

**TRIBHUVAN UNIVERSITY**

**INSTITUTE OF ENGINEERING**

**PULCHOWK COMPUS**

**DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING M.SC. IN INFORMATION AND COMMUNICATION ENGINEERING**

**THESIS NO: 064/MSI/F/610**

**“PERFORMANCE COMPARISION OF DIFFERENT CHANNEL ALLOCATION SCHEME IN CELLULAR MOBILE COMMUNICATION”**

**BY:**

**NILESH JOSHI**

**A THESIS**

**SUBMITTED TO THE DEPARTMENT OF ELECTRONICS AND COMPUTER ENGINEERING IN PARTIAL FULFILLMENT OF REQUIREMENT FOR THE DEGREE OF M.SC. IN INFORMATION AND COMMUNICATION ENGINEERING**

**JULY, 2011**

**Performance Comparison of Different Channel Allocation Scheme in Cellular Mobile Communication**

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A thesis submitted in partial fulfillment of the requirements for the

Degree of Master of Science in Information and Communication

Engineering

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**July, 2011**

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**Dedicated to My Family**

**Specially to**

**My Brother**

**ACKNOWLEDGMENT**

It gives me immense pleasure to thank all the persons who directly or indirectly help me and co-operated me for completing this dissertation work.

First of all, I would like to express my sincere thanks to my thesis supervisor ***Sharad Kumar Ghimire*** for his constant support, continuous help throughout the research time and for giving valuable suggestion during my research period.

I would like to give special thanks to Assist. Prof. ***Mr. Rajesh Kumar Sharma*** for motivating me for this research work. I also would like to express my sincere gratitude to ***Prof. Camela Galdi and Prof. Maurizio di Bisceglie*** from University of Sannio, Benevento for helping me regarding the simulation work in Matlab and providing research material.

I am thankful to my wife ***Rabita Raya*** for her constant support and valuable suggestion for this work and helping me on preparing this paper work.

I am also grateful to ***Bhupesh Kumar Mishra, Mahesh Dhungana*** and ***Praswish Maharjan*** for giving continuous motivation for this research work.

At last but not the least, I would like to thank all my friends and colleagues for the help they have given me in innumerable ways.

**ABSTRACT**

This research work concentrates on the efficient use of the available radio resources in cellular mobile communication system. In this research work, performance of different channel allocation schemes is investigated. This dissertation work has been divided into two parts. In first part already available channel allocation schemes are examined and performance comparison between them is done. In the second part, new channel assignment scheme is proposed and performance comparison between proposed channel allocation scheme and already available channel allocation schemes in literature is done.

Obtained simulation result shows that the proposed channel allocation scheme significantly performs better compared to dynamic and hybrid channel allocation scheme in terms of blocking probability. Proposed channel allocation scheme considerably reduced the total number of block call and hence can serve more number of calls with same number of channels as compared to other scheme.

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**LIST OF SYMBOL**

**Symbol Description First Used in Page**

N Number of cells in a cluster 6 S Number of Duplex Channel Available For Use 6 D Co-Channel Distance 6 R Radius of Each Cell 7 q Co-Channel Reuse Ratio (D/R) 13 C Capacity of Cellular System 7 Au  Traffic Intensity Per User 9 Ac  Traffic Intensity Per Channel 10 λ Call Requested Per Unit Time 9 H Average Call Holding Time 9 A Total Offered Traffic Intensity 10 U Number of Users in a System 10 Ct  Carried Traffic 9

**ABBREVIATIONS**

**Abbreviation Full Form First Used in Page**

GOS Grade of Service 10 MATLAB Matrix Laboratory 4 DCA Dynamic Channel Assignment 12 FCA Fix Channel Assignment 12 HCA Hybrid Channel Assignment 15 LCC Lost Call Cleared 58 LCD Lost Call Delayed 52 SB Simple Borrowing 13 SBR Borrow from Richest 14 BA Basic Algorithm 14 BAR Basic Algorithm with Reassignment 15 BFA Borrow First Available 15 ITU International telecommunication Union 8 AMPS Advance Mobile Phone System 10

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**CHAPTER 1: INTRODUCTION**

* 1. **Background**

Wireless Mobile telecommunication is one of the fastest growing telecommunication services. Rapid growth of wireless communication system due to technological advancement has expanded the area of the telecommunication. Each day every service provider is trying to deploy the new services to attract the new customer. In present scenario, mobile telecommunication system is popular for voice conversation as well as for short message service (SMS), multimedia service and GPRS and many more other services. This new trend in the telecommunications industry to provide continuous information access causes continuous growth of the mobile users at the exponential rate.

The tremendous growth of the wireless mobile user population requires efficient reuse of the scarce radio spectrum allocated to wireless mobile communications. Efficient use of radio spectrum is also important from a cost-of service point of view, where the number of base stations required to serve a given geographical area is an important factor. Reduction in the number of base stations, and hence in the cost of service, can be achieved by more efficient reuse of the radio spectrum. The basic prohibiting factor in radio spectrum reuse is interference caused by the environment or other mobiles [1]. The main constrain in the reduction of system capacity is co-channel interference caused by the base station using the same set of frequency. The use of efficient technique like cell splitting and others can reduce number of co-channel cell in the system. [1,8]

As we know, the radio spectrum is scare radio resource in wireless communication system. Therefore, efficient reuse of the radio spectrum may increase the system capacity. If we can manage the radio spectrum efficiently then the blocking probability for the same number of channel can be reduced and system can handle more traffic. [1,8,12]

It can be said that if the system performs better with efficient reuse of spectrum then channel utilization factor also improves. For this, different channel assignment strategy has been studied extensively in this dissertation work.

* 1. **Objective :**

This dissertation work focuses on the efficient utilization of the radio spectrum which leads to improvement in the system capacity so that same number of channel can be used to serve more number of calls. Hence, we obtain considerable improvement in grade of service. In addition, in this work some study on the traffic behavior of the cellular system is also studied.

In this research work, different method of efficient channel allocation method like fixed channel, dynamic channel and hybrid channel are studied quite extensively and performance comparisons of dynamic and hybrid is done with fixed channel assignment.

Main objective of this work is to find out the better channel utilization algorithm. Based on the user behavior of the calling and call holding time, new channel assignment is proposed in this dissertation work and the result is compared with the already existing channel assignment scheme.

**1.3 Scope and Application**

In last few years, number of mobile subscriber has increased exponentially not only from voice conversational point of view. Each day each service provider has announces new facilities to its subscribers like data services, and many more. As the number of subscriber increases, previously design network may overload and system will face the heavy traffic and call attempted may block and service provider may lose its active subscriber, which is not good for every service provider from its economical point of view.

Moreover, previously designed cellular network can overload due to some unpredictable reason for certain interval of time. Such reason could be environmental reason and other. Therefore, research work that can cope up with such condition has great potential in wireless communication system. Those systems, which can automatically adopt such high traffic demands in certain condition, will improve the system performance by efficiently utilizing the available channel. Such adaptive system will remove burden to service provider from quick installation of the new base station (BS).

In cellular telecommunication network, as there is available free channel requested user will get the channel and conversation will established. However, because of mention reasons that are sometimes unpredictable user may not get the free channel at requested time. If no resources are available, the arriving customer is blocked. Hence, such type of system, which is adaptive to the unpredictable traffic variation, performs better for wide range of traffic variation.

Allocating the channel for certain busy hour traffic does not mean that it satisfies the condition of efficient utilization of available resources. In fix channel assignment strategy, fixed number of channel is provided to serve the requested call. Fix channel assignment strategy will not perform better at certain service time. Therefore, in such case other channel assignment scheme can be applied to improve the system performance. However, the dynamic and hybrid channel scheme are available for improving the channel efficiency but the proposed system will perform much better than the rest.

**1.4 Overview of Report**

This is an overall report on ‘Performance Comparison of different Channel Assignment Scheme in Cellular Mobile Communication’. The report consists of all the activities done by author. The report is divided into different sections and subsections. Chapter 1 includes the introduction, objectives, scope and application of this dissertation work. This section briefly explains about the outline of this report. All the terminologies and basic terms related to the mobile communication are included in chapter 2. Chapter 3 includes research methodology, which includes how the system was implemented in Matlab and the flow charts of all the channel assignment strategy. In this same chapter proposed system is explain in great depth with algorithm and flow chart. Chapter 4 deals with result obtained from the simulation and its performance analysis. Chapter 5 gives the limitation of the simulated work and final chapter 6 gives concluding remarks of the dissertation work and the future work that can be performed.

**CHAPTER 2: LITERATURE REVIEW**

**2.1 Introduction:**

The rapid growth in the demand for mobile communication has led the industry into intense research and development efforts towards a new generation of cellular system. The limited resources in cellular system can be reused in such systems in no interfering cells. Efficient utilization of the scare channels for cellular system, however, is one of the major challenges in cellular system design.

**2.2 Cellular concept**

Normally, in communication system we use high power transmitter to cover large geographical area, where incase of cellular system we replace high power transmitter by low power transmitter to cover small geographical area called cell and each cell is severed by single transmitter called base station. Each base station is allocated a portion of the total number of channels available to the entire system, and nearby base stations is assigned with different set of channel to minimize the interference between the base stations. By systematically spacing the base station and the available resources, cellular system can cover whole geographical area. As we all know that the radio resources is sacred resources so for covering the whole area we can reuse the same frequency which are geographically quite from the other cell which is using same sets of frequency. We should be careful here that the one cluster is using different sets of frequency. [8]

**2.3 Frequency Reuse**

The design process of selecting and allocating channel groups for all of the cellular base stations within a system is called frequency reuse or frequency planning*.*

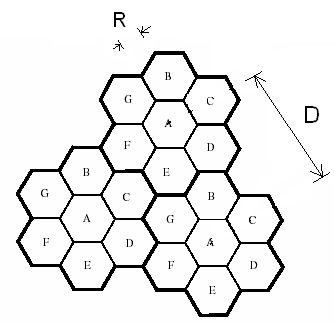
Cellular system provides the reuse of same sets of frequency spectrum. By this feature, within the same geographic location, we can use same frequency but we should maintain minimum signal to noise ratio as demand by the system. In cellular system, total available channel is divided into the total number of cell in cluster. *Cluster* is the group of cell in which no frequency reuse is applied.

Figure below shows the concept of frequency reuse for cluster size of seven. Where the distance between two cells using same frequency is D and R is the radius of the cell.

For calculating number of cell in one cluster, we use formula

N = i2 + ij + j2

For figure below i=2 and j=1 which gives N=7.



**Figure 2.1** Frequency Reuse

Consider a cellular system, which has a total of S duplex channels available for use and if each cell is allocated a group of k channel and if the S channel is divided among N cells, the total number of available radio channels can be

S = k N

From this also we can define the cluster as, group of cells, which collectively use complete set of available frequency. Normally cluster size is taken 4, 7 or 12. If cluster is repeated M times to cover the entire designed geographical area then capacity of the cellular system ‘C’ is expressed as

C = M k N = M S

As we can say from this expression that capacity of cellular system is directly proportion to the number of times a cluster is repeated in a geographical area. [7, 8]

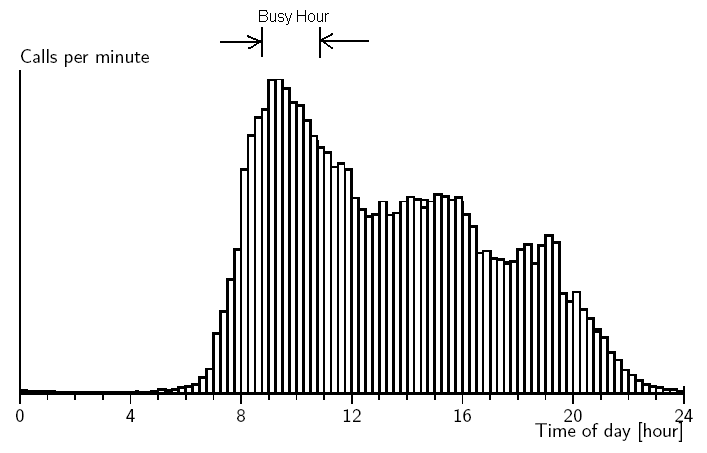
**2.4 Traffic Engineering**

**2.4.1 Traffic Variation:**

Traffic of the telecommunication varies according to the behavior of the society. Figure below shows traffic variation of exchange serving the whole of a town. For an exchange serving the centre of a city, where few people live, in such area traffic intensity at evening will be low where as exchange, which is, serving the residential area most obviously have high traffic intensity at the evening time. In addition to this number of call carried varied over a week and season as well.

Traffic distribution for 24 hour of day is shown figure 2.2, which shows number of call per minute (traffic intensity) varies according to time. It can be seen from above figure that the traffic will be maximum are time 10 to 12 so this period of time is called *busy hour.* The telecommunication operating company provided the most of the equipment to cope up with the call for the busy hour, so most of it is remain idle for other period. This is the reason telecommunication operator provides cheaper calls for the off peak period.

The costs of a telephone system can be divided into costs, which are dependent upon the number of subscribers, and costs that are dependent upon the amount of traffic in the system.



**Figure 2.2** Traffic Distribution

The task of teletraffic theory is to design systems as cost effectively as possible with a predefined grade of service when we know the future traffic demand and the capacity of system elements.[9]

**2.4.2 Unit of traffic**

In teletraffic engineering the word traffic is used to denote the traffic intensity i.e. traffic per unit time. Traffic intensity is the average number of calls simultaneously in progress during a particular period of time. It is measure in Erlang or CCS. According to ITU -T (1993 [34]) we have the following definition:

Traffic Intensity:The instantaneous traffic intensity in a pool of resources is the number of busy resources at a given instant of time.

Most commonly used unit of traffic is Erlang, which is named after A.K. Erlang, the Danish pioneer of traffic theory. A traffic intensity of one Erlang means continuous occupancy of a facility during the time period under consideration.[9,19]

**2.4.2.1 Carried traffic:**

It is the volume of traffic carried by the switch.

**2.4.2.2 Offered traffic:**

Offered trafficrefers to the average generated total traffic including the traffic that is blocked in the system. So the capacity should be higher than offered traffic; otherwise, many users would not be able to get service because all lines would be occupied all the time on average.[9]

Relation between offered traffic and carried traffic

Carried traffic (Ct) = offered traffic (1- Blocking probability)

**2.4.2.3 Lost or Rejected traffic***`***:**

The difference between offered traffic and carried traffic is equal to the rejected traffic. The value of this parameter can be reduced by increasing the capacity of the system.

**2.4.2.4 Holding Time**

It is average duration of a typical call and denoted by ‘H’.

The traffic intensity offered by each user is equal to the call request rate multiplied by the holding time. That is, each user generates a traffic intensity of Au Erlang given by

Au = λH

Where λ is average number of call request per unit time for each user and H is holding time. For design process we take, Au is 30 mErlang. For a system containing u users and an unspecified number of channels the total offered traffic intensity A, is given by

A = UAu

Moreover, in a C channel trunk system, if the traffic is equally distributed among the channel, then the traffic intensity per channel, Ac, is given by

Ac=

When the offered traffic exceeds the maximum capacity of the system, the carried traffic becomes limited due to the limited capacity. The maximum possible carried traffic is the total number of channels, C, in Erlang.[8,9]

**2.5 Trunking**

Trunking allows large number of user to share smaller number of channel in cell by providing access to each user, on demand, from pool of available channel. In a trunk radio system, each user is allocated a channel on a per call basis, and upon the termination of the call, the previously occupied channel is immediately returned to the pool of the available channel. [8, 9, 19]

**2.6 Grade of Service**

It is the measured of proportion of calls that is lost due to congestion (Erlang B). In AMPS cellular system, GOS of 2 % is specified which means 2 out of 100 called were rejected. Mathematically we defined GOS as

GOS =

So the GOS is specified for the traffic at the busy hour. At other times, it is much better. If it is too large, subscribers are unable to complete the call and are unsatisfied with the operator and this means congestion in the system may occurred at the busy hour. Therefore, if the offered traffic increases the number of trunks must obviously be increased to prove a given grade of service.

In loss Call Cleared system, if the channel is available, the requested user will get that channel immediately upon request. If the channel is not available, the requested user is blocked without access and is free to try again later. This is called Loss Call Cleared (LCC). Erlang B formula is used to measure the GOS or for measurement of blocking probability which is given by the following relation

Pr [Blocking] =

Where C is the number of trunked channels offered by a trunked radio system and A is the total offered traffic. [8, 9]

**2.7 Channel Allocation Scheme**

A given radio spectrum can be divided into a set of disjoint or noninterfering radio channels. All such channels can be used simultaneously while maintaining an acceptable received radio signal. Main purpose of channel allocation scheme is to efficient utilization of available radio resources so that total number of blocked call can reduce. Normally in certain geographical area, in given time, all cells may not face same traffic. Like in office time, cell area around residential site may face low traffic while in same time cell having large shopping mall, departmental store, and government office may have large traffic demand. In such scenario, resources in former case may underutilize while later cell over utilized and overall system performance is reduced. To overcome this type of problem in cellular system different channel allocation schemes are proposed. [14, 17]

**2.7.1 Fixed Channel Assignment (FCA):**

In fixed channel assignment scheme, a set of nominal channels is permanently allocated to each cell for its exclusive use. Here a definite relationship is assumed between each channel and each, in accordance to co-channel reuse constraints.

The total number of available channel in the system C is dived into sets, and the minimum number of channel sets N required to serve the entire coverage area is related to the reuse distance as follows.

N = ()σ2

Here σ is defined as D/R, where R is the radius of the cell and D is the physical distance between the two cell centers.

In the simple FCA strategy, the same number of nominal channels is allocated to each cell. This uniform channel distribution is efficient if the traffic distribution of system is also uniform. In that case, the overall average blocking probability of the mobile system is the same as the call blocking probability of in the cell.

In nonuniform channel allocation, the number of nominal channels allocated to each cell depends on the expected traffic profile in that cell. Thus, heavily loaded cells are assigned more channels than lightly loaded ones. [1]

With fixed channel assignment scheme, all the resources will not effectively utilize because in such system, some cell may have faced light traffic and its channel will be in free while at same time, other cells faced heavy traffic and large number of incoming call may blocked which gives dissatisfaction to subscriber. [1, 13]. Hence another technique to improve the channel efficiency was introduced.

**2.7.2 Dynamic Channel Assignment (DCA):**

Due to short-term temporal and spatial variations of traffic in cellular systems, FCA schemes are not able to attain high channel efficiency. To overcome this, DCA scheme have been introduced. In contrast to FCA, there is no fixed relationship between channels and cells in DCA. As in the FCA, channels are nominally assigned to all cells. However, it is only a nominal channel assignment and is used as a first choice group for a particular cell. If it is not possible to serve a particular call with a channel from this group, then the search is extended to other channels. When an idle channel is found because of this extended search and the call is assigned to this channel, this channel is said to be borrowed. Thus, a channel is borrowed whenever it is assigned for use in a cell to which it is not nominally assigned. It is assumed that the transmitters of the cell to which it is assigned always radiate a channel. In most cases, there is more than one, in fact many, channels that can be borrowed for a given call.

In DCA, a channel is eligible for use in any cell if signal interference constraints are satisfied. Because in general, more than one channel might be available for borrowing to a cell that requires a channel, some strategy must be applied to select the assigned channel. The main idea of all DCA scheme is to evaluate the cost of using each candidate channel, and select the one with the minimum cost provided that certain interference constrains are satisfied, the selection of the cost function is what different entities DCA schemes. [4, 8, 5, 22]

**2.7.2.1 Channel Borrowing Scheme**

**2.7.2.1.1 Simple Channel Borrowing Schemes**

In the simple borrowing (SB) scheme a nominal channel set is assigned to a cell, as in the FCA case. After all nominal channel are used, an available channel from neighboring cell is borrowed. To be available for borrowing, the channel must not interfere with existing calls. Although channel borrowing can reduce call blocking, it can cause interference in the donor cells from which the channel is borrowed and prevent future calls in these cells from being completed.

Because the set of borrowable channels in a cell may contain more than one candidate channel, the way a channel is selected from the set plays an important role in the performance of a channel borrowing scheme. The objective of the entire scheme is to reduce the number of locked channels caused by channel borrowing. The difference between them is the specific algorithm used for selecting one of the candidate channels for borrowing. Along these lines, several variation of the simple strategy has been proposed where channel are borrowed from non-adjacent cells. [1]

**2.7.2.1.2 Borrow from the Richest (SBR)**

In this scheme, channels that are candidates for borrowing are available channel nominally assigned to one of the adjacent cells of the acceptor cell. If more than one adjacent cell has channels available for borrowing, a channel is borrowed from the cell with the greatest number of channels available for borrowing. Channel borrowing can cause channel locking. The Simple borrowing scheme does not take channel locking into account when choosing a candidate channel for borrowing. [1, 2, 4]

**2.7.2.1.3 Basic Algorithm (BA)**

This is an improved version of the simple borrowing scheme, which takes channel locking into account when selecting a candidate channel for borrowing. This scheme tries to minimize the future call blocking probability in the cells that is most affected by the channel borrowing. As in the simple borrowing case, channels that are candidate for borrowing are available channels nominally assigned to one the adjacent cells of the acceptor cell. The algorithm chooses the candidate channel that maximizes the number of available nominal channels in the worse case nominal cell in distance to the acceptor cell. [4]

**2.7.2.1.4 Basic Algorithm with Reassignment (BAR)**

This scheme provides for the transfer of a call from a borrowed channel to a nominal channel whenever a nominal channel becomes available. The choice of the particular borrowed channel to be freed is again made in manner that minimizes the maximum probability of future call blocking in the cell most affected by the borrowing. [10, 6]

**2.7.2.1.5 Borrow First Available (BFA)**

Instead of trying to optimize when borrowing, this algorithm selects the first candidate channel I finds. Here, philosophy of the nominal channel assignment is also different. Instead of assigning channels directly to cells, the channels are divided into sets, and then each set assigned to cells are reuse distance. These sets are numbered in sequence. When setting up a call, channels sets are searched in a prescribed sequence to find a candidate channel. [1, 4]

**2.7.3 Hybrid Channel Assignment (HCA)**

Hybrid channel assignment scheme employ a mixture of two schemes thus name hybrid. These are the Fixed and Dynamic channel assignment scheme. If we have total of T channels for service and that they are divided into two sets A and B, not necessarily equal. Then channel set A contains channel that are used in the system using a fixed channel assignment scheme. Channel set B contains those channels that can be used in any cell in the system, using the Dynamic channel Assignment Scheme. Since the Hybrid channel Assignment Scheme uses both Fixed and Dynamic Channel Assignment scheme, its average number of function performed per call will be in between that of the Fixed and Dynamic, provided comparison are made on exactly the same system for the three channel assignment schemes. Therefore, using Hybrid, instead of dynamic, channel assignment schemes will enable the processor to complete more calls per unit time. The advantage of Hybrid over Dynamic channel assignment, in terms of average processing time per call, is that in the case of dynamic channel assignment, there are many more channels to consider each time a request for a free channel is received. [3, 24]

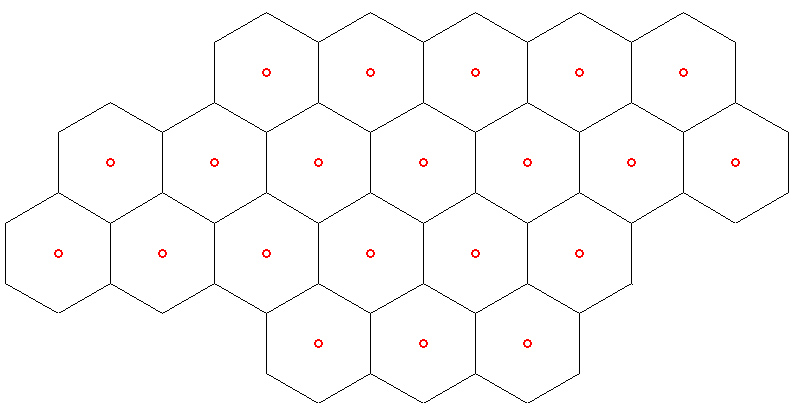
**CHAPTER 3:**

**RESEARCH METHODOLOGY**

In cellular mobile communication system, the entire cell may not be loaded at the same time. I.e. when the call in the certain cell may in progress and that call may block due to lack of the available free channel in call originating cell. At the same time, in the neighbor cell channel may be spare or unutilized. Therefore, technique to overcome such problem has to be explored so that spare channel from the neighbor can be borrowed and returned the channel after call termination. Different author has proposed different techniques for this. Some of such techniques are dynamic channel assignment strategy and hybrid channel assignment strategy. Dynamic channel assignment strategy can improve the system capacity by borrowing the channel from neighbor cell if it is free in neighbor [5,4].

Similarly, another technique to improve the system capacity is Hybrid channel assignment scheme. In hybrid channel assignment scheme channel is divided into two groups namely nominal channel and the channel for borrowing. Nominal channel cannot borrow by other cells while dynamic channel can borrow by other neighbor cells. Setting the different ratio of nominal channel set and dynamic channel set gives different performance [3]. This effect also observed in this research work. Besides this, other channel assignment techniques are proposed like channel switching technique proposed by Said M. Elunubi. [6]. Based on the [6], another new channel assignment technique is proposed which gives much better performance than the hybrid channel assignment scheme.

For comparing the performance of different channel allocation scheme, 21 hexagonal cell layouts with reuse ratio of 7 shown in figure 3.1 has been considered in this work. In addition, it is assume that there is an average holding time of 3 minute, which is usual in real scenario. In this simulation work, number of traffic channel is assumed 10 and according to the requirement, this can be varied.



**Figure 3.1** Simulated cellular model (N= 7)

Other assumption for simulation works are as follows:

* Blocked call are cleared and do not return.
* The calls in each cell are assumed to have a Poisson distribution with known arrival rate. This leads to assumption that interarrival time between the calls are exponential distribution.
* The effect of fading are not modeled
* Movement of the mobile from one cell to another cell is not considered i.e. no handoff has been considered.

In hybrid channel assignment scheme, consider the condition that all the available nominal channel is occupied and two channels are borrowed from the neighbor cell. Now new algorithm proposed in this work states that if the channel is free in the nominal channel set than call in the borrowed channel are transferred to the nominal channel set but condition is applied. Only last incoming call is transferred to the nominal channel set because normally latest incoming calls hold the channel channels for long time. So if we can transfer the call having longer holding time than channel occupied by the call in dynamic set may terminate quicker and borrowed channel may get free for serving other incoming call. Hence, system capacity will increase.

**3.1 Algorithm and Flow Chart for Fixed Channel Assignment**

Is it Last Call?

Select the first free Channel

Served the call

Update the channel NFC=NFC-1

Find list of Free Channel

Block the call Update the block call matrix NB=NB+1

Is Nominal channel available in Cell?

Determine Calling Cell Determine called time

If call request go to subroutine Check\_ch for updating channel

Initialized parameter

NB=0, NFC=No of ch

Start

Call per cell

Average holding time

No. of Channel per cell

Calculate GOS GOS =

END

NO

YES

NO

YES

**Figure 3.2**: Flow chart of Fixed Channel Assignment Scheme

**Subroutine: Check\_ch**

YES

NO

Are there any call having termination time< present call time

Determine all Call

Remove all those call from channel

Update No. of free Channel

Return

**Figure 3.3**: subroutine check\_ch

In fixed channel assignment scheme, total number of channel in each cell is made fixed and incoming calls are served from available free channel of those cells. If it did not find available free channel, call will be blocked. In fixed channel assignment first all the required parameter like total number of block call, total number of free channel etc are initialized. When the call request from cell, system first remove the call from channel which are already terminated and now system search for the total number of available free channel. If it finds the number of free channel than system will provide the first channel to the call and reduced the number of available free channel by one. If there is no free channel in the call-originating cell than call will be blocked and the blocking count flag will be increase by one. This process will run until the last call is served. As all the calls are processed by this system than system will come out from the loop and it will calculate the total number of block call in percentage, which gives the GOS of the system.

**3.2 Algorithm and Flow Chart for Dynamic Channel Assignment**

Start

**Figure 3.4:** Main Program flow of Dynamic scheme

Call per cell

Average holding time

No. of Channel per cell

NO

YES

NO

YES

NO

YESH

END

Calculate GOS GOS =

Call is blocked Update the block call matrix NB=NB+1

Call is served

Select the first free Channel

Served the call

Update the channel NFC=NFC-1

Is it Last Call?

Find list of Free Channel

Is Nominal channel available in Cell?

Determine Calling Cell Determine called time

If call request go to subroutine Dych\_check for updating channel

Go to subroutine Cha\_check

Check block flag

Is block==0

Initialized parameter

NB=0, NFC=No of ch

Block=0

**Subroutine: dych\_check**

Return

NO

YES

YES

* Return the Borrowed Channel
* Free the lock channel in from interfering cells set also

Update No. of free Channel

NO

Is there borrowed Channel?

Are there any call having termination time< present call time

Determine all Call

Remove all those call from channel

**Figure 3.5:** subroutine dych\_check

**Subroutine: ch\_check**

NO

YES

Served the Call

Return Block=1

YES

Is count==0?

NO

Count=Count-1

YESH

* Select Last Candidate Channel
* Lock same channel in all interfering cell also

NO

NO

YESH

NO

YES

YESH

NO

Find List of channel in all cells

Select cell having more number of free Channel

Is same channel is free in interfering Cells also

Find All Borrowing Candidate Cells

Is there any lending cell having interfering cells

Select the cell having more free Channels

Find List of Channel in all candidate Cells

Is there any lending cell having no interfering Cells

Is Channel available for borrowing?

* Borrow the last channel
* Update the channel

Served the call

Return Block =1

Return Block =0

* Set Count=total no of eligible cells
* Find list of free Channel

Is channel available for borrowing?

**Figure 3.6:** Subroutine ch\_check

Similar to the Fixed channel assignment scheme, input parameter to the dynamic channel simulation scheme are number of call, average holding time ( which is normally set to 180 minute ), and offered traffic which is chosen such that blocking probability is 2% for based load. Each time offered traffic is increased by 10% of based traffic until required condition is met. In dynamic channel assignment scheme also initially block call is set to zero and number of available free channel is set to total number of channel per cell.

As the call request in cell, first it searches for its own nominal channel. As the nominal channel found free than system will select the first free channel (In this algorithm, first set of channel is given priority to the originating call cell). As the call found channel in its own cell, call will be served and system will reduce total number of available free nominal channel by one and channel status is updated. Now system will check whether the served called is last one or not. If it was last call then system will come out from loop and calculate the Grade of service.

If the requested call did not find the free nominal channel in the call originating cell, cell searches the available free channel in adjacent cells. While searching the available free channel, it first searches those cells, which have no interfering cell. In this process of searching, it can find more than one such candidate cells. If there is more than one such cells, the system will first find out the total number of available free channel in all cell and select only those cell which has maximum number of free channel. After identifying the borrowing cell, channel will be borrowed from this cell and the call will be served. In process of borrowing, acceptor cell channels will be increased by one while number of channel in donor cell is decreased by one. And channel status is updated.

In searching sequence, if it did not find the channel in non-interfering cell group or if it does not have the non-interfering cell than search is extended to interfering cell group. Now it searches for those adjacent cells, which have interfering cells. Similar to earlier cases it can find more than one candidate for lending the channel and it selects that adjacent cell which has more number of free channels. It selects that channel of selected cell, which is also free in interfering cell group also. If the selected channel is not free in the interfering cell, search is extended to other interfering cells. Now if the channel is free in both selected cell and interfering cell group, channel is borrowed from the donor cell and same channel is lock to all interfering cell. If there are more than one channel for borrowing, system will select the last channel since first group of channel are given priority to its own call. Now channel status is need to be updated here also.

If it could not find the free channel in both non-interfering cell search group and interfering cell search group than call will be blocked and the block call flag is increased by one.

After deciding the whether the call is served or not system will determine whether the served call is last call or not. If it is not a last call, another call requested is check and similar process repeats. In the case when the served call is last call, system will come out from the loop and calculate the GOS of the system.

Before deciding whether call is to be served or not first system will call the subroutine dych\_check. It is because before the call originates other calls which was engaged in conversation before may already have been terminated and channel was already been free. In addition, there may be the case that call served by borrowing the channel from other cell may be terminated and channel need to return. So for doing this process, system will call the subroutine dych\_check.

If there are calls which are already been terminated then it will update its nominal free channel and if the system will find that the calls served by borrowing the channel from adjacent cells is also terminated than it will return the borrowed channel and also unlock the channel in interfering cell group also.

**3.3 Algorithm and Flow Chart for Hybrid Channel Assignment**

YES

NO

NO

YES

NO

YES

NO

END

Calculate GOS GOS =

Call is blocked Update the block call matrix NB=NB+1

Call is served

Select the First free channel

Served the Call Update NDCh=NDCH-1

Update the channel NCH=NCH-1

Is it Last Call?

Go to subroutine Ch\_check

Check block flag

Is block==0?

Is Dynamic Channel Set Available?

Served the call

Initialized NB=0, NnFC, NDFCH No of ch

Block=0

YES

Start

* Call per cell
* Average holding time
* No. of Nominal(NCH) and dynamic Channel (NDCH) per cell

Is Nominal channel available in Cell??

Select the first free Channel

Find list of Free Channel

Determine Calling Cell Determine called time

If call request go to subroutine Checkch\_nominal and checkch\_dyn for updating channel

**Figure 3.7:** Main Program Flow of Hybrid Scheme

**Checkch\_nominal subroutine**

Are there any call having termination time< present call time

Determine all Call

Remove all those call from channel

Update No. of free Channel

Return

No

YES

**Figure 3.8:** Subroutine check\_ nominal

**Subroutine: checkch\_dyn**

NO

YES

Return

Update No. of free Channel

* Return the Borrowed Channel
* Free the lock channel in from interfering cells set also

NO

Is there borrowed Channel?

YES

Are there any call in Dynamic channel set having termination time< present call time

Determine all Call

Remove all those call from channel

**Figure 3.9:** Subroutine checkch\_dyn

**Subroutine: ch\_check**

NO

YES

Served the Call

Return Block=1

YES

Is count==0?

NO

Count=Count-1

YESH

* Select Last Candidate Channel
* Lock same channel in all interfering cell also

NO

NO

YESH

NO

YES

YESH

NO

Find List of channel in all cells

Select cell having more number of free Channel

Is same channel is free in interfering Cells also

Find All Borrowing Candidate Cells

Is there any lending cell having interfering cells

Select the cell having more free Channels

Find List of Channel in all candidate Cells

Is there any lending cell having no interfering Cells

Is Channel available for borrowing?

* Borrow the last channel
* Update the channel

Served the call

Return Block =1

Return Block =0

* Set Count=total no of eligible cells
* Find list of free Channel

Is channel available for borrowing?

**Figure 3.10:** Subroutine ch\_check

In hybrid channel assignment scheme channel is divided into two groups Fixed and Dynamic (called nominal and dynamic set) hence named hybrid. Here input parameters are number of fixed and dynamic channel which was express in terms of ratio in simulation result. Other parameters are same as that of the dynamic channel scheme. Initially number of free nominal channel and dynamic channel are set to number of nominal channel and number of dynamic channel respectively also block count is set to zero.

As the call request from the cell, it first searches the nominal free channel in call originating cell. If it finds the channel, it will serve the call from first available nominal channel and it will update its available free channel.

If it did not find the channel in nominal channel set, it searches the channel in dynamic set of same call originating cell. If it finds the dynamic channel set than call is served from first available channel in dynamic set and it updates its dynamic channel set.

Now if the call did not find the channel in both nominal channel and dynamic channel, search is extended to its adjacent cell. While searching the channel in adjacent cell, it first searches those adjacent cells, which have no interfering cell. (Same as that in dynamic assignment). Point to be note here is that systems will searches only dynamic channel set of the adjacent cells. If it finds the free dynamic channel set in non-interfering group, it will borrow channel from that cell. Here also there may be more than one candidate for channel lending. So it will select only that cell which has maximum number of free channel and the selected channel will be the last channel of the available dynamic set. Again, if it did not find the channel in the non-interfering set than search process will head towards the interfering cell group. It searches the entire candidate cell, which have free dynamic channel set and select the cell from interfering group with maximum number of free dynamic channel. After selecting the cell, it tests the cell whether the same channel is free in interfering cell also or not. If same channel is free in all interfering cells also than it can borrow the channel from selected cell, and update its dynamic channel set. At the same time, it locks the same channel in interfering cell, which restricts the utilization of same channel for future use. If it did not find the channel in selected cell than search is carried out in all other candidate cells. If it did not finds the channel in interfering cell group, the call will be blocked and its block counter is increased by the one.

After deciding whether call is served or blocked, system will check whether the processed call is last or not. If it is not than same process is repeat for next requested call also. If the processed call is last one, loop will terminate and the system will calculate the GOS.

Before the call is being processed, system will first go through two subroutine namely checkch\_nominal and checkch\_dych.

System will pass to the checkch\_nominal because before call is being established three may be a call, which already had been terminated and channel might be free. So passing though the checkch\_nominal subroutine will remove all the call from channel, which was already terminated. Now again system will update its channel.

Also after passing through the checkch\_nominal, system will now pass though the checkch\_dych and find out those calls, which are already being terminated. If the terminated call is of same channel then it updates its dynamic channel and if the terminated call is from the borrowed channel set, it will return back the channel to that cells from where it had borrowed and unlock the channel in all interfering cell group so that they can use it again for own purpose.

**3.4 Proposed system algorithm and flow chart**

NO

NO

YES

NO

YES

Initialized parameter

NB=0, NnFC=No of ch Block=0

Start

* Call per cell
* Average holding time
* No. of Nominal(NCH) and dynamic Channel (NDCH) per cell

If channel is free in nominal channel set go to subroutine shift\_channel

YES

Select the first free Channel

Find list of Free Channel

Served the call

Is Nominal channel available in Cell??

Go to subroutine Cha\_check

Check block flag

Is block==0?

Call is blocked Update the block call matrix NB=NB+1

NO

YES

Is Dynamic Channel Set Available?

Select the First free channel

Served the Call Update NDCh=NDCH-1

Update the channel NCH=NCH-1

Is it Last Call?

END

Calculate GOS GOS =

Call is served

Determine Calling Cell Determine called time

If call request go to subroutine Checkch\_dyn, Checkch\_nominal for updating channel

**Figure 3.11:** Main Program flow of Proposed System

Are there any call having termination time< present call time

Determine all Call

Remove all those call from channel

Update No. of free Channel

Return

**Subroutine Checkch\_nominal**

**Figure 3.12:** Subroutine checkch\_nominal

No

Yes

**Subroutine: dych\_check**

NO

YES

NO

Return

Update No. of free Channel

YES

Is there borrowed Channel?

* Return the Borrowed Channel
* Free the lock channel in from interfering cells set also

Are there any call in Dynamic channel set having termination time< present call time

Determine all Call

Remove all those call from channel

**Figure 3.13:** Subroutine dych\_check

No

Yes

Yes

No

Yes

No

No

NO

Yes

**Subroutine shift\_channel**

Select Next Cell

Count=count-1

Is Cell borrowed channel from other cells

Is nominal Channel free?

Unlock channel

Determine total number of borrowed Channel

Shift the call to nominal channel and free the borrowed channel

Select the call having latest incoming time

Is borrowed channel==1

Is their lock channel?

Shift call to nominal channel and free the borrowed channel

Set Count=no. of cells

Select first cell

Is borrowed Channel occupied by its own call?

Select the call having latest incoming time

Yes

**Figure 3.14:** Subroutine shift\_channel

**Subroutine: ch\_check**

NO

YES

Served the Call

Return Block=1

YES

Is count==0?

NO

Count=Count-1

YESH

* Select Last Candidate Channel
* Lock same channel in all interfering cell also

NO

NO

YESH

NO

YES

YESH

NO

Find List of channel in all cells

Select cell having more number of free Channel

Is same channel is free in interfering Cells also

Find All Borrowing Candidate Cells

Is there any lending cell having interfering cells

Select the cell having more free Channels

Find List of Channel in all candidate Cells

Is there any lending cell having no interfering Cells

Is Channel available for borrowing?

* Borrow the last channel
* Update the channel

Served the call

Return Block =1

Return Block =0

* Set Count=total no of eligible cells
* Find list of free Channel

Is channel available for borrowing?

**Figure 3.15:** Subroutine ch\_check

Initialisation and input parameter of proposed system is same as that of the hybird channel assignment scheme.

In this scheme also as the call request, it first searches its own available free nominal channel. If it find nominal channel of its own, call will be served else search process for channel will proceed to its dynamic channel set. If dynamic channel found, call will be served from first one channel from dynamic channel list else channel is searched in the adjacent cell.

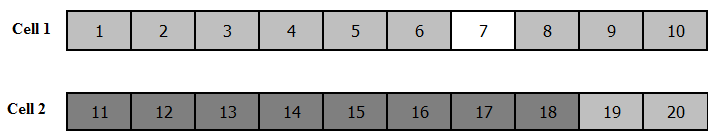
Similar to the hybrid channel allocation scheme, if channel could not find in both nominal and dynmaic channel list search is extended to non interfering and interfering cell group and accordingly call is served or block. Finding the channel in the non interfering cell group is advantage to the system because in this case system need not to lock the channel in interfering cell.

As in the hybrid channel assignment scheme here also system will pass through the subroutine chechch\_nominal and checch\_dych to remove the call from the channel which was already terminated. In the same subroutine, it determines whether there is the borrowed channel or not. If cell had borrowed the channel from other cell it will return back the channel after call completion and unlock the channel of interfering cell group.

In proposed system new mechanism is added which try to make dynamic channel set of all cell to be free as early as possible.

**Case I**

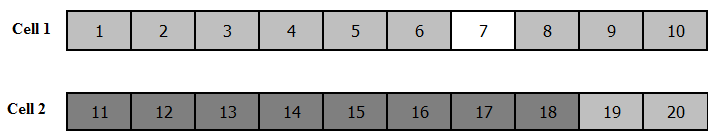
Now, consider the case shown below after passing through the subroutine checkch\_nominal and checkch\_dych which says that nominal channel 7 is free since call in channel 7 is already been terminated. Also it suggests that cell 1 had borrowed 2 channels(19 and 20) from cell 2 because its all channel was occupied in last calling time.



**Figure 3.16:** channel status of two cells

In hybrid channel allocation scheme system will reponse this as normal and call is established according to algorithm mention before.

In proposed method, call trafer mechanism for latest incomming time is used. In the paper [6], call is simply transfer from borrowed channel list to nominal channel list. But in proposed method first total number of channel borrowed by cell one is searched ( in this case two). Now the call with the latest incomming time, say call in channel 19 was came after call in channel 20. General statistics of user calling behavior is that average holding time of user is 180 second. Reason for selecting the call with latest incoming time is that latest call will remain in the channel more time than the earlier call ( i.e. call in the channel 20 will terminate before the call in channel 19). So if we could tranfer the latest call to the nominal channel 7 of cell 1 than after call termnation of call in channel 20 of cell 2, both of the two channels of cell 2 will be free and correspodingly all locked channel also free which means at least 6 channel will be free from this algorithm. Now the following figure illustrate the more clearly



**Figure 3.17:** Call selecting Procedure

Choose call with latest incoming time

In conventional hybrid channel allocation scheme channel will be free only after the call termination. So in scenario after the termination of call in channel 20 of cell 2, only channel 20 will return by cell 1 and other interfering cell channel will unlock. If we have 2 interfering cell than there are total of 3 channels will be free because call 19 still in the borrowed channel list of cell one, which is not terminated. In proposed algorithm call in channel 19 have already been transferred to the nominal channel of cell 1. So, channel 19 is already free. Hence, after call termination both the dynamic channel list of the cell 2 are free and can be used for serving other call.

**Case II:**

Now consider the case of figure 3.18. In this state nominal channel 7 of cell one is free while remaining are in use. At the same instant of time borrowed channel (9 and 10) are also used by the cell one itself.



**Figure 3.18:** Borrowing Channel Status

In hybrid channel scheme mention before system will do nothing. In the proposed system call transfer mechanism is used. As we know that there are two calls in progress in channel number 9 and 10. Hence, proposed system will select the call with latest incoming time. Reason of selecting the call with latest incoming time is to reduced the blocking probability of future call in cell one and its neighbor. Figure below clearly explain the call transfer procedure.



Select the Call with Latest Incoming time and transfer

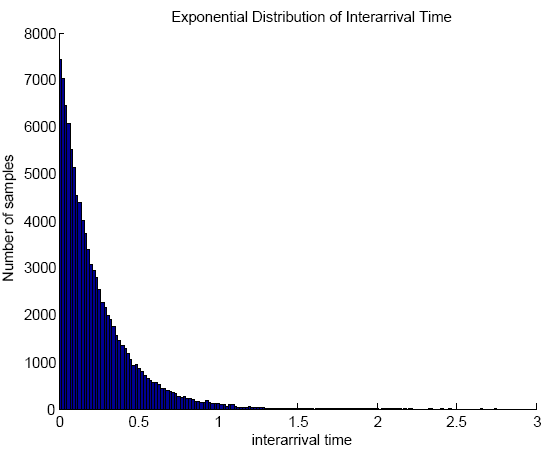
**Figure 3.19:** Call Transfer procedure for borrow channel

**CHAPTER 4:**

**RESULT AND PERFORMANCE ANALYSIS**

**4.1 Result**

**4.1 Plot of Holding Time and Interarrival Time**

****

**Figure 4.1(a):** Plot of Interarrival time

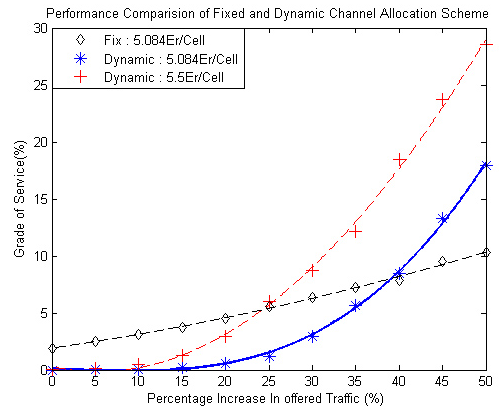
For getting result of figure 4.1 a, 2,10,000 call has been processed. Plot of figure 4.1a was obtained for the average call arrival rate of 100. From figure, one can see that the interarrival time is of exponential distribution, which satisfies with the theoretical agreement.

****

**Figure 4.1(b):** Plot of Holding time

For getting result of figure 4.1 b, 2,10,000 calls has been processed. Plot of figure 4.1 b was obtained for the average call holding time of 180 second (3 minutes). From the figure obtained, one can see that holding time has exponential distribution, which satisfies with the theoretical agreement.

**4.1.2 Simulation Result of Fixed and Dynamic channel Assignment**

****

**Figure 4.2**: Performance comparison between Fix and Dynamic at Traffic load of 5.084Er/cell and 5.5Er/Cell.

For obtaining the figure of 4.2, 21-cell system with 10 channels per cell is considered with cluster size of 7. In figure 4.2, each point was obtained with 20,000 Calls per cells. Every time traffic load in the each cell is increased by 5% of base traffic. Plot of the fixed channel assignment scheme is also compared with the Erlang B table shown in Appendix for validation, which satisfies with the simulated date.

For simulating the system of figure 4.2, base GOS of 2% was considered which is also the GOS of fixed channel assignment scheme at base load.

In the figure 4.1 curve with plus sign was obtained for the base load of 5.5Er/Cell which is the drawn for comparison purpose.

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**Figure 4.3**: Performance comparison between Fix and Dynamic at Traffic load of 6.216Er/cell an6.4 Er/Cell.

For obtaining the figure of 4.3, 21-cell system with 10 channels per cell is considered with cluster size of 7 and base GOS of 5%. For obtaining the figure 4.3, each point was simulated with 20,000 Calls per cells. Each time load in the cell was increased by 2% of base traffic. Plot of the fixed channel assignment scheme is also compared with the Erlang B table shown in Appendix, which satisfies with the simulated date.

In the 4.3 figure curve with plus sign was obtained for the base load of 6.4Er/Cell which is the drawn for comparison purpose.

**4.1.3 Simulation Result of Fixed and Hybrid channel Assignment**

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**Figure 4.4**: Performance comparison between Fix and Hybrid channel Assignment at Traffic load of 5.084Er/cell.

Similar to Dynamic scheme result, figure 4.4 was obtained while simulating, 21-cell system with different ratio of nominal and dynamic channels (8:2 and 5:5) per cell with cluster size of 7. For obtaining the above result, each point was simulated with 20,000 Calls per cell and each time traffic load in the cells were increased by 10% of its base traffic.

For comparison purpose, same system is simulated with the fixed channel assignment scheme with 10 channels per cell and result obtained was compared with the Erlang B table shown in Appendix, which agreed with the simulated result.

While simulating system of 4.5, base GOS of 5% was considered which is also the GOS of fixed channel assignment scheme at base load.

C:\MATLAB7\work\Results\hybrid\13.18\untitled.tif

**Figure 4.5**: Performance comparison between Fix and Hybrid channel Assignment at Traffic load of 13.18Er/cell.

The above figures was obtained while simulating , 21-cell system with different ratio of nominal and dynamic ( 18:2, 10:10) channels per cell was considered with cluster size of 7. For obtaining the above result, each point was simulated with 20,000 Calls per cells. Each time load in the cell was increased by 5% of its base traffic.

For comparison purpose, same system is simulated with fixed channel allocation scheme with number of channel per cell 20. Plot of the fixed channel assignment scheme is also compared with the Erlang B table shown in Appendix, which agreed with the simulated date.

While simulating system of 4.5, base GOS of 5% was considered which is also the GOS of fixed channel assignment scheme at base load.

**4.1.4 Simulation Result of Proposed System:**

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**Figure 4.6:** Performance Comparison between Fix, Hybrid and Proposed

System at 5.084Er/Cell

Figure 4.6 was obtained while simulating 21-cell system with different ratio of nominal and dynamic channels per cell with cluster size of 7. For obtaining the result of above figure, each point was simulated with 20,000 calls per cell and each time, traffic was increased by 10% of its base load.

For comparing the purposed system with fixed system and hybrid system, all three systems are simulated at the base traffic of 5.084Er/Cell and total number of channel equal to 10.For validation the fixed scheme is checked with the Erlang B table at appendix B. One can see the agreement between two theoretical and simulated data.

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**Figure 4.7:** Performance Comparison between Fix, Hybrid and Proposed

System at 13.18Er/Cell

Figure 4.7 was obtained while simulating 21-cell cellular system with different ratio of nominal and dynamic channels per cell with cluster size of 7. In case of Fixed scheme channel total number of channel per cell 20 was considered. For obtaining the above result, each point was simulated with 20,000 calls per cell and each time load in every cell were increased by 10% of its base traffic. Plot of the fixed channel assignment scheme is also compared with the Erlang B table shown in Appendix, which agreed with the simulated date.

While simulating system of figure 4.7, base GOS of 2% was considered respectively this is also the GOS of fixed channel assignment scheme at base load

**4.2 Performance Analysis**

From theory, we know that user behavior on call holding time has exponential distribution and average call arrival rate has Poisson’s distribution. We also know that there is a relation between the Poisson’s and exponential distribution. However, the call arrival rate is Poisson’s distribution but interarrival time between samples has exponential distribution. Hence, we have to find the interarrival time between two calls, which should be exponential distribution and can be obtained from Poisson distribution with known call arrival rate. Figure 4.1 a and b both satisfies with theoretical agreement of holding time and interarrival time distribution. From figure, one can clearly see that number of call with long holding time is very less which can be seen in real life scenario also. Similar argument also true for interarrival time also.

When we analyze the result of figure 4.2 and 4.3 one can say that dynamic channel assignment scheme system perform better as compared to fixed at low traffic condition. However, if the load on cells keep on increasing than the fixed scheme will perform better which means there is no more advantage of using dynamic channel assignment scheme in heavy traffic environment. Further, use of dynamic channel scheme at heavy traffic condition degrades the system performance. This is because in low traffic condition when call request in cell, there may not be free channel of its own and it needs to search free channel in neighbor cells and neighbor cells might have more than one free channel to donate and lending the one channel may improve the system performance. Now problem arises when the cells faced heavy traffic. In this condition when call is attempted, call-originating cell may not have its own free channel to serve the call. Now cell request for channel in the neighbor cell, the lending cell may not or may have only one cell for donating. Now as the donor cell donates the channel there may be call request in cell. Now for serving the call it does not have own. So it also needs to borrow the channel. Now as the donated channel return, another cell may request for the channel. Now clearly we can see the problem of oscillation, which is called ping-pong state. Because of this system blocking probability increases.

From the result obtained, it can be said that dynamic channel assignment scheme significantly improves the performance of the system at low traffic. This can also be interpreted as dynamic channel assignment scheme is much less sensitive to traffic variation as compared to the fixed channel assignment scheme at the low traffic condition. For the cluster size of 7 , up to 25 to 40% increase in traffic of its base load (5.084Er/Cell), dynamic channel scheme is less sensitive to traffic variation.

From the result obtained from figure 4.4 and 4.5, one can quickly answer that for same base traffic load (5.084Er/Cell), hybrid channel assignment system will perform better than dynamic if we could select the better ratio of the nominal channel and borrowing channel set. For the same base traffic situation, hybrid channel scheme is less sensitive to traffic variation (up to 70% of its base load) as compared to dynamic (up to 40% of its base load). Hence, there is significant improvement in system capacity. But similar to dynamic case at for heavy traffic condition (beyond 70% of its base load in simulated case), hybrid channel scheme also could not function better. After this, there is no advantage of using hybrid channel assignment.

There is considerable improvement in the system capacity with the proposed system. For the same base traffic of 5.084Er/Cell, dynamic system could not function well after 40% while hybrid has 70% of its level but implementation of proposed system can function well more than 100% increase in offered load. Also, one can say that proposed system is less sensitive to traffic variation as compared to other two scheme mention in literature.

**CHAPTER 5: LIMITATION**

While comparing the different channel assignment scheme, issue of complexity is need to be considered. From complexity point of view Dynamic system is more complex one as compared to fixed scheme. In dynamic channel assignment scheme it has to continuously monitor the borrowed call whether it has been terminated or not and if so it has to return all the channel which it had borrowed earlier. In addition, it needs to unlock the channel in interfering group. While comparing the proposed system with the hybrid and dynamic system, it is even more complex one. In proposed system, first, it has to monitor the borrowed call and if call has been terminated earlier then it has to return the channel and unlock the interfering cell channel also. Moreover, in proposed system it has to check the nominal channel status and dynamic channel status. If the channel is free in the nominal channel set it has to transfer the latest call to the nominal channel set. These extra works need extra hardware, which leads to complexity in design.

While considering performance analysis, continuous monitoring of call has not been considered. In some cases, call may drop due to coverage issues. In such case, call may terminate (which is due to fast and slow fading) before it was expected to and channel may be free. Such analysis has not been considered in proposed work.

In the simulated work, only the call that has been originated within the same cell has been considered. I.e. no handoff call has been considered.

**CHAPTER 6:**

**CONCLUSION AND FUTURE ENHANCEMENT**

While simulation the system following condition has been assumed

* Call holding time has exponential distribution and average call holding time of 3minute is considered in the simulated case.
* Interarrival time between the call has exponential distribution.
* For comparison purpose, all the system should be loaded with same offered traffic. In the simulation, offered traffic of 5.083Erlang per cell was given and it is considered as base load.

Under the above condition, when simulating the dynamic and fixed scheme, dynamic system will perform better at low traffic condition. As the traffic increases, dynamic system will perform poor and it will give high probability of blocking. However, in case of the hybrid scheme (8:2), it performs better for large range of traffic variation. In simulated case, it is order of 70-percentage increase in base traffic.

Compared to the dynamic and hybrid channel allocation scheme proposed system performed better in mention environment. Number of block call in the proposed system is significantly reduced and hence serving large number of customer with same number of channel for large variation of offered traffic.

Validation of the simulated data with the real time data was not done in this work because for this operator has to reconfigure its system. This reconfiguration of the system for validation purpose is not realistic.

Since there is considerable effect of fading for maintaining the call in highly faded region, which leads to force call termination. The main restriction of this work is that in this work force call termination effect has not been considered.

This research work can be further extended by considering the coverage analysis part. All of us know that as the mobile is moving, there is considerable effect of fast and slow fading. Due to poor signal strength call might drop and channel may be free earlier as it was expected to and this freed channel can served more call. This effect has not been considered in this work. So those who want to continue this work can incorporate fading mechanism so that system will look even more realistic. Also same work can be extended to lost call delay (LCD) Erlang C system.

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**APPENDIX A**

**DERIVATION OF ERLANG B FORMULA**

The Erlang B formula determines the probability that a call is blocked, and is a measure of the GOS for trunked system that provides no queuing for blocked calls ( Lost Call Clear system). Erlang B model is based upon the following basic assumption

1. Call requests are memoryless process which means all users, including blocked user can request a channel.
2. All free channels are fully available until channels are occupied.
3. The probability of a user occupying the channel is exponential in nature. i.e. longer calls arrival rate are less.
4. Interarrival times of call requests are independent of each other.

The number of call arrival in a given system has Poisson’s distribution. Mathematically it can be written as

P[(N(t+τ)-N(t))=k] = k=0, 1, 2 ….. 1

Where N(t) is the number of call request that have occurred at t=0 and is the call interarrival time. λ denotes the average holding time of requested calls.

Similarly mathematically interarrival time can be expressed as

P(t)=

Probability that the interarrival time is greater than or equal to t is given by

P(T≥t) = ---------------------------2

Call holding time is also exponential distribution

P(t) = --------------------------3

P(T≥t) = --------------------------4

The exponential distribution of interarrival time and holding time is used to model Poisson process, which are situations in which an object initially in state A can change to state B with constant probability per unit time. For any positive numbers s and t we have from equation 1

Pr(T>t+s│T>t) = Pr(T>s)

Let consider that the system is in state 0 initially when no channel is occupied by the call. The probability that there will be a change from 0 channel to 1 channel in use is given by the mean number of arrivals during the time δ. We choose δ very small such that only one of the events occur during that interval:

* One call arriving with probability P(a)
* One call terminating with probability P(e)
* No change with probability 1-P(a)-P(e)

Since the mean arrival rate is λ, the probability of call arrival during the interval δ is given by

P(a) = λδ

If k channels are occupied, there will be k termination during the mean holding time h and the termination rate will be k/h so the number of calls ending during time δ is given as kδ/h.

P(e)= kδ/h=kµδ

λδ λδ λδ

µδ kµδ Nµδ

Fig.8 A Markov Chain as a birth death process in the traffic model

Let j is be the lower state and K is the higher state, then

Where, is the probability of transition from state j to k and

Where, is the probability of transition from state k to j.

Under steady state condition, =

P (a) =P (e), i.e., λδ= (k/h) δ

From which,

==

For k=1,

P1= = P0A

Where, A is offered traffic, similarly,

= = =

In general, =

For lossless system, 0≤x≤∞

Which gives, substituting the value of in general expression of , we get,

,

Which Poisson distribution. This means the number of requests calls has Poisson distribution. The mean value of gives the average Carried Traffic. So,

X =

= = A

Which shows that the carried traffic is equal to offered traffic as there is no loss in the system (since the number of channels is infinite). But this is not the case in the real system where N is finite.

Now, Lost Traffic in LCC system is given by,

Lost Traffic= Offered Traffic- Carried Traffic

Similarly, Blocking Probability =

The blocking probability and Lost Traffic is determined by the Erlang Blocking Formula, when the channel is the system is finite.

Let us consider the channels in the system is finite, 0≤x≤N

, ) = 1

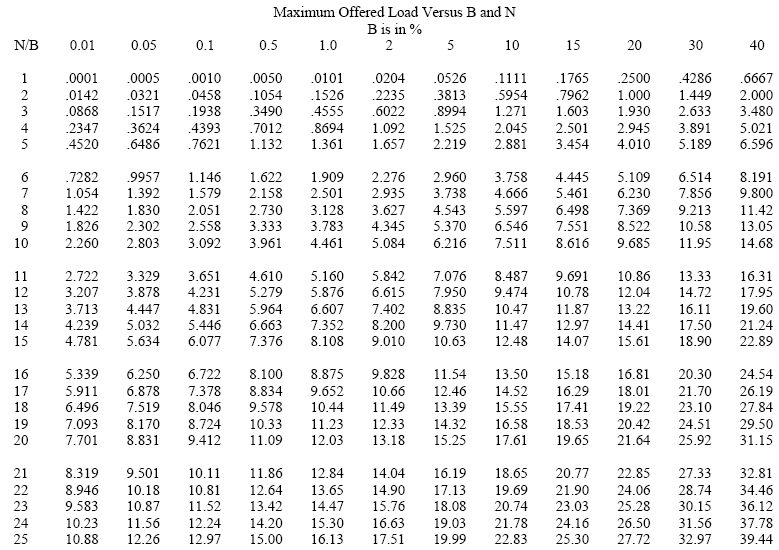
which gives,

The probability that N channel are occupied gives the probability of blocking which is also called Grade of Service (GOS). Therefore substituting X=N, we get

Which is Erlang Blocking Formula.

Reference : [8]

**Appendix B**



Reference [8]