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Review of Fixed Channel Assignment in Mobile Communication Systems

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Abstract— *The radio spectrum is limited. But there is a rapid advancement in mobile communication system. Therefore we should pay attention towards effective methods for proper management of existing radio spectrum. The number of channels available is not at all sufficient to meet the needs of the populated users. Thus the core point here is that we need to employ quite effective channel allocation schemes. In this paper, we have prearranged the comprehensive information about fixed channel allocation in cellular mobile network by reviewing some of the earlier studies. We have also given our opinions, comments as well as all possible advantages and disadvantages of all the reviewed articles.*
Keywords— Fixed Channel Allocation, Handoff, Channel Borrowing, Congestion, Blocking probability.

I. INTRODUCTION

The popularity of mobile phones is increasing Day by day because of the fast advancement of mobile technology. The network used in mobile communication system is termed as cellular Network. The number of channels assigned to a particular base station or cell is quite insufficient. So the effective management in channel allocation and maximum employment of Available bandwidth is the core issues to consider for a better and satisfactory communication.

There are basically two types of channels in cellular mobile communication system. The first type of channel is known as communication channel which are used for establishing connection or communication in a cell.

The second type of channel is called as control channel which are used to send messages that are generated by the channel allocation algorithm. There are many channel allocation schemes available. These schemes are generally classified into three Categories: Fixed channel allocation (FCA), Dynamic channel allocation (DCA) and Hybrid channel allocation (HCA).

II. FIXED CHANNEL ALLOCATION (FCA)

Fixed Channel Allocation (FCA) systems Allocate Specific channels to specific cells. This Allocation is static and cannot be changed. When a call is initiated by a user, it will search a free channel in the cell Where the user is present. If free channel is available in that cell then it will be assigned to that call otherwise the call will be blocked. For efficient operation, FCA systems typically allocate channels in a manner that maximizes frequency reuse. Thus, in a FCA system, the distance between cells using the same channel is the minimum reuse distance for that system. Reusability of same channel by different cells is advantageous and permissible. But the distance between the two cells should be more than a minimum reuse distance D_{min}.

If the distance is less than D_{min}, then interference will occur. Such interference is known as co-channel interference. A cell Cx is said to be an interference neighbors of another cell Cy, if geographical distance between them is less than minimum reuse distance D_{min}.

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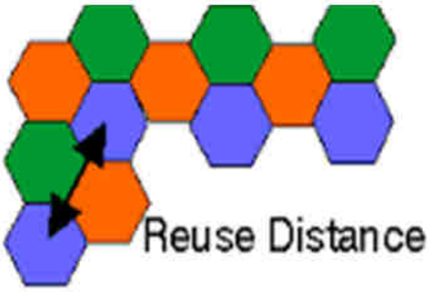

Fig.1: depicts fixed channel allocation with reuse distance.

III. TYPES OF FCA BASED ON TRAFFIC

There are two types of fixed channel allocation Schemes based on traffic. They are FCA with uniform traffic and FCA with non-uniform traffic. In FCA with uniform traffic, the number of active users in each cell is the same and it remains constant with time. But in nonuniform traffic, the number of active users in each cell is not constant with time.

3.1 Advantages of FCA In Uniform Traffic

The FCA strategy is simple to implement if the Traffic is uniform. It is also an optimum channel allocation strategy. It is widely used in the cellular networks because of its simplicity. In addition, FCA has the advantages of maximizing the utilization of wireless channels. It is better under heavy traffic load. It is suitable for microcellular sized cells.

3.2 Disadvantages of FCA in Uniform Traffic

The main disadvantage of FCA in uniform

Traffic is the increased dropping rate of handoff calls. Let us consider a mobile network in which FCA strategy is used. The traffic is also assumed to be uniform. In many situations, this traffic can be turned into nonuniform. The fixed number of channels assigned to all cells will be sufficient sometimes and insufficient some other times depending on the traffic load. In the light traffic cell the free channels are available but due to the adoption of FCA we cannot use them effectively. Irrespective of this limitation, FCA scheme is widely used today.

3.3 Requirement of Non Uniform Allocation of Channels in FCA

To equalize the utilization of channels in all Cells, the obvious solution is that the cells with higher traffic load should somehow use the free channels available in low traffic cells. This is possible by a non uniform allocation of channels to cells.

3.4 An Investigation of a Non Uniform Compact Algorithm

Algorithms that distribute channels among the cells according to their traffic load have been investigated. A *non uniform compact channel allocation algorithm* is discussed in [3]. Results of example simulations in show that non uniform distribution of channels adopted by this algorithm provides better call blocking probabilities in the system.

The reduction in call blocking probabilities allows an average of 10 percent and maximum of 22 percent traffic to be added to the system while maintaining the same call blocking probability as that of uniform channel allocation. It should be noted here that channels are permanently allocated to cells and this corresponds to After reviewing this algorithm, we have seen that the non uniform channel allocation is quite Complicated. The traffic load in a particular cell is not a stationary factor. It will vary time to time which will reduce the performance of the above algorithm. The variables namely the number of channels per cell and the cost function to be minimized is the probability of call blocking. This has a very complex expression involving cell A these variables. The minimization process is far more Complex than the uniformly distributed traffic case for which we know that the same number of channels per would provide the minimum blockage rate. The regular frequency reuse patterns become much more complex as we start thinking of unequal number of channels per cell. With a non uniform channel allocation technique, we need to include the call blockage Probability as a criterion for the above channel allocation algorithm. Because the relation between the number of channels and the call blockage probability is a complex function, the above algorithm sounds more complex.

IV. CHANNEL BORROWING TECHNIQUES

A simple scheme enables high-traffic cells to Borrow channel frequencies from low-traffic cells. These techniques are usually referred to as *channel borrowing techniques*. We have reviewed a channel borrowing technique [5]. The technical issues are how can we relate the traffic distribution to the channel allocation?

And which cell should we borrow the channels from?

There are two methods to borrow channels: *temporary channel borrowing* and *static channel borrowing*. In static channel borrowing, the channels are not uniformly distributed among cells according to the available statistics of the traffic and changed in a predictive manner. Temporary channel borrowing deals with short- term allocation of borrowed channels to cells. Once the call associated with the borrowed channel is completed, the channel is returned to the cell from which it was borrowed.

A number of methods for selecting free channels from a lightly loaded cell for borrowing by another cell are summarized in [4]. These methods either make all channels

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available for borrowing (this is called simple borrowing schemes) or they partition the channels into borrowable and non borrowable (such schemes are referred to as hybrid borrowing schemes).

The simulative result in [5] shows that simple Borrowing schemes are found to be better under light or moderate traffic loads. A quantitative comparison of some of these techniques is provided in [6].

After reviewing these articles we have found the problems in these techniques that some channels May not be in use and others may be continually in use. Depending on how often a channel is used and where it is used, it may cause a high or low interference to its co-channel elsewhere. We have taken an example to illustrate this problem. Suppose the cell A in the central cluster in Figure [2] borrows a channel from the solid-shaped cell F within its cluster to accommodate extra traffic load.

This means that the corresponding channel in three Cells labeled F and cross-hatched in neighboring clusters are locked until this channel is released by the cell A.

This is because the reuse distance for the borrowed Channel has decreased since it has been moved from the solidly shaped cell F, to the cell A.

FCA. The general idea is to increase the number of channels in cells with the higher traffic load and decrease it in cells with a lower traffic load so that the overall blockage rate of the network is minimized.

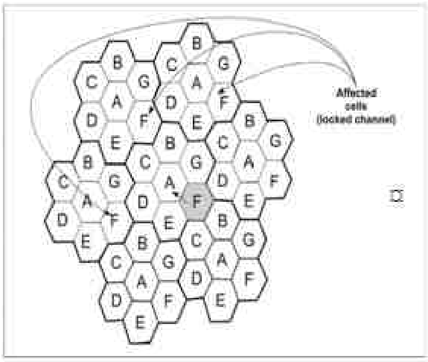

Fig.2: Temporary Channel Borrowing

Some of the suggested borrowing techniques are found to be capable of supporting up to 35 percent more traffic than uniformly distributed FCA. Channel borrowing schemes; however, require additional computational complexity and frequent switching of channel. They may also affect handoff strategies.

V. HANDOFF & FRESH CALLS

In general, it is less desirable to drop a *handoff* Call than to block a fresh call. The dropping probability of *handoff* calls is considered as one of the major metrics that measures the QoS. It is fine, if a *fresh* call is not initiated due to unavailability of channel. But a *handoff* call should not be dropped at any cost. Therefore so many recent research works were carried out on various channel allocation schemes to bring down the dropping probability of *handoff* calls [7], [8], [9], [10]. *Handoff Queuing Scheme* (HQS) is one of that. According to this Scheme, whenever a user moves from a particular base station (BS) to another base station, the received signal strength of the old base station will be decreasing gradually. So at this time a hand off operation will be started. The direction of the base station where the user is moving towards will be identified. If it is found That there is free channel in that base station, then the call will be transferred from the old base station to the new base station with the assignment of the free channel available in the new base station.

When there is no free channel in the new base Station, the handoff call will be kept in a queue.

As soon as a channel is released, it will be assigned to this call. When there are so many handoff calls in the queue, first in first out queue policy will be adopted. According to this policy, the first released channel will be allocated to

Queue, *first in first out queue policy* will be adopted. According to this policy, the first released channel will be allocated to the first *handoff* call in the queue. Then the second released channel will be assigned to the second *handoff* call, and so on. This process will continue till all the *handoff* calls are allocated with released channels. No *fresh* calls in the new base station will be initiated during this period.

After going through this *Handoff Queuing Scheme*, we could conclude that higher priority is given to handoff calls than fresh calls. This scheme not only decreases the dropping probability of handoff calls but also increases the dropping probability of fresh calls. Actually, in one way it is better and effective. But the overall performance of the system is decreased because it neglects the fresh calls under some situations. So we suggest that care should be taken to increase the customer satisfaction in fresh calls to some more extent. *Guard Channel Scheme* (GCS) is another channel allocation strategy where more importance is given to handoff calls than fresh calls. According to this scheme, a fraction of wireless channels are kept reserved only for handoff calls in each base station (BS). These channels are referred as *reserved channels.* The remaining channels, known as *normal channels* are kept for handoff as well as fresh calls. Initially, all the normal channels are assigned to all kinds of calls until they are finished. All fresh calls will be blocked afterwards. But the reserved channels will be assigned to handoff calls only. The number of channels that should be set aside for handoff calls depends on a lot of parameters such as, the call arrival statistics, the call duration statistics, mobility of the MSs and so forth.

We can conclude that this *Guard Channel Scheme* (GCS) in the positive side reduces the dropping -probability of handoff calls (handoff *call -congestion*). However, we can clearly see one thing here that a fresh call is blocked if there are only reserved channels left even though no handoff calls exist. So this scheme fails To bring an increase in total channel utilization. This scheme also fails to satisfy fully the fresh call customers by blocking the calls even though reserved channels are available.

In *Guard Channel Scheme* (GCS), the normal channels are shared by handoff and fresh calls. But the guard or reserved channels are kept exclusively for handoff calls. A fresh call will be blocked if there are no free normal channels even though reserved channels are available which is not effective. So the free reserved channels can be wisely used in a *dynamic channel reservation scheme* (DCRS) based on user movements [11]. The guard -channels can also be assigned to the fresh calls whose request probability is a function of the mobility of users. If there is no arrival of the handoff calls, the request probability will be one, and the guard channels will be used by the fresh calls. If there is no arrival of fresh calls, the request probability will be zero, and the guard -channels will be used by the handoff calls. When the arrival rate of handoff calls is larger than that of fresh calls, the request probability is decreased quickly and when it is lower the request probability is decreased slowly.

After reviewing this scheme, we are quite glad to find that the fresh calls have a chance to use available guard -channels. This scheme aims to reduce the blocking probability of fresh calls. At the same time it can guarantee the required dropping probability of -handoff calls. Therefore the total channel utilization is increased.

VI. CONCLUSION

To equalize the utilization of channels in all cells, the obvious solution is that the cells with higher traffic load should somehow use the free channels available in low traffic cells. Results of example simulations in [3] show that non uniform distribution of channels adopted by this algorithm provides better call blocking probabilities in the system. The reduction in call blocking probabilities allows an average of 10 percent and maximum of 22 percent traffic to be added to the system while maintaining the same call blocking probability as that of uniform channel allocation. Because the relation between the number of channels and the call-blockage probability is a complex function, this algorithm sounds more complex.

The simulative result in [5] shows that simple borrowing schemes are found to be better under light or moderate traffic loads. Some of the suggested borrowing techniques are found to be capable of supporting up to 35 percent more traffic than uniformly distributed FCA. Channel borrowing schemes; however, require additional computational complexity and frequent switching of channel. They may also affect handoff strategies. In general, it is less desirable to drop a handoff call than to block a fresh call which is reflected in *Handoff Queuing Scheme* (HQS) and *Guard Channel Scheme* (GCS). But however, the customer satisfaction in fresh calls is decreased in HQS and GCS. The dropping probability of handoff calls is -considered as one of the major metrics that measures the QoS. Kim *et al*. in [11] shows that the *Dynamic Channel Reservation Scheme* (DCRS) based on user movements decreases the blocking probability of fresh calls without sacrificing the dropping probability of handoff calls, which increases the total channel utilization.

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AUTHOR'S BRIEF INTRODUCTION

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