There exists a Base Station within each Cell that acts as a Transceiver. Day by day the traffic in these cellular networks increase hence the amount of power consumption by the so called base stations will also increase drastically. As per the current statistics, the base station with in a cell consumes more than 80 percentage of the total power.

Green Networking mainly focuses on choosing the best energy efficient networking mechanisms and techniques. This helps a lot to minimize the utilization of the available resources. Hence green networking helps to minimize the hazardous impact on the nature and improve its greenery.

In order to reduce the power consumption associated with the base stations, several high impact idea are been proposed. The two of the important techniques for such reduction in the power consumption are COMIC Algorithm [1] and Sleep Modes Technique [5].

The COMIC (Cell Overlap Minimization with Intersection Covered) [1] is an efficient cell Optimization algorithm. This algorithm performs an efficient way of reducing the power consumption on average of the cellular networks. Effectively turning the base stations on and off as per the traffic load, the power consumption can be reduced along with retaining the network coverage. It is commonly found that during the day time the network traffic is enormously large in the company areas but in the residential area the amount will be comparatively low. The situation gets reversed during the night time. So that with the COMIC algorithm a base station is switched off and that the cells neighboring to that particular base station will intersect the coverage area of the switched off base station effectively.

In the case of a sleep mode technique [5] to reduce the power consumption within the base station, within the base station some hardware entities are switched off. It can also be said as these entities function at very low modes of power.

In [9], the authors discuss an efficient mechanism to reduce the power consumption based on cooperation among the base stations such that those base stations which are having less traffic are made inactive. In this manner the number of base stations and its associated power consumption can be reduced effectively.

2. RELATED WORK

There is an efficient and effective technique proposed for the purpose of traffic load balancing and reducing the consumption of more energy by the base stations. The paper "Cell Zooming for Cost – Efficient Green Cellular Networks" by Zhisheng Niu, Yiqun Wu, Jie Gong and Zexi Yang describes a technique referred to as Cell Zooming [4] for the purpose of balancing the load in the network traffic and minimizing the consumption of energy by the base stations.

The concept of cell zooming can be illustrated well by the Fig. 1. The diagram depicts five cells within a cellular network. A single cell at the centre is surrounded by four other cells. The base stations are present at the centre of the cells which are represented by squares which are hollow. The mobile Users which are represented by dots are distributed within the cells. There is a tendency for that the mobile users may move towards the cell at the centre making it more crowed and congested. At this time for reducing the cell size and thereby reducing the congestion within it, the cell at the centre will zoom in. On the other hand the neighboring cells zoom in and the cell at the centre will zoom out when there is tendency for the mobile users to travel out from the cell at the centre. The neighboring cells will perform the zoom out or cooperatively serve the remaining mobile users, when the neighboring cells are having high capacity such that the central cell can go into the sleep mode for minimizing the energy consumption.

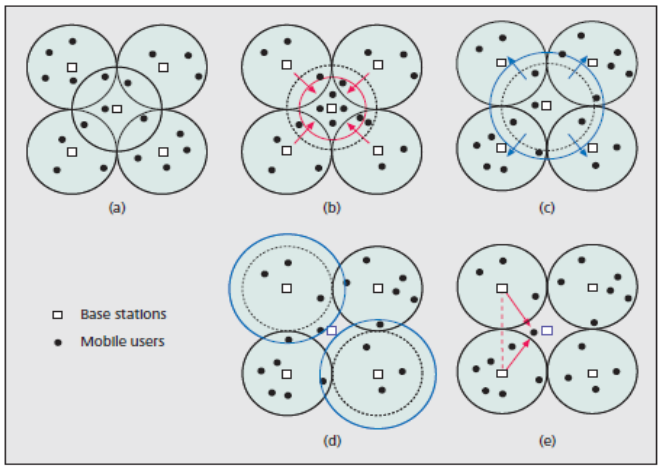

Fig 1.Different Operations of cell zooming within the cellular Networks

There is a specific framework for the implementation of Cell Zooming. The framework is depicted in the Fig. 2. The entire cell zooming process is controlled by the cell zooming server. For cell zooming, the cell zooming server will monitor and evaluate various factors associated with the cellular networks such as load of the network, the necessities of the users, the conditions application for the channel etc. This process is performed by control messages. Once the details above mentioned are collected, the cell zooming server will take the decision whether the cell zooming is to be performed or not. There exists coordination between the cell at the centre and its neighborhood cells for zooming in and zooming out whenever it is necessary.

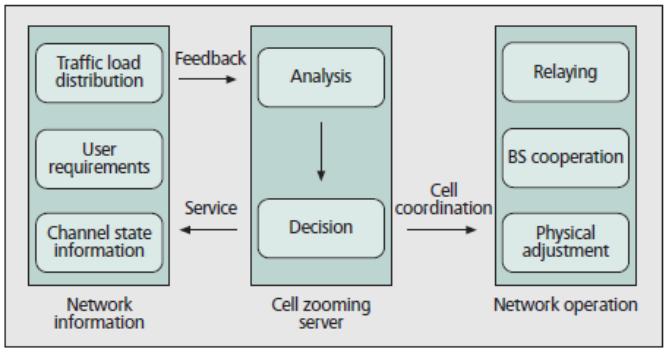

Fig 2. The Cell Zooming Framework

There are various mechanisms for implementing the concept of cell zooming. Fig 3. Indicates the different mechanisms.

1. Adjustment of Physical Parameters: Implementation of cell zooming is supported by adjusting the network parameters that are physical. The adjustment of the antenna height and antenna tilt can be used for cells for zooming in and zooming out.
2. Cooperation among the existing Base Stations: Here the creation of a Cluster takes place. The cluster is formed by many Base Stations. These base stations that formed the cluster will together send and receive data from the mobile users. The Base Station Cooperation can minimize the inter-cell interference. Hence in order to enhance the coverage the cells do the process of zooming out.
3. Deployment of Relay Stations: For improving the efficiency and performance of cell – edged mobile users, the Relay Stations are brought into effect. Here the cells that are deployed with Relay Stations will have the tendency to zoom out.
4. Sleep Mode Base Stations: Base Station when working in the sleep mode can be turned off, to avoid the wastage of the energy. Here Base Stations in sleep mode will zoom in to the value zero. While the cells in the neighborhood of the base station turned off will zoom out to provide the effective coverage.

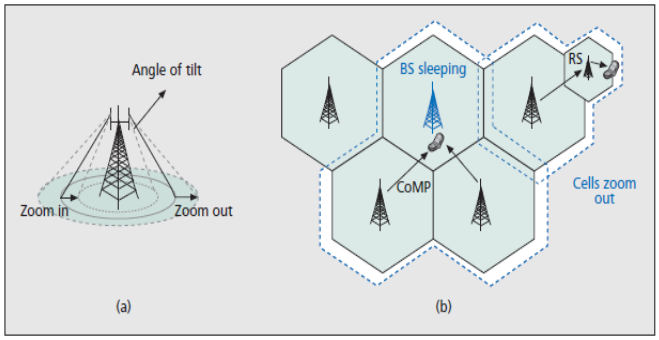

Fig 3. Mechanisms for Implementing Cell Zooming

Some of the important benefits of Cell Zooming include effective load balancing. This is performed by transferring the network traffic from the cell with more loads to the cell with comparatively less load. Cell Zooming can also be implemented for the energy conservation of the base stations.

3. IDENTIFIED PROBLEMS

The major drawbacks associated with the cell zooming are cell to cell or so called inter cell interference, which happens when few neighboring cells try to zoom out while cell zooming is implemented. For a mobile node within the coverage area of cells which are zoomed out will encounter several better quality links from the active zoomed out cells. So there occurs redundant and consecutive hand offs between the neighboring base stations. Hand off is a process by which a mobile node disconnects from an access point ,whenever there is a low quality links and connects to other access point having good quality link. Ping pong effect also occurs between two base stations. Ping pong is nothing but when a mobile node moves back and forth between the overlapped areas of two adjacent cells.

4. PROPOSED TECHNIQUE

For the purpose of overcoming the identified problem of inter cell interference, which causes redundant and consecutive hand offs between the zoomed out cells, we propose a high impact handoff process. The process of shifting a mobile node from a base station to another is referred to as Handoff, illustrated in Fig 4.1. In other words if within the call duration a mobile node migrates from a coverage area to a new coverage area, then the transferring of call takes place to the new area base station or base station of the so called new cell.

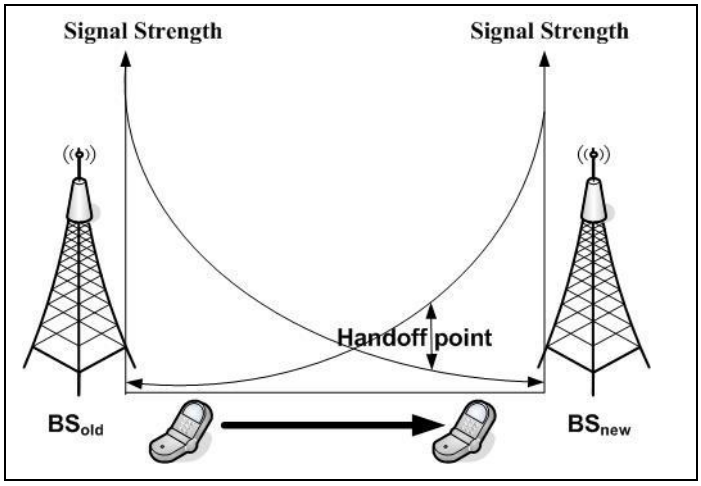

Fig 4.1: Handoff Basic Diagram

When a call gets terminated and a kind of interference has taken place within the network channels, the handoff can be applied. Handoff process is broadly categorized into two, the hard handoff and the soft handoff.

The hard handoff is a kind of handoff process in which the mobile has to cut the link or the network connection with the existing base station before getting connected to the new base station, illustrated in Fig 4.2. Hence in the case of hard handoff there exists only a single communication link path or channel. For example if there are two base stations BS1 and BS2 , the mobile node is initially connected to the first Base Station 1 but finds a better coverage under the second base station, then for getting connected with the second base station it needs to discontinue it connection with the initial base station.

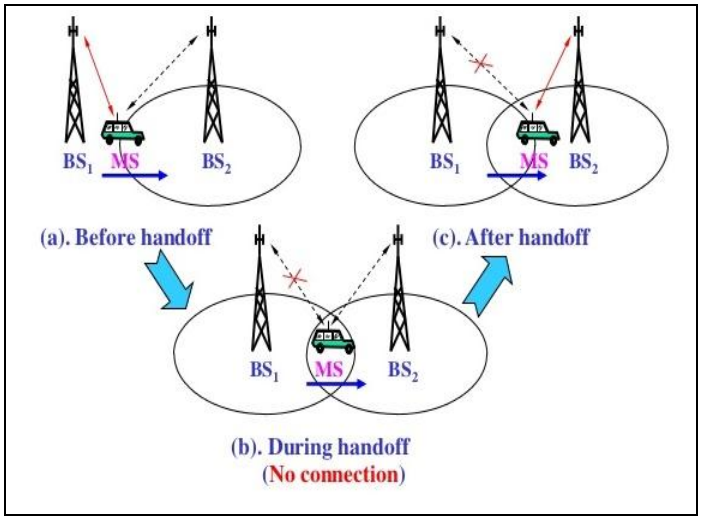

Fig 4.2: Hard Handoff Mechanisms Illustration

While in the case of a soft handoff mechanism, while the call is ongoing the mobile node is connected to more than one cell. Here the node to establish the network connection for communicating with base stations makes use of multiple channels. For example if there are two base stations and that the mobile node is having an existing connection with the first base station, retaining that connection it will try to get connected with the second base station, once the connection is being established and completed, it removes the link or connection with the initially connected base station. Hence for a soft handoff the mobile node need not disconnect the existing connection for setting up a new connection or link with the new base station. The soft handoff is well illustrated in Fig 4.3.

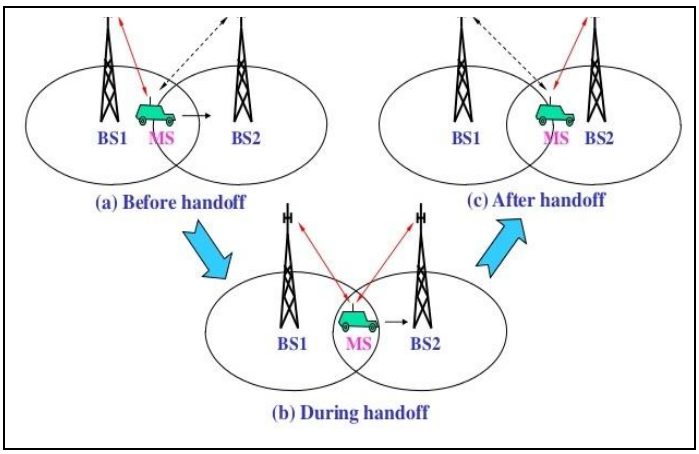

Fig 4.3: Soft Handoff Mechanism Illustration

Among the two handoff mechanisms discussed above, we make use of the hard handoff mechanism. Among different kinds of handoff process for overcoming the interference and coverage hole while the process of cell zooming is performed, we came across Smart – Hop [3], the technique put forward by H. Fatouhi, M .Zuniga, M. Alves, A. Koubaa, P. Marr'on and Hand off Management [8] proposed by W.G. Teng, which can overcome interference and redundant handoff.

As a part of the proposed system, we first need to recognise the Handoff Margin which is denoted as HO-Mar). Apart from identified HO-Mar, we need to identify the threshold values. These values are obtained on the basis transition region under consideration from one base station to the other base station covered by the mobile node.

The handoff process is to be done with at most precision such that the time for deciding to which base station, the mobile node needs to establish the connection is important. As per the threshold values are considered, there are mainly two values the low threshold value denoted as TH-l and the maximum threshold value denoted as TH-h.

Considering an example with two base stations, say BS1 and BS2 and a single mobile station denoted as MS. Currently when we consider the MS is under the area of coverage of the BS1. Once the MS starts shifting or migrating from BS1 to BS2, the relative strength of the signal from BS1 to MS will reduce, which turns out to be less than the TH-l value. At that particular instant of time the MS will repeatedly broadcast enquiry message to all nearby base stations. The base station that responds to the enquiry message send by the MS, say in our example BS2, will be the new base station to which the MS starts communicating. This communication link between the MS and BS2 happens if and only if a condition is satisfied, which is said to be the received signal strength (RSS) from BS2 to MS is greater than TH-h. This is illustrated in Fig 4.4.

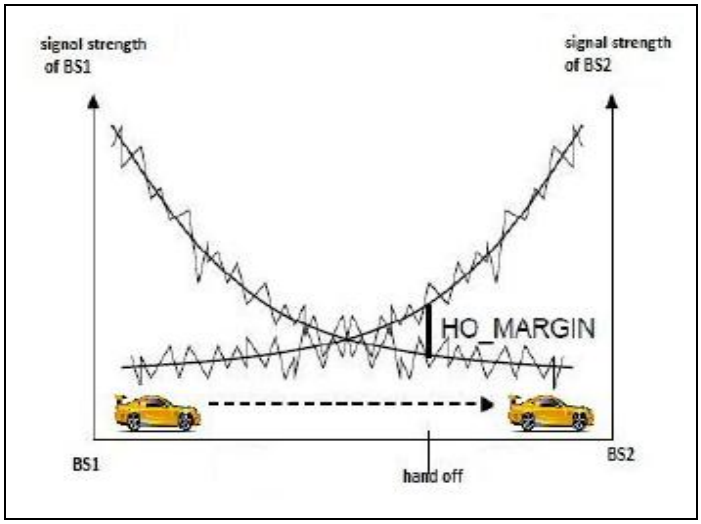

Fig 4.4: Decision for Handoff and Handoff Margin

A case arises when multiple base stations respond to the single enquiry message send by the MS. At this particular point of time the mobile stations need to check the value for threshold, if all of them are greater than the TH-h then go for calculating the values of relative signal strength denoted as RSS and signal to interference and noise value. Based on these calculated values, the MS will decide the best link to which it is to be connected.

The Algorithmic way of expressing our proposed system is as follows:

1. Initially the mobile node is connected to base station and communicating with it under the condition that the received signal strength of the current base station, denoted as RSScurrent is greater than the set maximum threshold.

   RSScurrent > TH-h

2. When the mobile node starts moving it recognizes multiple base stations and that if the link quality of the base station to which it is currently connected goes down below TH-l, the mobile node looks for a better signal base station based on the following criteria:

   RSScurrent < TH-l

   RSSn > TH-h

   RSSn > HO-Mar

   Where RSSn is the newly received signal strength and HO-Mar is the Handoff Margin.

3. Once a greater quality signal is found the mobile node will get connected to that base station.

4. If the mobile node could not identify any base station with better signal strength, it still continues to get connected to the older base station and the search for the new base station with better signal strength continues.

5. Immediately once the handoff is done, the mobile node starts communicating with the base station newly recognized with better signal strength.

5. CONCLUSIONS

The amount of power consumed by the base stations within the cellular network increases day by day hence there happens to be more energy loss. The green networking brings into existence the concept of reducing the power consumption of the base stations. Cell zooming is a technique that provides an efficient way to reduce the network traffic load and to minimize the consumption of energy. But cell zooming has a greater disadvantage of inter cell interference and coverage hole. We through this paper brings forth a new technique to reduce the inter cell interference while performing the cell zooming. In this paper we propose a technique of the hard handoff process combining with handoff techniques suggested in Smart-HOP [3] and Handoff Management [8]. Hence we through our paper, suggest an efficient handoff mechanism that overcomes the limitation of Cell zooming technique.

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