The Performance Evaluation of Hybrid Channel Allocation Strategy in Cellular Networks

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ABSTRACT
One of the main goals in cellular network design is to provide high quality and efficiency of communications using limited resources, such as an available radio bandwidth. The role of channel assignment strategy is to allocate channels to cells in such way as to minimize call-blocking probability or call dropping probability and also maximize the quality of service. Different strategies have been proposed to optimize the utilization of the spectrum. The main strategies are fixed channel allocation (FCA) strategy and Dynamic channel allocation Strategy (DCA). In this paper we have analyzed the call blocking probability using Hybrid Channel Allocation (combination of FCA and DCA). In HCA the ratio between fixed to dynamic channels is an important parameter and it depends on traffic load. The results show that HCA gives better performance that too with more number of dynamic channels than fixed channels. The simulation has been done in matlab software.

Keywords – Fixed channel allocation, Dynamic channel allocation, Hybrid channel allocation, blocking probability, delay probability

I. INTRODUCTION

The radio spectrum allocated to wireless cellular mobile communication system is fixed one. Efficient use of available spectrum will produce an increased number of users. The fundamental operational principle of wireless cellular mobile communication system is the reuse of frequencies at different places within the areas of service. The channel allocation strategy is the technique used to make the most efficient and intelligent way of utilizing the available radio spectrum by the way in which channels are allocated to mobile multimedia calls. The channel allocation strategy is the soul of all portable communication systems. It affects not only the quality and availability of connections but also the traffic distribution which, in turn, affects the capacity of the system.

The Channel allocation strategies [1] are broadly divided into two types : Fixed channel allocation (FCA) and Dynamic channel allocation (DCA).Another type of channel allocation strategy is also available known as Hybrid channel allocation which is the combination of both FCA and DCA. The

Quality of service (QoS) is the major issue for these applications in any kind of communication networking environment [2]. The Hybrid channel allocation is another strategy which can give better quality of service there by reducing the call blocking probability. In this work the quality of service is decided by the blocking probability of calls in respective strategies. The other parameters such as delay Probability [2,3].

The rest of the papers is organized as follows: Section II describes the channel allocation strategies FCA, DCA and HCA. Section III gives the overview of the parameters that are used for simulation such as blocking probability, delay probability, bandwidth utilization etc. In section IV the network model assumed and the simulation results are described. Finally section V gives the conclusion.

II. CHANNEL ALLOCATION STRATEGIES

Channel allocation deals with the allocation of channels to cells in a cellular network. Once the channels are allocated, cells may then allow users within the cell to communicate via the available channels. In cellular communication, various channel allocation schemes have been proposed [1, 4,5].
They are
1. Fixed channel allocation (FCA),
2. Dynamic channel allocation (DCA),
3. Hybrid channel allocation (HCA).

1. Fixed channel allocation

In FCA, [4,5] channels are allocated to each cell in advance according to the estimated traffic intensity in the cell. In each cell. a channel is assigned to communicate between the BS and MS out of the allocated channels. This permanent assignment of channel sets requires extensive frequency planning and maintains a constant frequency reuse distance for all cells. This permanent allotment of channels is efficient if the traffic distribution of the system is also uniform. The non-uniform nature of motorway traffic which causes spatial and temporal fluctuations can result in a poor network performance in one cell due to lack of channels while other cells posses unused channels.

2. Dynamic channel allocation

In a dynamic channel assignment strategy [4, 5,6], voice channels are not allocated to different cells permanently. Instead, each time a call request is made, the serving base station requests a channel from the MSC. The switch then allocates a channel to the requested cell following an algorithm that takes into account the likelihood of fixture blocking within the cell, the frequency of use of the candidate channel, the reuse distance of the channel, and other cost functions. Accordingly, the MSC only allocates a given frequency if that frequency is not presently in use in the cell or any other cell which falls within the minimum restricted distance of frequency reuse to avoid co-channel interference. Dynamic channel assignment reduce the likelihood of blocking, which increases the trunking capacity of the system, since all the available channels in a market are accessible to all of the cells. Dynamic channel assignment strategies require the MSC to collect real-time data on channel occupancy, traffic distribution, of all channels on a continuous basis. This increases the storage and computational load on the system but provides the advantage of increased channel utilization and decreased probability of a blocked call. Dynamic Channel Allocation (DCA) attempts to alleviate the problem mentioned for FCA systems when offered traffic is non-uniform. In DCA systems, no set relationship exists between channels and cells. Instead, channels are part of a pool of resources. Whenever a channel is needed by a cell, the channel is allocated under the constraint that frequency reuse requirements cannot be violated.

3. Hybrid Channel Allocation

Hybrid channel assignment schemes [4, 7] are a mixture of the FCA and DCA techniques. In HCA, the total number of channels available for service is divided into *fixed* and *dynamic* sets. The fixed set contains a number of nominal channels that are assigned to cells as in the FCA schemes and, in all cases, are to be preferred for use in their respective cells. The second set of channels is shared by all users in the system to increase flexibility.

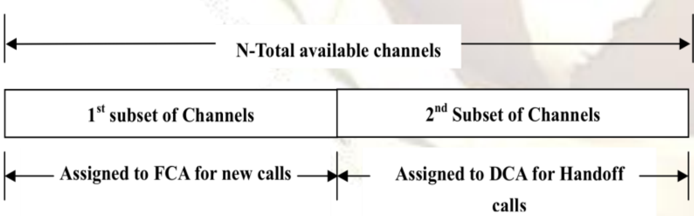

Fig:1.Channel Division In HCA

when a new or handoff call arrives at the cell BTS, the first attempt to serve, it is by a nominal or fixed channel, if there is no fixed free channel, then a channel from a dynamic set is assigned to the calls. If this also fails, then the call is blocked. The ratio of fixed to dynamic channel, is a significant parameter that determines and defines the performance of the system in much, the same manner that the ratio of nominal to borrowable channels defines the performance of a strategy with channel borrowing. In general, the fixed to dynamic ratio of the channel is a function of the traffic load and would vary over time according to the offered load distribution estimations.

III. PARMETERS FOR SIMULATION

In this paper, all the discussions are based on the following suppositions [8] :

The total number of available duplex channels in the whole cellular system is M. Given a cellular mobile system which has a total of M duplex channels available for use, if each cell is allocated a group of ***k*** channels *&<M),* and if the *M* channels are divided among ***N*** cells into unique and disjoint channel groups which have the same number of channels each, the total number of available radio channels can be expressed as

$$M=kN$$

The ***N*** cells which collectively use the complete set of available frequencies is defined as a cluster *{C,,C,, ..,C,,,).* N is called cluster size or cell reuse factor.

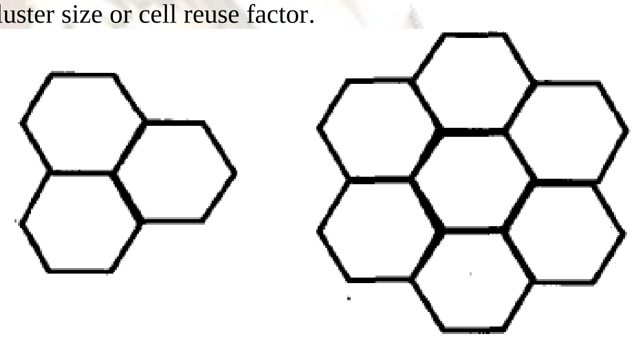

Fig2 : Illustration of cell cluster N=3 & N=7

It is assumed that call arrives according to the Poisson distribution. Simply, we suppose in each cell of the whole system,the average call arrival rate is the same, represented by **A ,** so **we** can obtain the probability distribution

$$Pr = \{a(t+\tau) - a(t) = n\}$$
$$= e^{-\lambda t} (\lambda t)^n/n!$$
$$\text{For } n= 0,1,2\ldots..$$

where *a(t)* is the number of arrivals that have occurred since **t=0** and **λ** is the call inter-arrival time. If a call is blocked, it will be cleared immediately. That is, there is no queuing in the trunking model, where *ErlangB* formula [2,3] can be used. Call duration times are assumed to be exponential with mean call duration *H*, and **μ**=*1/H* is the mean service rate. The probability density function of the service time is

$$P(S_n) = \mu e^{-\mu s}$$

In FCA strategy each cell is allocated a group of ***k*** channels ***k=M/N).*** The traffic load in each cell can be expressed as

$$A_{per\ cell} = \lambda/\mu \text{ (Erlang)}$$

As each cell in the system is supposed to be the same, the call blocking probability for each cell is also the same, which can be obtained by the *ErlangB* formula as below [2, 3]

k

$$P_b(FCA) = A^k/(k! \sum_{j=0} A^j / j!)$$

where ***A*** is the total traffic load of the cell and ***k*** is the number of usable duplex channels which is allocated to the cell by FCA strategy. The number of the total cells in the system is ***N*** and channels in the system cannot be reused. As a result, the total traffic load within the cluster is

$$A_{total} = N.\lambda/\mu \text{ (Erlangs)}$$

the total number of available channels in the cluster is *M*, which equals ***k*** times ***N.*** The average block probability under the basic DCA principle can be obtained

$$P_{b(DCA)} = (NA)^{(Nk)} / ((Nk)! \sum_{j=0}^{Nk} (NA)^j / j!)$$

where ***A*** is the average traffic load in each cell, ***N*** is the cluster size, and ***k*** is the number of available channels in each cell in the case of Fixed Channel Allocation. Another parameter called delay probability [9] is used to calculate the probability of a call being in wait state before allocating the channel. This is given by Erlang C formula.

IV. SIMULATION RESULTS

The Network model assumed for the simulation purpose is of cluster size N=3 and N=7. The number of channels allocated to each cell is 10 (k=10). The traffic load is being varied and the blocking probability is calculated for FCA and DCA with different cluster size.

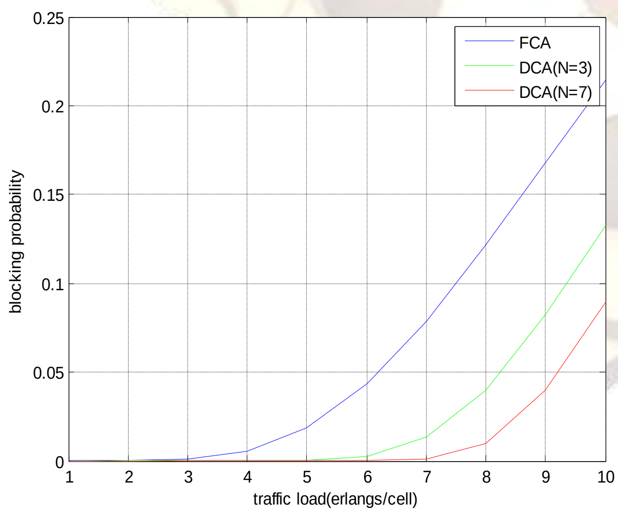

Fig 3: Comparison of FCA and DCA with N=3 and 7 with k=10

The figure 3 shows that the DCA performs better with less blocking probability than FCA and as cluster size increases the blocking probability is further reduced.

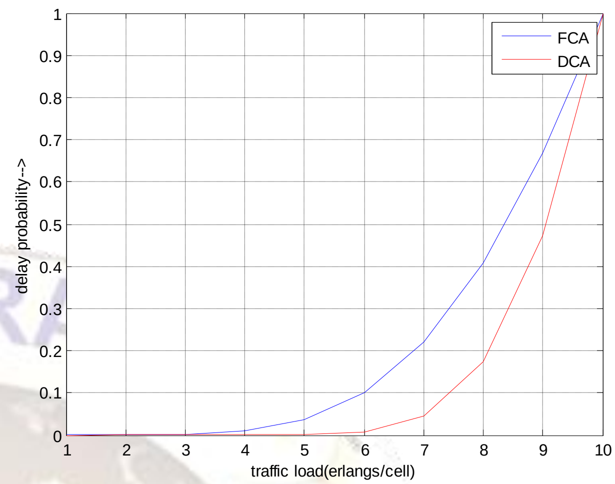

Fig 4 : Comparison of delay probabilities with traffic load

The figure 4 shows the variation of delay probabilities with increase in traffic load. As the load increases the delay is also increased. The delay probability in DCA is less than FCA and it accounts to the fact that the channels are not permanently assigned to the users and they are retained in DCA strategy.

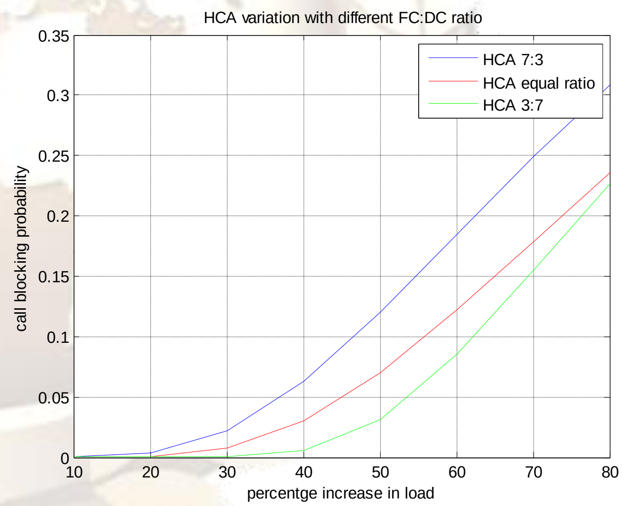

Fig 5 : HCA strategy with different FC:DC ratio

The figure 5 shows the blocking probability curves of HCA strategy with different FC:DC ratio's. It is evident from the figure that as the ratio of dynamic channels is increased the blocking probability is reduced. Also as the load is increased the blocking probability is increased. So in HCA first the fixed channels are utilized and then the dynamic channels will be used, so the blocking probability is reduced than in FCA and DCA independently.

V. CONCLUSION

A hybrid channel allocation strategy uses co-channel as criterion and assigns co-channel to cells placed near the central pool at MSC. In this paper for HCA the channels are divided into two sets and one set for fixed channels and other for the dynamic channels. Based on this ratio of channels the blocking probability is calculated and it is observed that as number of dynamic channels increases the call blocking probability is reduced. The main advantage of this method is that HCA adopts to FCA at lower traffic load and to DCA at higher traffic loads there by providing better quality of service than the other channel allocation strategies. Further the HCA can be analyzed over other parameters and can be combined with genetic algorithms and neural networks for much better performance.

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