Effective Handing over of Mobile Nodes for Optimal Utilization of Channel Capacity

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***Abstract*--- Users expect quality communication without any interruption even during their travel. Handover occurs when the ongoing communication is transferred from one cell to another. If the new base station to which the signal is to be handed over is having sufficient frequency channel capacity then handover occurs smoothly. Instead if the frequency channel capacity of new BS is fully occupied, then the mobile device searches for another BS, which consumes more time and also lead to dropage of data packets. If another BS with sufficient frequency channel capacity is not found, then it leads to reduced quality of service and break in communication. In the proposed procedure, when a BS has to take over an approaching node, the controller checks the availability of frequency channel capacity in that BS as well as in the neighbouring BSs and hands over some nodes in the current BS to another and accept a few nodes from others, including the approaching node. This procedure not only reduces congestion but also avoids interruption and packet drops for an incoming node. This procedure utilizes the bandwidth efficiently with better QoS.**

Keyword -Frequency channel capacity, Received Signal Strength Indicator (RSSI), Angle of Arrival (AoA), Time Difference of Arrival (TDoA)

I. INTRODUCTION

Due to the rapid changes in the technology (2G, 3G, 4G, WiFi, WiMax, WLAN ,.) the demand for faster wireless communication is also increased. The main role of wireless communication is to provide mobile device user maximum freedom of movement while using the mobile devices. Wireless network is made up of number of radio cells, each cell has a base station and a group of frequencies. When a MN moves, handover occurs from one BS to another BS so as to provide continuous communication. But the adjacent BS will not be using the same radio frequency channel. Hence during handover MN is transferred from one radio channel to another radio channel [1].

If the received signal strength of MN from existing BS is below the threshold value then BS initiates pre-allocation procedures. In pre-allocation procedure a new radio frequency channel is allocated for MN's further communication from new BS through existing BS. If the frequency channel capacity is already fully utilized by the new BS then mobile device has to either search for some other BS and gets connected to it or it has to drop the communication. This process affects the QoS and network traffic due to re-transmission of the packet again.

In the proposed system, the MNs in the boarder are identified based on location of the MN and its direction of movement. Then neighbouring BSs with free frequency channel capacity are identified and the MNs in those boarders are handed over to the appropriate BSs with free frequency channel capacity based on the direction of movement of MN. All these happen before the receiving signal falls to handover threshold. This reduces the handover delay and makes it as a congestion free network. This also avoids handover to heterogeneous network which would otherwise happen and avoids communication dropage.

II. REVIEW OF RELATED WORK

Dynamic cell sizing is suggested by T. Togo, I. Yoshii and R. Kohro[3]. In this the coverage area of a cell is dynamically adjusted based on load of BS. If the BS is fully occupied then it reduces its coverage area by reducing the transmitted power of BS, so that the MNs beyond its coverage limit are abruptly disconnected and get connected with other BSs. As per this method the entire surrounding BS must be lightly loaded otherwise, some of the MNs may be disconnected. But it is not sure that always the adjacent BS overlaps with neighbouring cell.

In the papers proposed by Mohamed Hossam Ahmed [4], Courcoubetis[5], HannesEkstrom[6] and Soldatos [7], propose that if the BS do not have free TCH, then further handover request as well as the new registration service request is rejected. Due to this the congestion will be avoided and the MNs using the BS will not be affected. But due to rejection of the handover request the communication may be dropped, until that time the transmitted packets are lost. Also due to the rejection of handover request, MN has to connect with heterogeneous network which may cause the mobile user to bear additional cost. For the proposal by Ekstrom,

H. [6], the applications such as video, online gaming, e-mail, voice, etc scheduling and queuing mechanisms effectively utilizes the bandwidth. The drawback of this is like GSM (25 MHz bandwidth is subdivided into 124 carrier frequency channels and each spaced 200 kHz apart) the frequency channel is fully utilized and hence there is no possibility to provide further frequency channels.

Falowo[8] suggested that dynamic pricing improve the network efficiency and load balancing of different networks. This mechanism also helps to avoid congestion problem. In this approach additional cost is levied to MNs which are accessing the network. To provide access to a single additional mobile device multiple devices are levied with additional cost. The abrupt termination of MNs not accepting the additional amount, leads to increase in the complexity of managing network.

In David Shrader's Dynamic Pricing in Heterogeneous Wireless Cellular Networksresearch work [2] a dynamic pricing algorithm into a channel allocation and call admission control process is introduced. Inorder to overcome the deficiency of TCH, BSs demand modified pricing from all the MNs under communication. The MNs which accept the price continues the communication and for the remaining MNs the call is terminated abruptly. The drawback of this approach is additional cost has to be given to access the particular BS which disturb all the MNs belonging to the particular BS. This process also leads to packet loss and increased handover delay.

To overcome the above said drawbacks the proposed mechanism identifies the traffic free BSs among the neighbouring BSs. The MNs which are moving towards the particular BS are to be identified based on location and direction of movement. Then the particular MNs are intimated with pre-handover request, so that the handover process is done in a smooth manner without affecting the QoS.

III. PROPOSED WORK

In order to make the fully loaded BS as lightly loaded BS, the base station controller has to do the following steps.

Step 1: Identification of BS which has fully utilized frequency channel capacity (fully loaded)

Step 2: Identification of neighbouring BS with some free frequency channel capacity (lightly loaded).

Step 3: Identification of MNs which are in between fully loaded BS and lightly loaded BSs.

Step 4: From the set of listed MNs from step 3, select MNs which are moving towards the lightly loaded

BS based on location and direction of MN.

Step 5: Smooth handover procedure only for the list of MNs in step 4.

A. Identification of BS with fully utilized frequency channel capacity (fully loaded)

For a mobile device to communicate with full duplex communication both uplink frequency (transmission frequency of the MN and receiving frequency of the BS) and downlink frequency (receiving frequency of the MN and transmission frequency of the BS) are needed. This frequency allocation is called Traffic Channel (TCH) allocation. In GSM 900 MHz model, the uplink frequency band is 890–915 MHz and the downlink frequency band is 935–960 MHz. This 25 MHz bandwidth is subdivided into 124 carrier frequency channels, each spaced 200 kHz apart. Every BS has a controller called Base Station Controller (BSC), which is used to allocate frequency channels to every user. Fig. 1 shows the TCH activation procedure during registration.

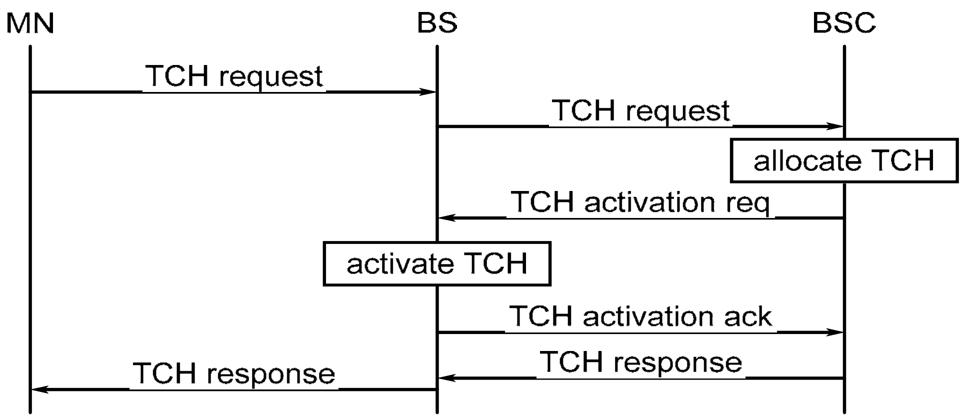

Fig. 1: TCH activation procedure during MN registration

When the MN is be handed over from existing BS to new BS, then new TCH allocation request is sent to new BS through existing BS and BSC. BSC allocates a new TCH and then sends the TCH activation request to new

BS. New BS activates the particular TCH for MN and then sends acknowledgement to BSC. BSC sends TCH response message (TCH information) to MN via existing BS. After receiving new TCH, MN is disconnected from the existing BS. Fig. 2 shows the TCH activation procedure during handover.

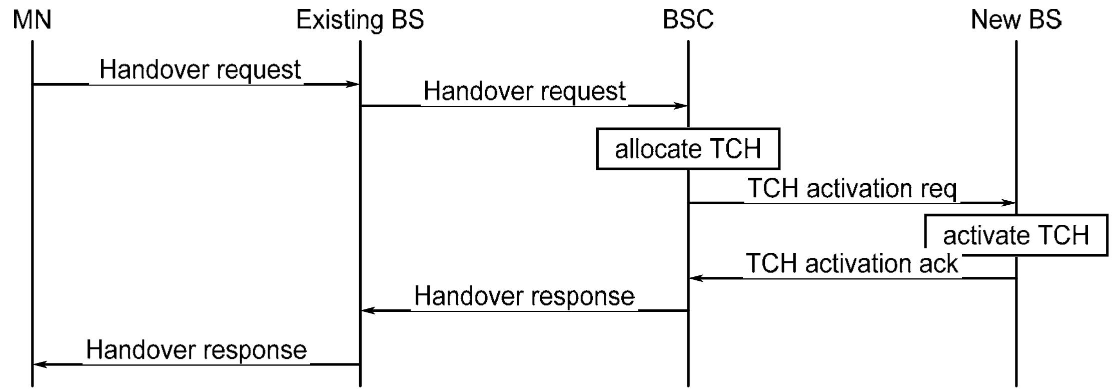

Fig. 2: TCH activation procedure during handover

The registration or handover channel frequency information is stored in BSC. Therefore BSC has the database of used and unused TCH information of every BS belonging to it. If a handover request or registration request is received by BSC then it checks the availability of TCH from its database. If there is no availability then BSC sends negative acknowledgement otherwise it allots a TCH to it.

B. Identification of Neighbouring BSs with some free frequency channel capacity (lightly loaded)

After identifying the fully loaded BS by BSC, BSC collects the neighbouring BSs of the particular BS. This information is available in every BSC. If all the neighbouring BSs are under the same BSC (intra BSC) then the particular BSC itself knew the channel availability of neighbouring BSs. If the neighbouring BS is under a different BSC then BSC sends the utilization request to the new BSC. The new BSC provides the information to the BSC. From this information BSC identifies the BSs which are having availability of TCH (lightly loaded).

C. Identification of MN which is in between fully loaded and lightly loaded BS

For every 480 ms, MN identifies and sends received signal level (RXLEV), received signal quality (RXQUAL) of current communication and received signal level of neighbouring cells (BSs) through Slow Associated Control Channel (SACCH) to its connected BS. BS forwards this information to BSC to initiate handover if needed. If the BS is fully loaded then BSC verifies the SACCH information of MNs which has lightly loaded neighbouring BS identity. If it has then that particular MNs are separated by BSC for next process.

D. Select MNs which are moving towards the lightly loaded BS

To find out location and direction of MN, BSC maintains a database $\{X_i, Y_i, r_i\}$ of BSs located under it and also surrounding BSs which are in the borders of the BSCs, where $\{X_i, Y_i\}$ is the latitude and longitude value of BS_i, r_i is the maximum coverage range of BS_i in kms; i varies from 1 to n (n refers to total number of BSs in BSC zone).

To find out the location and direction of the selected MNs, BSC has to send special location parameter request only to the selected MNs without disturbing MNs under communication.

If the selected MNs has GPS facility then after receiving the location parameter request from BSC, each MN measures its latitude and longitude value [9]. This value is sent to BSC as location parameter response as shown in Fig. 3. The location updation process is repeated for every Δt time interval in BSC. From the consecutive locations BSC identifies the direction of MN.

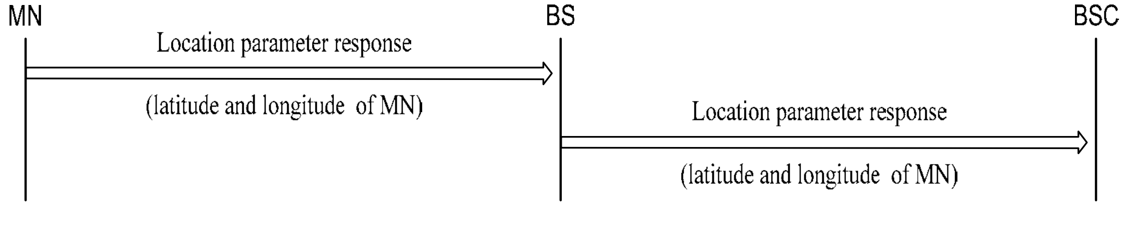

Fig. 3: Special location parameter response if MN has GPS facility

In case if the selected MNs does not has GPS facility, then after receiving the location parameter request from BSC, each MN measures the received signal strength, starting and arrival time of the beacon (Broadcast Control Channel) packets from various surrounding BSs. If the MN has angle sensor then it measures the signal received angle. Then MN sends the location parameters response (signal strength, signal starting time, signal receiving time and signal received angle (if available)) of each BS to the BSC (shown in Fig. 4). BSC finds the location of MN based on RSSI method (with the help of MN received signal strength from various BSs), AoA method (with the help of signal received angle of various BSs) and performs TDoA method (with the help of starting and receiving time of beacons of various BSs) [10]. To improve the accuracy average of the three sets of location (x and y co-ordinates) obtained from RSSI, AOA and TDOA is taken as the exact location of MN. For every Δt time interval the above said process of location identification is repeated and sent as parameters response to BSC. From these consecutive locations BSC identifies the direction of MN [10].

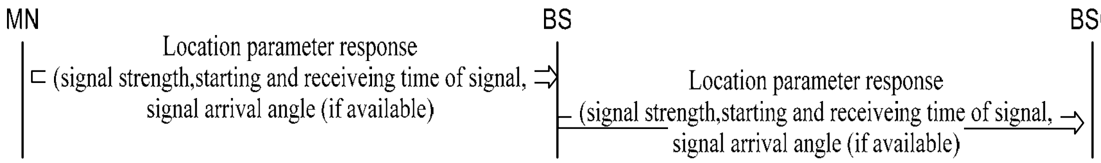

Fig. 4: location parameter response if MN does not has GPS facility

From this information, BSC short lists the MNs which are going towards the lightly loaded BSs. Simulation is done using MATLAB mfile and execution time taken for new BS identification is 246.471 ms.

E. Smooth handover to the short listed MNs

BSC has to perform smooth handover to the short listed MNs before reaching the handover threshold so as to avoid congestion in the network, reduce handover delay and to efficiently utlize bandwidth in the network. BSC allocates frequency channel (TCH) for every short listed MNs and then sends TCH activation message to the concerned BSs to be activated. After activation, BSC sends request to handover along with the new TCH information and new BS identification. After receiving this message MN has to be handed over immediately to the new BSs. Since handover process, including pre-allocation of TCH is carried by BSC, the handover becomes smoother and also in intra MSC handover there is no need of authentication and identity verifications. It consumes lesser time delay. The existing TCH which are allocated to the short listed MNs are released from the concerned BSs. This TCH can be utilized for future work.

IV. SIMULATION RESULTS

The simulation result obtained from yellow jacketsting editor simulator. In Fig. 5, the BSC identifies BS which utilizes frequency channel capacity beyond its limit.

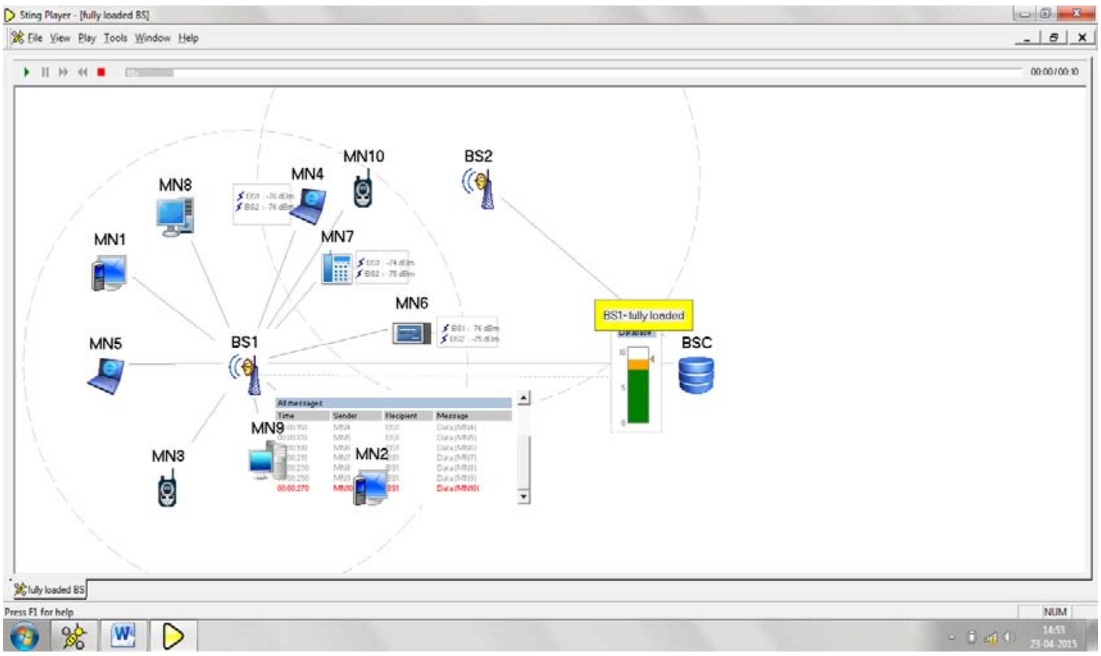

Fig. 5: BSC finds the fully loaded BS

After identifying the border MNs from the SACCH packets, BSC sends special location parameter request to selective border MNs which is shown in Fig. 6. After identifying the direction of MN and availability of frequency channel capacity in the neighbouring BSs, selected mobiles are handed over with new BS which is represented in Fig. 7. The time taken to complete the handover simulation is 1924 ms and the data dropage time is 48ms.

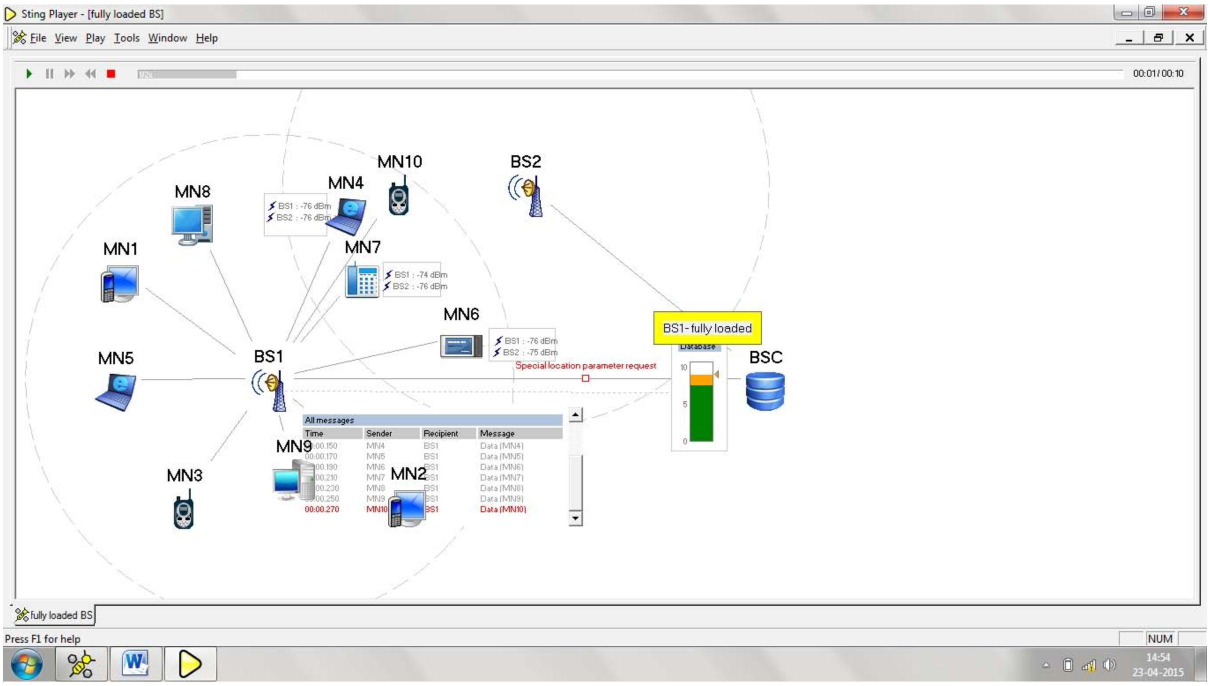

Fig. 6: BSC sends special parameter request to mobile nodes

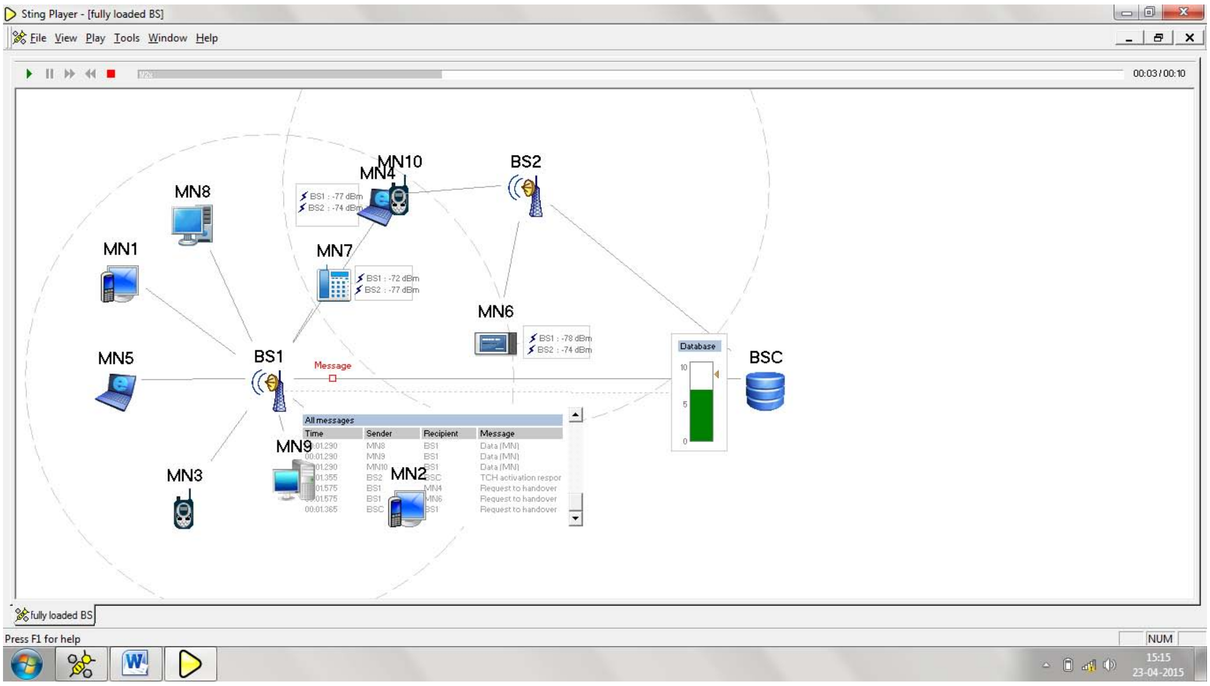

Fig. 7: MNs are connected with new Base Station

V. CONCLUSION

The proposed procedure avoids the fully loaded condition of BS if there is availability of free frequency channel capacity in the neighbouring BS. This procedure efficiently utilizes the network and bandwidth and also improves the overall performance of network. Five sets of samples were used to find out the direction of MN. If number of set of samples is small then the process time is reduced, but increased sets of samples increases the accuracy. The time taken to complete the entire handover process is 1924 ms. The data dropage time taken during this process is only 48 ms. If due to lack of frequency the MN could not handover with the concerned

BS, then MN has to search for other BS. For heterogeneous network, authentication and identity checking process also are done which consumes high data dropage with increased cost. In case of time sensitive application (multimedia, video, on line gaming) QoS is affected. If MN cannot find any BS then the communication will get stopped.

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