Channel Assignment and Minimum Dropping Probability scheme for Handover Calls in Mobile Wireless Cellular Networks

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ABSTRACT

Due to the increase of users' demand for wireless cellular connectivity, service provider is finding difficulty in allocation of resources for mobile nodes. In order to accommodate more number of users, the cell size in mobile wireless cellular networks is being reduced. Because of that bandwidth in each cell has become limited. Due to decrease of cell size, more number of handovers takes place. If bandwidth allocation to these handover calls is not done properly then dropping probability of handover calls will be increased. Also if sufficient bandwidth is not available to new calls, then blocking probability for newly generated calls will be increased. Dropping of handover calls is less desirable than blocking of new calls. Many schemes have been proposed to solve the problem in resource allocation. Presently available solutions are not enough to provide and maintain QOS (Quality of Service) for handover calls. In this paper we propose TDMA based dynamic channel allocation along with bandwidth window in heavy load conditions. We evaluated the performance for dropping probability for handover calls in busy traffic conditions. We applied bandwidth window, where the bandwidth window changes its size according to changing network traffic conditions. With this solution higher priority handover call (multimedia call) will get requested bandwidth, lower priority handover call (Data call) will get minimum bandwidth and probability of dropping of handover calls is reduced to minimum. More number of users will be able to get connected to network and service provider could generate more revenue.

KEYWORDS: *Dynamic Channel Allocation, TDMA, QOS, Handover, Dropping Probability*

I.   Introduction

This section will brief about work done previously by researchers. Demand for wireless connectivity is increased in mobile wireless cellular networks and service providers need to accommodate more number of users within the limited available bandwidth. Allocated bandwidth has to be utilized properly. Wastage of bandwidth leads to reduction in revenue generation for service provider. Bandwidth allocation, efficient resource utilization and management in the cell are the most concerned issues and many researchers proposed solutions in this regard. In [1] 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. Update search distributed dynamic channel allocation based on combined search based and update based is proposed in [2]. Cross layer resource allocation model is presented in [4], where authors applied cross layer control algorithm and analyzed resource allocation. Channel assignment to radio interfaces in multi radio, multi channel wireless mesh networks is discussed in [5]. Traffic demand model and channel assignment model are proposed in [9], in which channel demand by cells and channel assignment methods are specified. Novel localized channel sharing scheme is proposed in [10] to improve system capacity and QOS in wireless cellular networks. In this scheme, channels are shared between adjacent cells, the fixed number of adjacent cells grouped together are called meta cells. Channel reuse and blocking probability is reduced in [11]. Bandwidth sharing for real time and non - real time handoff calls proposed in [12], where bandwidth is reserved in more than one cell which is not necessary if the mobile node's future location is predicted properly. In [13] authors allocated the

limited channel bandwidth to satisfy growing channel demand. Frequency allocation at each base station follows the offered load which is shown in [14]. Time split method of channel allocation [15] provides better bandwidth management solution and proper utilization of resources [16] generates more revenue and could connect more number of users. Bandwidth reservation using GPS system [17] will avoid unnecessary reservations at many neighboring base stations and avoid wastage of resources. Genetic approach of channel allocation for handover calls [19] is one of the solutions based on previous history of calls. This paper is organized as follows. Section 2 talks about different channel allocation schemes in wireless networks, section 3 describes the traditional channel allocation process. Section 4 talks briefly about TDMA IS – 136 Standard. Section 5 presents our proposed solution followed with mathematical model in section 6. Section 7 shows analytical evaluation and simulation results. This paper ends with our conclusions in section 8. This paper is the extended version of our previous work published, where channel allocation is done based on number of handover calls received, applying basic analytical method. In this paper dropping probability of handover calls is evaluated applying extended mathematical solution and both the solutions are based on the same time slot division method and TDMA IS – 136 Standard.
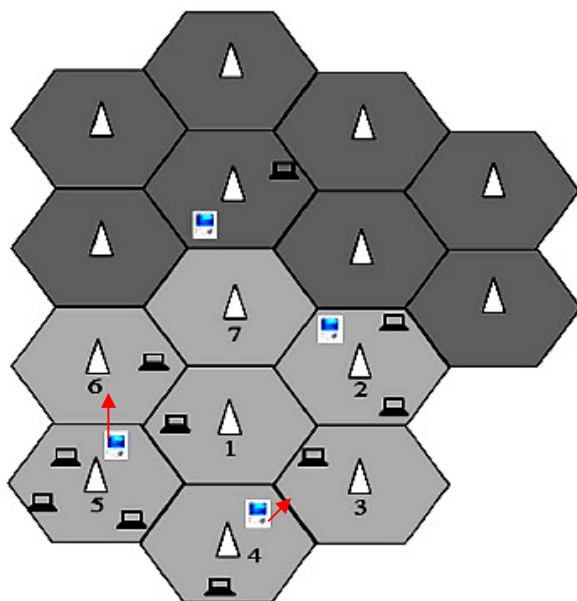

Figure 1. Cellular Architecture

II.   Channel Allocation Schemes in wireless networks

Channel Assignment methods are mainly divided into three categories. 1. Fixed Channel Assignment (FCA),   2. Dynamic Channel Assignment (DCA) and 3. Hybrid Channel Assignment (HCA) and explained briefly as follows.

2.1 Fixed Channel Assignment (FCA)

In this method fixed number of channels are allocated permanently to all the cells, (whether all the channels will be used or not) according to some reuse pattern depending on the desired signal quality. In this method bandwidth will be getting wasted if all the allocated channels are not used and if the channels are not freely available then bandwidth will not be allocated. Various sub methods are being added including barrowing the channels from neighboring cells in order to reduce the dropping probability of handover and blocking probability of locally generated calls. FCA schemes are very simple however they do not adapt to changing network traffic conditions and distribution. In order to overcome these deficiencies Dynamic Channel Assignment (DCA) method has been introduced.

2.2 Dynamic Channel Assignment (DCA)

In DCA all channels are stored in a central pool and assigned to cells whenever new calls arrive, by following the CIR criterion. After the call is completed channel will return back to central pool. DCA scheme provides flexibility and traffic adaptability. Dynamic channel allocation (DCA) method will provide better Quality of Service (QOS) than FCA method, because channels are assigned only upon demand and capacity requirement of the mobile node in cell. With this DCA method, bandwidth in the network will be utilized properly. DCA scheme is less efficient than FCA Scheme under high load traffic conditions. To overcome this drawback Hybrid Channel Assignment (H C A) techniques are applied by combining FCA and DCA schemes.

2.3 Hybrid Channel Assignment (HCA)

The HCA, method is the combined techniques of FCA and DCA. In this scheme, total numbers of channels are divided into two sets. One is fixed and other one is dynamic. Fixed set contains number of nominal channels assigned to cells as assigned in FCA Scheme. Dynamic set of channels are shared by all users in the system.

III. Channel Allocation Process

This section will brief the common channel allocation process. In general, mobile node (Mn) first initiates the call to the base station in the cell through signaling channel. Base station will look for the availability of requested bandwidth. If enough bandwidth is available, that will be allocated as traffic channel. If free channels are not available, then mobile node will be blocked. When mobile node (Mn) migrated to new cell, base station in this new cell will allocate channels as per bandwidth requirement of the user and channels in old base station will be disconnected. If no channel is available or no channel is allocated during the waiting time then handover call will be dropped.
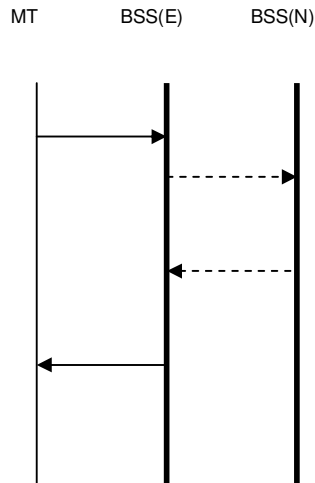

Figure 2. Communication between mobile node and Base station

IV. TDMA IS – 136 Standard

Since we applied TDMA IS – 136 technology in this paper, to explain in detail is out of scope of this paper, but it is briefly mention here, some important aspects of TDMA IS – 136 standard. Wireless cellular systems ran under capacity limit during 1990, due to the demand for wireless cellular network need was increased. Survival and growth of service provider is to accommodate more number of customers within the limited radio spectrum has become a greater issue and concern. There are two capacity issues were discussed. One is voice channel capacity and another one is control channel capacity. Voice channel capacity was increased by dividing the radio channel into time slots and control channel capacity was increased by adding Digital Control Channel (DCCH). This standard allows flexible use of radio spectrum which helps the service provider in accommodating more number of calls. There are two types of channel usage is defined in IS – 136 standard. One is Full rate

IS – 136 system and another one is Half rate IS – 136 system. In the following figure 3, it is shown that, full rate TDMA channel is divided among three customers (mobile nodes), where each mobile node transmits data at every third time slot. Where as in half rate TDMA, channel capacity is doubled by dedicating only one slot per frame per customer, demonstrated in following figure 4, [8]. Newer IS – 136 version and IS – 136HS standards defined to facilitate enhanced data rates.
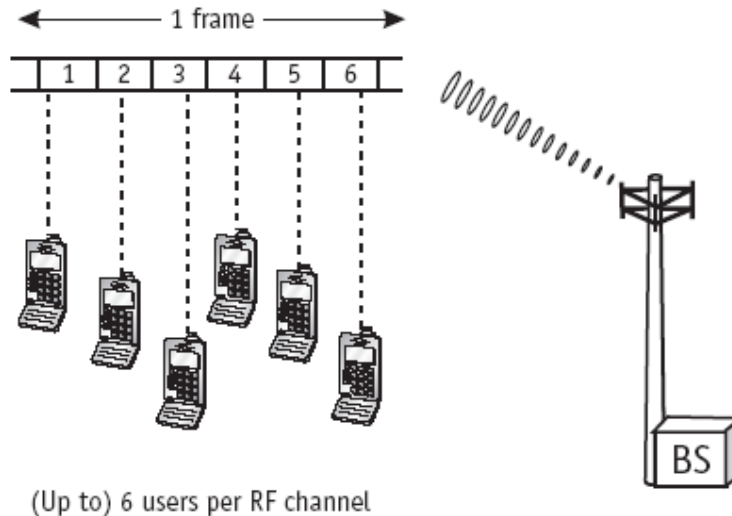

Figure 4. TDMA IS – 136 half rate [8]

V.   Proposed Solution

This paper is the extended version of our previous work published, where channel allocation is done for handover calls and in this paper dropping probability of handover calls is presented. In our proposed solution, we considered two types of handover calls. One is Class – I call which is higher priority handover call (video or multimedia call). Second one is Class – II call which is lower priority handover call (usually data call). In our solution bandwidth allocation or channel allocation means time slot allocation to the handover calls. Each channel in the cell is divided into six time slots (IS-136 TDMA System). If Class – I calls are there, first five time slots are used to accommodate Class – I handover calls. Sixth time slot is temporary time slot. Sixth time slot is 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. When ever handover calls arrive at the cell, base station in the cell will identify the number of Class – I calls and number of Class – II calls. First five time slots will be assigned to five Class – I calls. Remaining Class – I calls will share the sixth time slot along with Class – II calls. It means sixth time slot will be divided into sub time slots and assigned to remaining calls. If number of Class – I calls are less than five, then remaining time slots after Class – I allocation will be divided into sub time slots and assigned to remaining calls. In this paper we considered two types of outgoing calls, one is call completion call and second one is depart call which is migrated to neighboring cell. Two types of incoming calls are considered, one is handover call and another one is locally generated call, which is initiated with in the cell. Our focus in this paper is to allocate and manage the bandwidth to handover calls [15]. Bandwidth window is used in this paper and changes it's size according to changing network traffic conditions. In the following figure 5, it is demonstrated that, bandwidth window increased until four, it means four Class – I calls occupied four time slots and time slots five and six are assigned to Class – II calls. Bandwidth window will help the base station system and handover calls to take appropriate action. Dropping probability for handover calls is evaluated and analysed in next sections.
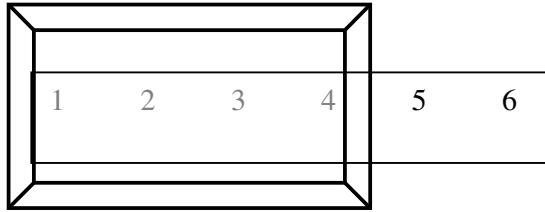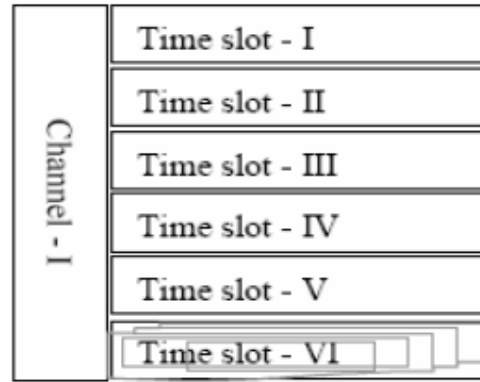
Figure5.Bandwidth window

Figure6. Time slots in a channel

Proposed Algorithm

BEGIN

   If calls are Class – I calls then
                    If channels are available then
                       Allocate channels up to 5 calls
                    Else divide 6th channel with (no.of Class – I + no.of Class – II calls) and allocate
Else add all available channels and divide among no. of class – II calls

END

VI.   Mathematical model

Sample space Ω = All randomly generated mobile nodes = {m1, m2, m3,……}
          Ω = {m │ m $\in \Omega$}
Set A is a group of Class – I calls
Set B is a group of Class – II calls
A $\subset \Omega$ and B $\subset \Omega$
We can consider the set S of all x elements (mobile nodes) that have a certain property P, and denote it by
S = {x | x satisfies P}.

A = {mc1 | mc1 is full slot t}.
B = {mc2 | 0 ≤ mc2 ≤ t}

P(Ω) = P(A)+P(B)

Total Calls Ω = {A1,A2,A3,……, An, B1, B2, B3……..Bn} ----------------------(1)
Class – I = A = {A1,A2,A3,……An} --(2)
Class – II = B = {B1,B2,B3,….Bn} --(3)
Maximum five slots are assigned for Class – I calls, excess Class – I calls will share with Class – II calls.

A = {A1, A2, A3, A4, A5} ----------------------------(4)
B= {A6, A7, ….B1, B2, B3, …Bn} --------------(5)

No.of channels allocated for Class – I calls = Bw1   (Bw1 ≤ 5) -------------(6)

No.of channels allocated to Class – II calls = (6 –BW1)*10 ------------------(7)

Total Timeslots (Channels) created = Bw1 + (6 –BW1)*10 ------------------(8)

Minimum channel capacity fixed is 0.1 unit for Class - II calls.

$$\text{Dropping probability } (P_d) = \frac{\text{Total Handover Calls} - \text{Total time slots}}{\text{Total Handover Calls}} \quad \text{........ (9)}$$

Assuming number of Class – I calls > Number of available channels in overload condition.

No. of available time slots ≤ 5 (as per IS-136 TDMA System from 6 timeslots, 5 slots are utilized by Class – I calls)

VII.   Analytical Evaluation

Performance is evaluated for single channel in cell. Single channel is divided into six equal duration time slots. Channels are allocated for Class – I calls, from first five time slots and remaining time slots are allocated to Class – II calls. If Class – I calls are more than five then five class – I calls will take first five time slots and remaining Class – I calls join with Class – II calls. Simulation results in figure 7 have shown that number of Class – I Calls and Class – II calls gradually increased with time, but dropping probability is maintained between 0.02 and 0.2.
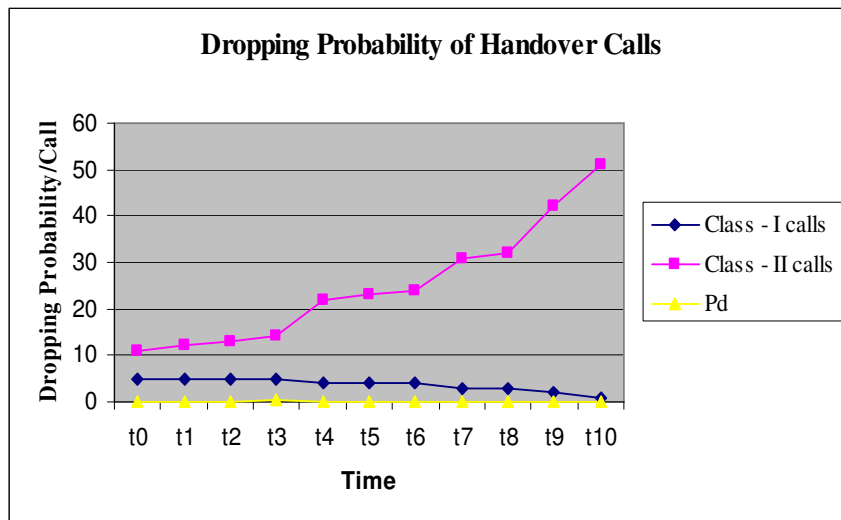

Figure7. Dropping Probability

Because sub channels are created in sixth channel in order to accommodate maximum number of handover calls with minimum 0.1 unit sub time slot. Excess Class – I calls which are accommodated along with Class – II calls with minimum slot duration during first interval of time will be given preference to get full time slot in next interval of time.

It is found that, even though total calls are increased to more than fifty, still dropping probability is at the acceptance level. It is demonstrated in figure 8, that the number of handover calls, dropped is very less in number during peak time. When Class – I calls are reducing and Class – II calls are increasing in number, dropping probability is very minimum, because more number of channels are created to accommodate Class – II calls and it is in figure 9. During peak time, traffic in network is increasing with time and new channels with minimum duration time slots are also created accordingly which is shown in simulations in figure 10.
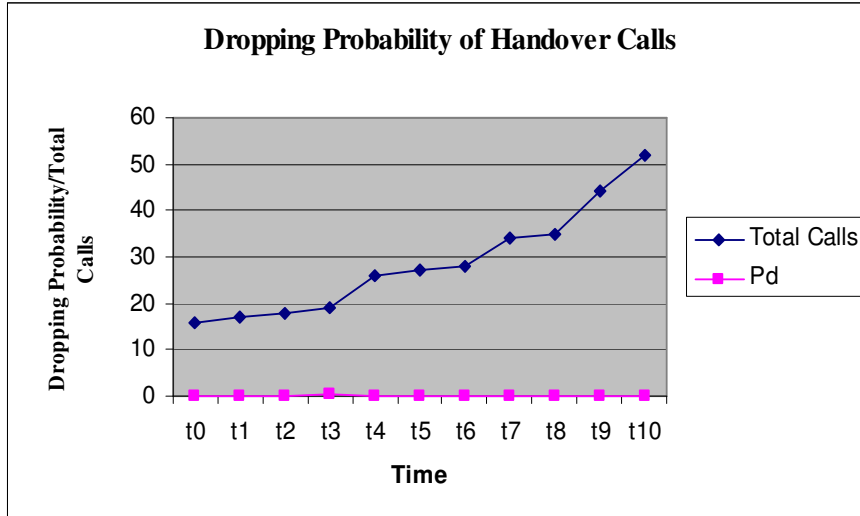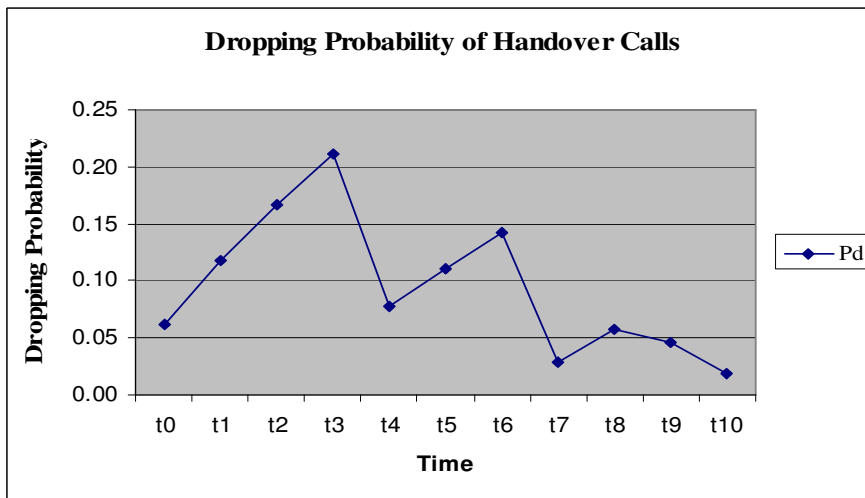
Figure8. Dropping Probability
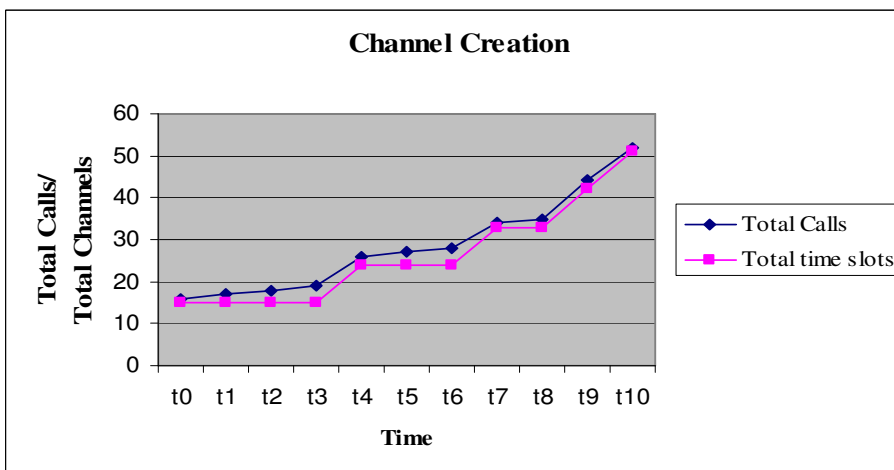

Figure9. Dropping Probability

Figure10. Channel creation

VIII.   Conclusions

In this paper, solution for channel allocation and evaluation of dropping probability to mobile nodes in heavy traffic load conditions is proposed. In our solution bandwidth window is used to indicate the occupancy and availability of channels and widow size varies as per the traffic conditions in the network. Bandwidth window helps the base station system and mobile nodes in taking appropriate action in channel allocation. Simulation results show that, Higher priority handover call (Class – I call) gets requested bandwidth without any difficulty and Lower priority handover call (Class – II call) will get minimum bandwidth in worst case scenario. Dropping probability is decreased to minimum and Quality of Service (QOS) could be maintained. With this proposed scheme 100% cell bandwidth could be utilized and wastage of bandwidth could be avoided. More number of users will be able to get connected which will help the service provider in generating more revenue.

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