Reducing Handoff Blocking Probability in Wireless Cellular Networks using Auxiliary Stations and TDMA

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Abstract - *The wireless communication among mobile users is restricted by frequency spectrum allotted to the network. When a mobile user enters the interference region between cells, the call in progress must be continued by registering to adjacent cell BS, resulting into successful handover. The call can only be continued in case there is free channel available at the base station otherwise the call is blocked. Several approaches have been evolved that aims to reduce the handoff blocking probability to a satisfactory level. The proposed algorithm integrates the concept of auxiliary stations with the TDMA approach to reduce the handoff call blocking probability in heavy network traffic conditions. The auxiliary stations hold these handoff requests while channels associated with the base station is busy and continually checks for the availability of channels at fixed time intervals. TDMA approach divides each channel in the network into time slots and allocating them to requests in some determined fashion. The algorithm is implemented and simulated in MATLAB. The results justify that the handoff blocking rate is reduced to an extent along with better bandwidth utilization provided and avoids network congestion.*

Key Words: **BS, AS, RSS, TDMA, handoff, handoff blocking probability**

1. INTRODUCTION

In a cellular system, distributed mobile transceivers move from cell to cell during an ongoing communication and switches electronically from one cell frequency to a different cell frequency without interruption and without a base station or manual interference. This is termed as the handover or handoff. Stereotypically, a new channel is automatically designated for the mobile unit on the new base station (BS) which will serve it. Therefore, the mobile unit automatically switches from the existing channel to the new channel and communication continues [20].

In cellular networks, blocking occurs when a base station (BS) has no spare channel to allocate to a mobile user or due to frequency interference among mobile users. There are two types of blocking: new call blocking and handoff call blocking. The former refers to blocking of new calls whereas the later refers to blocking of ongoing calls due to the mobility of the users [20]. Typically, on account of negative customer reaction, the rejection of a handover call is considered to be more hostile than the rejection of a new call request [8]. This draws our attention to successful completion of handover calls, contrary to attending new calls.

The exponential growth of users in cellular communication systems imposes the modern communication world to provide extensive information access. This requires increase in cellular network capacity as well as extension of effective call handling procedures to improve bandwidth utilization. Since each mobile cellular network has a predefined restricted range of frequencies, the capacity of the system (i.e. number of channels per base station) is also limited. Hence, efficient channel utilization turns out to be the main factor for the improvement of network performance. [8], [1], [22], [2], [3].

This paper focuses on reducing handoff call blocking probability as well as improves bandwidth utilization in a network. Handoff call blocking probability is reduced using auxiliary station (AS) technique. Auxiliary stations hold handoff call requests for specific amount of time while the channels in base station (BS) are busy [18]. Time split method of channel allocation [15] is employed to provide better bandwidth administrative solution and generate more profit and could connect more number of subscribers [14].

The paper is organized as follows. Section II gives a brief description of call blocking reducing schemes that were evolved and used in cellular network. In section III we present the method and propose algorithm based on it .Section IV present simulation results generated using the proposed scheme and compared with previous existing scheme. Section V gives conclusion and future work perspectives.

2. LITERATURE REVIEW

Reservation based channel assignment technique, according to call duration, assign channel groups to user groups so that short duration calls will not be blocked due to long duration calls. Here long duration calls may get blocked [19].

In hierarchical based scheme dual-band cellular mobile communication network, each macrocell and microcell is served by different base stations which are situated at center. Call is sent to the macro cell, if user's speed is find to be fast, else the call would be sent to microcell to be served. When a call is being sent to the microcell, the required bandwidth of the call is checked if it is larger than the available bandwidth, then the call would be dispatched to the macro cell. But in hierarchical cellular network, problems like call operation and signaling protocol for mobile terminal will become complex [9].

Hybrid channel allocation is the combination of fixed channel allocation and dynamic channel allocation [17]. When a mobile unit needs a channel for its call, and all the fixed set channels are occupied, then channels from the dynamic set is requested. After call completion, base station (BS) must return back channels to MSC otherwise there will not be channels in dynamic set for further requests and call will be terminated [17].

Call blocking can also be reduced using auxiliary stations. When channels of base station (BS) are all occupied, failure probability can be reduced if the handoff request is served by an Auxiliary Station (AS) nearest to the mobile station (MS). The mobile station, being in the auxiliary station, will send requests to the base station within predefined time intervals. If it finds any free channel available in base station, then it will automatically connect with it, eliminating the connection of the auxiliary station (AS). This process successfully reduces the handoff failure probability. But this approach results in handoff failure when all the channels of adjacent AS are busy. Call transfer time is required when nearest AS has no open channels and call forwarded to second nearest AS [21].

If all the channels of AS are busy, then request will send to next nearest AS till free channel get available with BS. When all the AS are busy then connection request will be rejected. To overcome this, an algorithm was presented to allocate AS according to call duration. One AS is assigned for long duration calls and another AS is allocated for short duration calls and if both AS are busy and BS is also busy then received signal strength(RSS) of the MS was checked. If RSS is weak and it is listed with adjacent cell, then MS connection request from AS is dismissed. Otherwise, third AS can accept the incoming connection request. If AS for short duration call and long duration call both are busy and BS is also busy then connection request is handled by reserved AS for some amount of time [18].

In the channel segregation dynamic channel allocation (CS-DCA) algorithm was applied to multi hop direct-sequence code division multiple access (DSCDMA) and DCA failure rate was evaluated [11]. Update search distributed dynamic channel allocation based on combined search and update was proposed [5]. Cross layer resource allocation model was presented where cross layer control algorithm was applied and analyzed resource allocation [12]. Channel assignment to radio interfaces in multi radio multi-channel wireless mesh networks was discussed [23]. Traffic demand model and channel assignment models were proposed, in which channel demand by cells and channel assignment methods are specified [4]. Novel localized channel sharing scheme was proposed to improve system capacity and QOS in wireless cellular networks [13]. In that scheme, channels were shared between adjacent cells. Fixed numbers of adjacent cells were grouped together as meta cells.

Channel reuse and blocking probability was reduced [10]. Bandwidth sharing for real time and non -real time handoff calls was proposed where bandwidth is reserved in more than one cell which is not necessary if the mobile node's future location is predicted properly [6]. The scheme allocated the limited channel bandwidth to satisfy growing channel demand [7]. Frequency allocation at each base station follows the offered load [16]. Another solution considered two types of handover calls. One is Class - I call which was higher priority handover call. Second one is Class - II call which was lower priority handover call. Bandwidth allocation or channel allocation means time slot allocation to the handover calls. Each channel in the cell was divided into six time slots (IS-136 TDMA System). If Class-I handover calls were there, first five time slots were used to accommodate Class –I handover calls. Sixth time slot was temporary time slot. Sixth time slot was used to accommodate the Class-II handover calls and excess Class – I calls temporarily. As soon as the free time slots are available in any of first five time slots, the Class – I calls will be transferred from sixth time slot to free time slot [15].

3. PROPOSED WORK

In this paper, we employ additional stations located in each single cell, called as main cell, along with their respective base stations distributed across the wireless network. An auxiliary station (AS) will hold the handoff requests in case all channels associated with base station are busy and send requests to the base station within fixed time intervals. If it finds any free channel available in base station it will automatically connect with the base station, rejecting its own connection.

Three ASs are placed in the coverage area of main cell as more the number of auxiliary stations; less the number of handoff requests is blocked. The handoff call requests are also classified as long duration and short duration requests. First AS serves long duration calls, second AS serves short duration calls and if both AS for short duration and long duration handoff calls are busy and BS is also busy then connection request is handled by third reserved AS for some amount of time. Reserved AS is used only when both short and long duration AS's channel are fully utilized. If both AS are busy and BS is also busy then received signal strength (RSS) of the MS is checked for the status of request. If RSS is weak and it is registered with adjacent cell then terminate that MS connection request from AS.

A TDMA channel allocation scheme is employed at the time the BS has free channels again and handoff call requests are already held by their consistent auxiliary stations. Now here channel allocation means time slot allocation to handoff requests. Each channel in the main cell is divided into six time slots, where the first five time slots are used to accommodate to short duration handoff requests and sixth time slot is used to accommodate long duration handoff requests.

3.1. Proposed algorithm:

Assume 3 A.S, t –time required by incoming M.S

1. M.S comes under M.C and wants to connect with B.S

2. M.S send request to MSC for checking channel availability

3. If (c! =0) , then connect to B.S

4. else

Check_AS () to perform handoff

a. If (t<=Ti), connect M.S to AS_i

b. else if (t>Ti) , connect M.S to AS_j

5. After fixed time interval check availability of free channels

a. If(c!=0)

i. If calls are of short duration

then allocate channels upto 5 calls

ii. else

allocate 6^{th} time slot to a long duration call

b. else if(Aux(fully utilised)=yes and B.S(fully utilised)) = yes

i. Check if(MS's RSS weak and registered with adjacent cell)

then terminate that M.S connection request from A.S

ii. else if (RSS strong)

then Incoming connection request is handled by AS_k

4. SIMULATION RESULTS

Matlab is used to simulate the result obtained by implementing proposed algorithm in C language. This result is compared with the existing approach without AS and without TDMA based on various parameters i.e. handoff requests serviced, handoff blocking probability and response time.

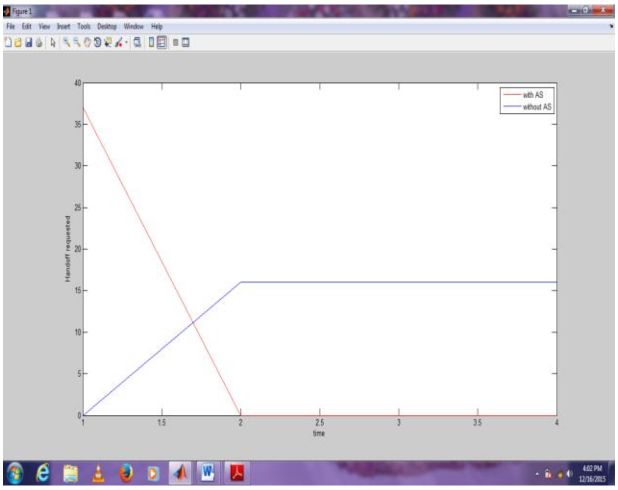

Fig-1: Graph plotted using with AS and without AS approach

Fig- 1 shows relationship between handoff requests serviced with respect to time using with or without AS technique. It is clear from above figure that the number of handoff requests serviced with AS is more than the number of handoff requests serviced without AS.

Table-1: Tabular representation of parameter values

	No of handoff requests	HBP	No of handoff requests	HBP
Without AS	0	1	0	0.68
With AS	42	0.82	37	0

Table-1 stores parametric values obtained in two instances using AS and without AS and seeing these values obtained, we can easily signify the handoff blocking probability is much less in case of auxiliary station. As in case of AS, the handoff requests are queued rather than being rejected and dropped, the expense incurred is low than that of without AS.

Another parameter response time is incorporated to enhance the application of auxiliary station in heavy traffic conditions by time slot division of handoff requests classified as short and long duration requests. When the number of handoff requests exceeds to a huge amount, then the long duration calls mainly cause blocking due to large channel holding time. In that case, short duration calls are dropped though they have completed to major proportion.

Using TDMA approach, the requests held by auxiliary stations are differentiated as short auxiliary station, long auxiliary station and hybrid auxiliary station at their respective base station. Each time slot is simultaneously used between short and long duration calls. When all short and long duration calls have been completed, then the time slot is used by the hybrid calls.

5. CONCLUSION AND FUTURE WORK

In this paper, an efficient algorithm has been proposed that reduces the handoff blocking probability in wireless cellular networks in heavy load traffic conditions. This algorithm has been implemented in MATLAB simulation environment. The algorithm incorporates the use of three auxiliary stations in addition to the base station for serving the incoming handoff requests. The handoff requests are distributed the free channels in the TDMA fashion. However, the probability of complete short duration call is more than that of probability of complete long duration call. The simulation results prove that the bandwidth utilization increases to an extent along with reduced handoff blocking probability.

The technique has been evaluated in terms of time slot allocation of channels to handoff requests. As a future work, this technique can be extended using FDMA approach for allocating handoff requests.

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