PERFORMANCE OF CHANNEL ALLOCATION SCHEMES IN CELLUALR SYSTEM

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Abstract—one of the main goals in cellular network design is to provide high quality and efficient communication using limited resources, such as an available radio band width. The role of channel assignment strategy is to allocate channels to cells so as to minimize call-blocking probability, delay probability to 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 work, call blocking probability using Hybrid Channel Allocation (HCA) has been analysed. In HCA the ratio between fixed to dynamic channels (representative ratio) 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.

Index Terms— Cellular network, Channel assignemt strategy, Call blocking probability, Call delay probability, Fixed channel allocation, Dynamic channel allocation, Hybrid channel allocation, Traffic load.

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1. Introduction

Wireless communication is one of the most vibrant areas in the communication field today. While it has been a topic of study since the 1960s, the past decade has seen an urge for research activities in the area. Cellular networks are of great current interest consists of a large number of wireless subscribers, a number of fixed base-stations that are arranged to provide coverage of the subscribers. The area covered by a base-station, i.e., the area from which incoming calls reach that base-station, is called a cell. Often a cell is a hexagonal region with the base-station in its centre. The base-stations in a given area are then connected to a mobile telephone switching office (MTSO, also called a mobile switching centre MSC) by high- speed wire connections or microwave links. The MTSO is connected to the public wired telephone network. Thus an incoming call from a mobile user is first connected to a base-station and from there to the MTSO and then to the wired network. From there the call goes to its destination, which might be an ordinary wire line telephone, or might be another mobile subscriber. Thus, a cellular network is not an independent network, but rather an appendage to the wired network.

1.2 The Grade of Service (GOS)

Grade of service is a measure of the ability of a user to access a trunked system during the busiest hour. The busy hour is based upon customer demand at the busiest hour during a week, month, or year. GOS is typically given as the likelihood that a call is blocked, or the likelihood of a call experiencing a delay greater than a certain queuing time. The traffic intensity offered by each user is equal to the call request rate multiplied by the holding time. The AMPS cellular system is designed for a GOS of 2% blocking. This implies that the channel allocations for cell sites are designed so that 2 out of 100 calls will be blocked due to channel occupancy during the busiest hour. There are two types of trunked systems which are commonly used. The first type offers no queuing for call requests. That is, for every user who requests ser- vice, it is assumed there is no setup time and the user is given immediate access to a channel if one is available. If no channels are available, the requesting user is blocked without access and is free to try again later. This type of trunking is called blocked calls cleared and assumes that calls arrive as determined by' a Poisson distribution. Furthermore, it is assumed that there are an infinite number of users as well as the following: (a) there is memory less arrivals of requests, implying that all users, including blocked users, may request a channel at any time; (b) the probability of a user occupying a channel is exponentially distributed, so that longer calls are less likely to occur as described by an exponential distribution; and (c) there are a finite number of channels available in the trunking pool. This is known as a MIMJm queue, and leads to the derivation of the Erlang B formula (also known as the blocked calls cleared formula).

International Journal of Scientific & Engineering Research, Volume [illegible]
ISSN 2229-5518

The Erlang B formula determines the probability that a call is blocked and the formula derived equation given by,

$$P_r\,[\text{blocking}] = \frac{\frac{A^C}{C!}}{\sum_{k=0}^{c} \frac{A^K}{K!}}$$

where, C is the number of trunked channels offered by a trunked radio system and A is the total offered traffic.

The second kind of trunked system is one in which a queue is provided to hold calls which are blocked. If a channel is not available immediately, the call request may be delayed until a channel becomes available. This type of trunking is called Blocked Calls Delayed, and its measure of GOS is defined as the probability that a call is blocked after waiting a specific length of time in the queue.

To find the GOS, it is first necessary to find the likelihood that a call is initially denied access to the system. The likelihood of a call not having immediate access to a channel is determined by the Erlang C

$$P_r\,[\text{delay} > 0] = \frac{A^C}{A^C + C!\left(1-\frac{A}{C}\right)\sum_{k=0}^{C-1}\frac{A^k}{k!}}$$

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2. CHANNEL ALLOCATION

For any communication, there must be a source of medium. Wireless communication is made possible through the Electromagnetic spectrum. Band width being the limited resource, it has to be used efficiently to accommodate large number of users simultaneously. Here the given bandwidth is divided into a number of **non interfering channels,** such that they maintain an acceptable received signal. 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. Channels in a wireless communication system typically consist of time slots, frequency bands and/or CDMA pseudo noise sequences, but in an abstract sense, they can represent any generic transmission resource.

Common Principles of Channel Allocation Schemes

The large array of possible channel allocation systems can become cumbersome. However, all channel allocation methods operate under simple, common principles. Throughout this report we have touched on three points which is an efficient channel allocation scheme should address:

1. Channel allocation schemes must not violate minimum frequency reuse conditions.
2. Channel allocation schemes should adapt the changing traffic conditions.
3. Channel allocation schemes should approach (from above) the minimum frequency reuse constraints so as to efficiently utilize available transmission resources.

3. VARIOUS CHANNEL ALLOCATION SCHEMES

For efficient utilization of the radio spectrum, a frequency reuse scheme that is consistent with the objectives of increasing capacity and minimizing interference is required. A variety of channel assignment strategies have been developed to achieve these objectives. They are: (i) Fixed channel allocation- Fixed Channel Allocation (FCA) systems allocate specific channels to specific cells. This allocation is static and cannot be changed. 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. The problem with FCA systems is quite simple and occurs whenever the offered traffic to a network of base stations is not uniform. (ii) Dynamic channel allocation- In a dynamic channel assignment strategy, 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. (iii) Hybrid channel allocation- To reduce the call blocking probability further and to have a better performance in all traffic scenarios the Hybrid Channel Allocation (HCA) strategy which is the combination of Fixed Channel Allocation (FCA) and Dynamic Channel Allocation (DCA) is used. Here a portion of total frequency channels will use FCA and the rest will use the DCA.

4. CALL ADMISSION PROCEDURE IN HCA STRATEGY

In HCA strategy, the call admission procedure is shown in figure 4.1. In this for new calls, if the system having capacity to accommodate the call, then the call is admitted otherwise the call is blocked. For handoff calls, the capacity is estimated and the according to the constraints in DCA, the call is admitted.

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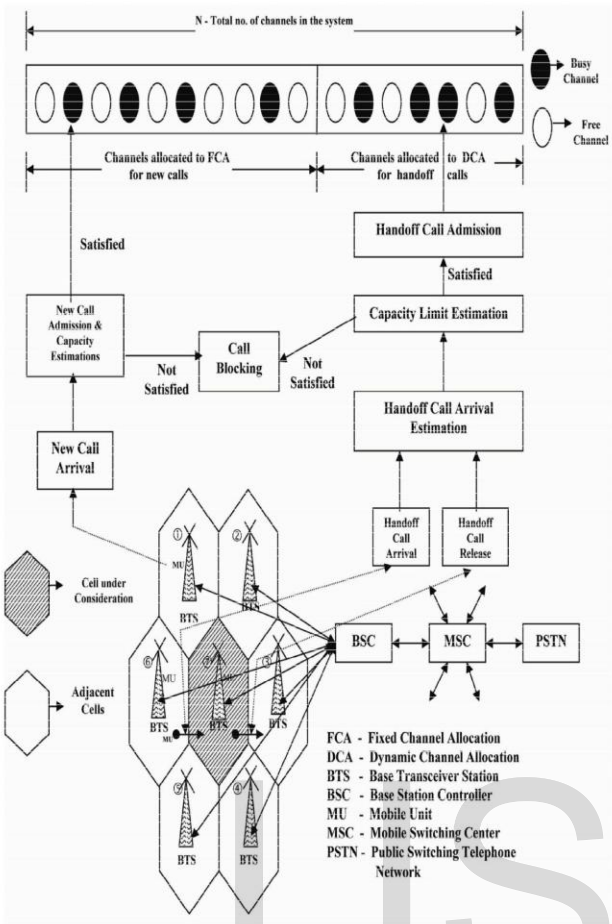

FIG.4.1.CALL ADMISSION PROCEDURE ADMISSION PROCEDURE IN HCA STRATEGY

Algorithm:

The channel request can be accommodated from the first group (B) by setting K=0.

1. When a mobile host wants to initiate a call, it has to send a channel request on the control channel to its request base station. If the base station has an available channel from first group (B), it will assign a channel to mobile host.
2. If no channel from the first group (B) is available, then base station updates the value of (K).

K=K+1, K=0+1

3. The base station then sends a request to borrow a channel from the central pool located at MSC. The MSC on receiving channel request from the base stations assign up to the (K) channels if available from dynamic pool.
4. When the base station successfully acquires channel from the dynamic pool at MSC, it also adds a channel to its temporary pool (T).

5. When a call terminates on a channel at a mobile host, the base station needs to find out which type of channel the call belonged to.

5. RESULTS

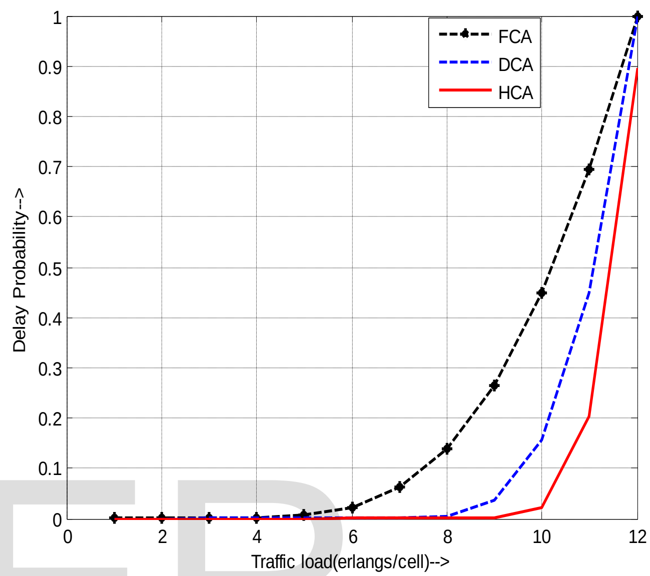

Fig: 5.1 Traffic load Vs Delay probability for FCA, DCA and HCA.

The figure 5.1 shows the plot of delay probability in fixed and dynamic channel allocation schemes with respect to traffic load. As the traffic load (erlangs/cell) is increased the delay associated with accessing the channel by a user is also increased. When compared with FCA and DCA the delay probability is less in DCA. This accounts to the fact that there are no permanent channels allocated to users in DCA and so if the traffic load is high there is no need of waiting for more time. Also as channels are available for every user, anybody can use the allocated channels if they are not in use.

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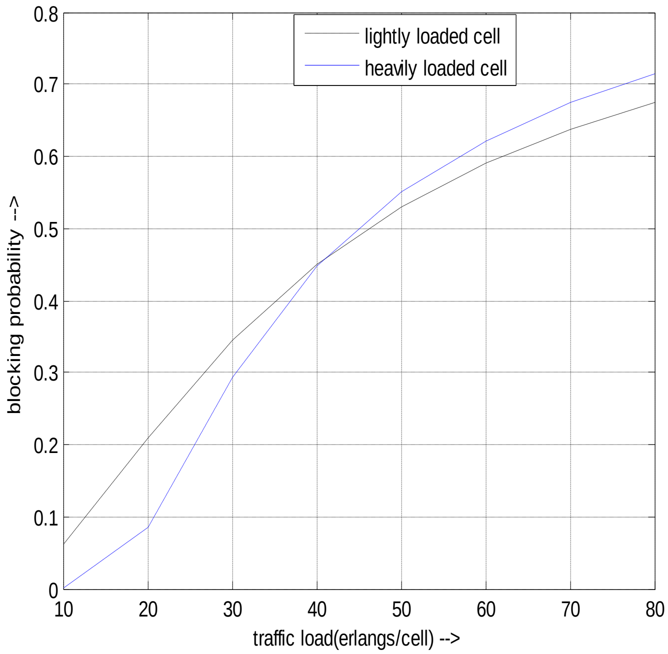

Fig: 5.2 Traffic load Vs Blocking probability for lightly loaded cell and heavily loaded cell.

The figure 5.2 shows the blocking probability of HCA in a lightly loaded cell and heavily loaded cell. In a heavily loaded cell traffic is high and number of call arrivals per second is three times than that of lightly loaded cell.

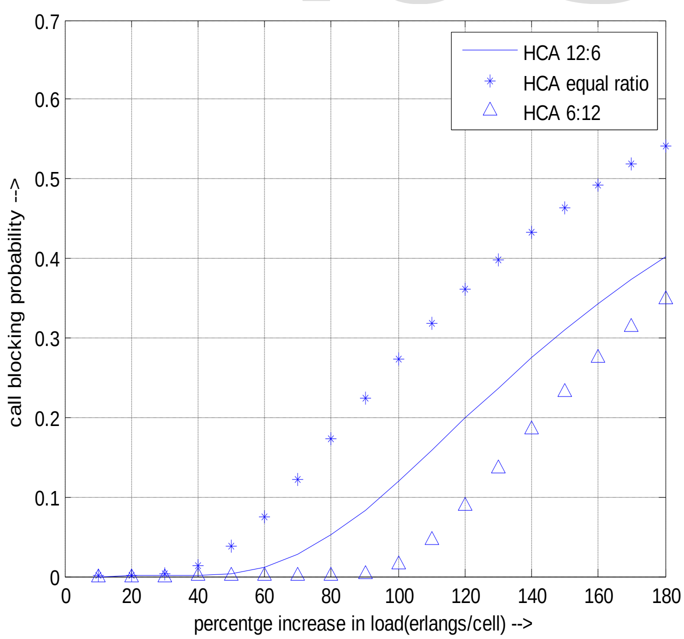

Fig: 5.3 Percentage Increase in Load Vs Call Blocking Probability for HCA variation with different FC: DC ratio

The important parameter in performing the simulation of Hybrid Channel Allocation is representative ratio which is the ratio of fixed to dynamic channels. Here for the simulation purpose the ratio's considered are FC: DC = 12:6, FC: DC = equal ratio and FC:DC = 6:12. The simulation for blocking probability for the above ratios is shown in figure 5.3.

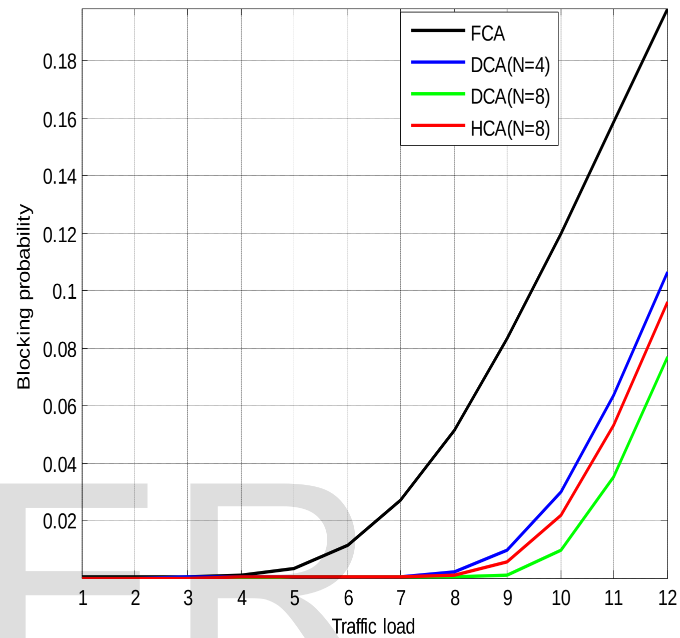

Fig: 5.4 Traffic load Vs Blocking probability for FCA, DCA & HCA with different cluster sizes

The Network model assumed for the simulation purpose is of cluster size N=4 and N=8. The traffic load is being varied and the blocking probability is calculated for FCA, DCA and HCA with different cluster size in fig: 5.4. Increase in cluster size from (N=4 to N=8) of DCA results to corresponding decrease in blocking probability.

6. CONCLUSION

There is no doubt that cellular network simulation is a very complicated procedure. From the point of view of network designer the development and research of various channel allocation schemes must be faced from the lowest starting point. The type and the number of parameters that the designer should take in consideration depend on the type of the network and the focused procedure inside the network.

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 project for HCA simulation, the

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International Journal of Scientific & Engineering Research, Volume ШÓ(ÚÚÜÌKÓ ×ÙÐÓıÌŸħλ
ISSN 2229-5518

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.

7. FUTURE SCOPE

The main advantage of this method is that HCA adapts 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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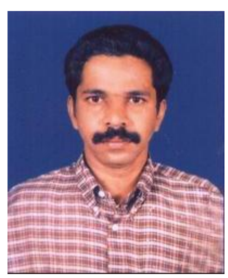

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International Journal of Scientific & Engineering Research, Volume ẀÓ(ÚÚÜÌKÓ ×ÙÐÓιƔhƛ
ISSN 2229-5518

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