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Different Techniques for Successful Handoff and Prevention of New Call Blocking Probability

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Abstract: The unsuccessful handoff and call dropping have been a fast growing, challenging and interesting area in real time application. The immense advancement in cellular networks communication study, has made tremendous improvement in the sphere of wireless technologies which are complementary to other and their union for specific area and services has created single wireless network system. The different wireless network systems having separate function have been combined under the concept of Next-Generation Wireless Communications Systems (NGNS) with a view to provide seamless high-quality wireless network services to mobile users. A set of mechanism are proposed for successful handoff process during the transfer of active calls or date session from one cell in a cellular network to another or from one channel in a cell to another maintaining uninterrupted service to a data session user. In this paper factors responsible for unsuccessful handoff and new call dropping probability method with probable control measures are reviewed. Methods are also proposed to increase handoff performance of mobile IP by decreasing the probability of false handoff initiation to a great extent under handoff management protocol of NGWS considering MT speed and handoff signaling which are directly proportional to false handoff initiation. In is reported that electromagnetic radiation is reduced to a considerable limit with the use of multi antennas instead of a single big antenna.

Keywords : Electromagnetic radiation, False handoff initiation, GPS (Global Positioning System), Handoff, MT (mobile terminals), Mobile IP, NGWS (Next-Generation Wireless Communication System).

I. INTRODUCTION

The cellular base station is a cellular enabled mobile network device area where in electronic communications instruments and antennas are placed on mobile tower, radio mast or some other erected structure with a view to create a cell or adjacent cells. Many such cells constitute a cellular network used to operate radio frequencies with efficiency and the operating area is called servicing area.

Generally, one of the famous networks called cellular network is being used by high level technology.

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The cellular network requires mobile or cellular tower. i.e. base trans receiver station (BTS) which sends and receives information through radio frequency. During the call cellular tower will receive the signal and send it to base station controller (BSC) which will in turn forward it to the mobile switching center (MSC). MSC is the network provider which sends signal to MSC receiver. The said signal will reach to BSC receiver and the BSC will pass it to the mobile tower or cellular tower. Ultimately the call from sender will reach the receiver. The entire cellular network process involving between sender and receiver is called encoding and decoding. Now it is established that cell is a geographical circular area covered by BS at the center and the MT's within that area are connected and serviced by the BS. The hexagonal area is the biggest area within the circular cell and as such sides of the hexagons are the common cords of two hexagonal cells and virtually the cells are hexagonal which form cluster of cells just like honey-comb structure.

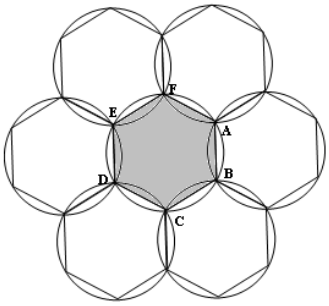


Fig 1. a cluster of seven hexagonal cells

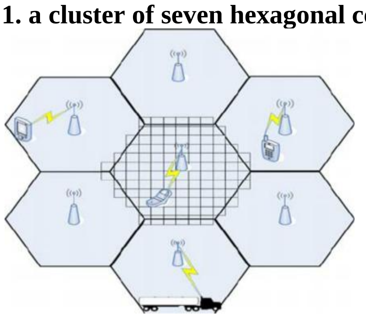


Fig 2. A cluster of seven hexagonal cells having a bs with multiple antennas.

The entire concept can be explained by considering a cluster of seven hexagonal cells (Fig.1 and Fig.2).
The cell coverage area is determined by the base station output power and the environment. Things such as trees, hill, buildings and land formation will have an effect on the coverage area. To help compensate, a lot more base stations are installed to cover the increasing demand of call requests and the cell sizes will have a 2-5km radius.

In country area the cell radius will be around 10-32 km. Using extender cell technology like that used by “Telstra’s Next G^{TM}Network, a radius of 80-200 km can be reached. A base station can only handle a certain number of calls at one time.

A typical base station has about 168 voice channels available and once the capacity is nearly reached the BS will seamlessly handoff a mobile user to another BS within the user’s range. The BS will also have the limit to the bandwidth available for internet and data session. The BS ensures that internet will not be slow during peak periods. The wider the channel bandwidth the wider the pipe is to send data packet and internet to a BS. During conversation when mobile terminal (MT) moves from one to another, MSC automatically transfer the call to a new channel of new BS. This process of transferring call is termed as Handoff. At the time of transferring call, radio signal becomes weaker at the first and strongest of the second BS. Weaker and stronger is quantified by a signal threshold level. There are two types of handoff one is called soft and other is hard. In hard handoff, the mobile station is connected to only one BS at any time based on highest signal strength. Whereas, in soft handoff more than one BS is connected to MS for certain period of time and selects strongest signal among those BS’s. If the number of users using a particular cell, reaches its maximum capacity, then a handoff occurs. Some of the calls are transferred to adjoining cells, provided that the user is in the border line of both the cells. A handoff may occur while there is a transfer of duties from the large cell to the smaller cell i.e. micro cells and vice versa. Again, Handoffs may also occur when there is interference of calls using the same radio frequency for communication.

In cellular communications, the handoff is the process of transferring data session from one cell in a cellular network or from one channel to another. In satellite communications, it is the process of transferring control from one earth station to another. Handoff is required to prevent loss of interruption of service to a data session user. Handoff is also termed as Handover.

In case of hard handoff radio links from the mobile BS to the existing cell is interrupted before establishing a link with next cell and it is termed as inter-frequency handoff. It is a “break before make” policy, whereas at least one of the links is maintained when radio links are attached and removed to the mobile BS which ensures that during the handoff, no interruption occurs and this is usually adopted in co-located sites. It is called “make before break” policy.

Handoff is triggered according to the prevailing situation. In GSM cellular networks mobile devices assist the BSC to transfer a data session to another BSC. In other system handoff is the absolute work of the BSC and MSC without any role of mobile device. In GSM, when a mobile station does not use its time slots for communication, it measures signal availability to nearest BSC and there by BSC performs handoff according to the information.

The vertical and horizontal handoff have been shifted towards Next Generation of Wireless System and cellular environment to ensure seamless connectivity and also a better quality of service. The tele communication has been prospered by integration of mobile cellular networks and WLAN which has attracted significant research. The two types of handoff occur in an integrated network. The horizontal handoff between two BS under the same networks and vertical handoff between different networks.

The handoff decision, radio link transfer and channel assignment are the crucial steps in a handoff which is the essential element of cellular communication. Vertical handoff (Inter-system) refers to overlapping of wireless networks and horizontal handoff (intra- system) refers to movement of a mobile node with a single technology network from one access point to the other one. Vertical handoff changes the access technology network but horizontal does not change.

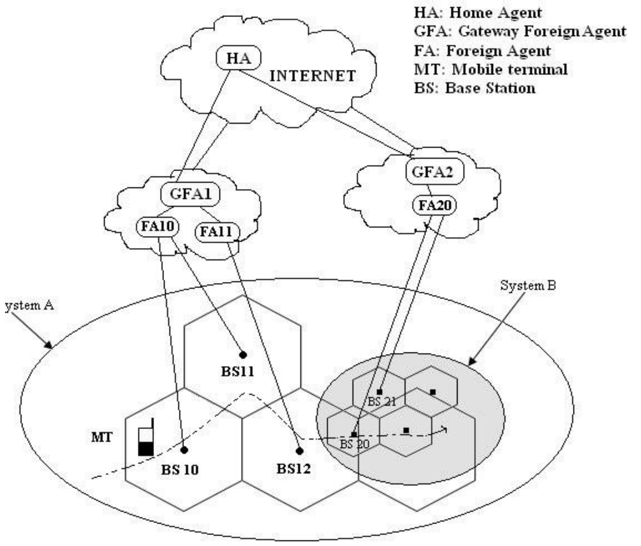


Fig 3. Overview of handoff process between foreign and home stations.

In other words, it may be explained that horizontal handoff occurs between two BSs of the same network and link layer horizontal handoff is happened between two BSs of the same Foreign Agent (FA) i.e. movement of a Mobile Terminal (MT) from BS10 to BS11 in Fig.3.

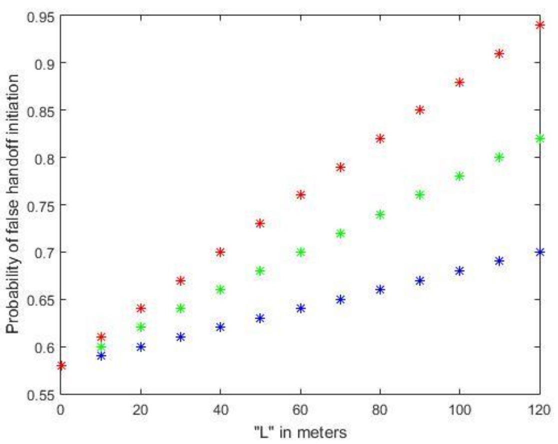
Intra-system horizontal handoff occurs between two BS of two different FAs under the same network i.e. under the same gateway foreign agent (GFA). i.e. movement of a MT from BS11 to BS12 in Fig.3. The phenomenon of vertical handoff is happened between two BSs of two different networks and two different GFAs i.e. hand off MT from BS12 to BS20 in Fig.3.

Again, vertical micro mobility is the handoff within the same domain applying different wireless technologies whereas Horizontal micro mobility is the handoff among the same domain applying same wireless technology. The vertical macro mobility is handoff among different domains using different wireless technologies whereas horizontal macro mobility is handoff within various domains applying same wireless technology.

The modern wireless world provides several communication networks which are complementary to each other and each of which provides ubiquitous connection always to the mobile users [16] and [17]. However, the entire mobility management system is divided into two different classes which are called location and handoff management.

The handoff management with the help of algorithm based BMBHO maintains active connection when MT moves from one BS to another whereas the location management co-operates the system to trace the MT among consecutive BSs. In this review work, a detailed discussion has been made in respect of several factors including false handoff initiation responsible for unsuccessful handoff i.e.
handoff failure and these factors limit the effectiveness of handoff and thereby consequent delay occurs in real time service to mobile users. The channel allocation strategy, new call admission algorithm and algorithm based BMBHO have played vital role in reducing the handoff dropping probability. Low power antennas have also significant role in reducing electromagnetic radiation to certain minimum level. Again, it has been revealed that signaling delay is directly proportional to probability of false handoff initiation.

On the basis of our findings, a consonance of mechanisms is being proposed in third section. In the fourth section, Result & discussion and in fifth section, conclusion & future work related to present work, are mentioned categorically.



II. RELATED WORKS

We are well aware of the fact that the process by which a mobile is handed over from one access point to another is known as "Handoff" In this process access point is used as particular changes of mobile. In other way it maybe said that the process of transferring active call or data session from one cell to another within the cellular network system or we can say that transferring of calls from one channel to another in a particular cell. Similarly Handover is the mechanism involved in transference of authority, control, knowledge and power from one BS to another or we may that 'handover' is the process of mobile communication and telecommunication through which an already connected call or a data session is being transferred from one BS to another without interruption of said session.

Mobility management on intra-system and inter-system handoff is undertaken keeping mind the large value of signaling delay which maybe fatal for delay-sensitive real time services. This management is being adopted to minimize the signaling delay by further reducing the probability of handoff latency.[1]

The system of handoff management operates on different layers of classical protocols stack as proposed in the previous research work,[8]

Again, the research work [4] highlighted anew enhanced Handoff Protocol for Integrated Networks(eHPINs) that localizes the mobility management for quick handoff. The study [9] conducted on integrating layer-3 handoff information into layer-2 information's and it showed that handoff latency is minimized through applications of WiBro system based on FMIP. In this different handoff algorithms operating on link layer were suggested for enhancement of Received Signal Strength (RSS) value results in minimization of handoff latency as well as handoff failure [10] and [11]. It is further revealed from link-layer assisted handoff protocols that the latency originated from inter-system and intra-system handoff is constant. It is required to be mentioned that if RSS of BS comes below the pre-defined fixed threshold value, the link-layer assisted handoff protocols will generate the handoff. Again, if the delay of the handoff signaling varies, the intra-system as well as inter-system will show poor performance.

It is mentioned here that the Handoff and other management methods for minimizing the handoff failure probability in next-generation wireless system were studied in past [1]. Again, the cost analysis of an algorithm based BMBHO method having better efficiency is comparison to other handoff methods, has been made as revealed from the study [2]. The above stated work not only provides an idea about the work done in past and assist in delineating of present problem of handoff failure probability and related cost but also provides a basis for interpretation of the present new approaches to further minimizing the hand off failure probability and to reduce new handoff. Call dropping probability during call waiting stage without disturbing the ongoing handoff data session.

The present review work is no way exhaustive but cares have been taken to illustrate the most of the basic findings which are very much pertinent to the understand various control mechanisms related to unsuccessful handoff as well as new call dropping probability.

III. PROPOSED WORK

As the handoff failure has been a fast growing challenging and problem oriented area in real time scenario, hence proposed consonance of methods for rapid minimization of handoff failure probability may be executed by proper utilization of channels and a consonance of mechanisms that will serve foreign as well as home mobile stations in respect of cell size of the base station[1]. This concept may be represented through the equation (1) which will show the number of available free channels where in numerator denotes number of free channels and denominator shown the total number of operating channels during successful handoff. This requires new models for further decrease in hand off failure and handoff latency probability. In this paper discussion has been made with regard to low cost-oriented algorithm based BMBHO and other standard methods [2] along with gainful utilization of existing and new channels to be obtained by HCA. In this direction the research work [1] and [2] have shown that low cost-oriented algorithm based BMBHO effectively may decreases in handoff failure probability and forced call dropping. As the handoff takes place in minimum time and data packets are sent through old link, the throughput of BMBHO is higher than that of Sea HO-LEO.

Again, the throughput of Sea HO-LEO is better than that of MIP during handoff stage as algorithm attached to BMBHO is a specific one which selects the most suitable satellite for connections it is best among four standard methods mentioned above.

This algorithm based BMBHO method may keep handoff failure to a very minimum level in comparison to other three standard methods [2]. Hence, in respect of algorithm based BMBHO the forced cell dropping probability may be reduced to zero during successful handoff due to decrease in scanning duration of data packets and auto selection properly for new satellite mobile node (MN) with a view to availing more free channels.

Due to overlapping of 7 circular cells common cords are formed which acts as sides of adjacent hexagonal structures and considered as hexagonal cells (Fig.1). As a result, some hexagonal like structures are formed between overlapping hexagonal cells [1]. Now the regular sides and common sides of hexagonal cells are served by Old Base Station(OBS) and New Base Station(NBS), respectively when the Mobile Terminal(MT) passes through common sides cords, it will come under NBS as its strength is greater than that of OBS on the right side of common cord[1].

The MT passing through the outer sides of cells ultimately reaches to the overlapped hexagonal portions. On the basis of this concept probability of hand off failure determined.

During the course of movement when the MT touches the particular point "P"(say) on the circumference of cell of NBS connected to centroid of rectangular overlapped area by a straight line (assumed), Hierarchical Mobile IP(HMIP) is registered with New Foreign Agent and the received signal strength(RSS) from OBS falls down. RSS of NBS at this particular point may not be sufficient to send the HMIP the messages to New Foreign Agent through NBS and then RSS of OBS may operate to send messages. Hence, HMIP registration with New Foreign Agent is acquired before MT moves beyond coverage area of OBS.

As soon as MT touches the said particular point "P"(say) on the circumference of the said cell, it may proceed to any direction and its probability density function will be 'Q' [1]. If its movement is to straight line, it will touch the side of rectangular overlapped area point at 'Q'. Again when MT crosses the midline of rectangular overlapped area, handoff will occur. Hence, we may say probability of false handoff initiation "Ha"(say) is independent of distance between the said particular point "P"(say) a circumference of cell and the centroid "R"(say) of rectangular overlapped area and the distance "PR" i.e. "PQ+QR" maybe represented by 'd+l'(say) [1]. Hence,

$$H_a = 1 - \frac{1}{\pi} * \frac{5\pi}{12} = 1 - \frac{5}{12} = \frac{7}{12} = Constant \ldots \text{EQN(1)}$$

In this case false handoff initiation is independent of 'd', but dependent on 'L'. Here L = "0" (assumed).

Therefore, false handoff initiation is independent of distance from 'P' to 'R' i.e. (d + L), if overlapping does not occur i.e. L= "0".

Now, based on available information's of false handoff probability and handoff performance Handoff latency and its failure probability along with call dropping chance may be reduced to zero by Hybrid Channel Allocation(HCA) and admission algorithm [15]. As a result data transfer will be enhanced to optimum level and priority call will be provided to the users during handoff latency period, if occurred. It is also revealed from the previous work[2] that algorithm based BMBHO may reduce handoff latency, data loss, canning duration of data packet to to a great extent and as a result forced call termination probability will be zero simultaneously it may enhance the mobile node (MN) efficiency.

III A. PROBABILITY OF HANDOFF FAILURE:-

Now, It maybe said that false Handoff initiation is the first stage of Handoff failure probability and it is directly proportionate to value of 'L' as shown in Fig. 4. Therefore, it maybe said, that

$H_a \propto L$
(L = Distance)
(Ha = False handoff initiation)

The increase in value of 'L' will certainly create loss to limited resources of wireless system networks and produce unnecessary load on the system that will result in probability of false Handoff initiation.

Again, if the radius of cells "a"(say) is decreased, the problem of false Handoff initiation will be increased. Hence, we are to keep the value of 'L' = 0 with a view to maintain a constant value of false Handoff initiation which is reflected in equation (1). The correlation between probability of False Handoff initiation and 'L' is shown graphically in Fig.4. probability of Handoff failure.

III B. CO-RELATION BETWEEN SPEED AND PROBABILITY OF HANDOFF FAILURE

It is revealed from the previous work in this direction that handoff failure probability "HF"(say) is directly proportional to the speed of MT 'S'(say), Then $HF \propto S$

The latency of intra-system handoff is less than that of inter-system handoff as the inter system HMIP signaling message are handled over by 'MT' Home Agent (HA) instead of Gateway Foreign Agent (GFA) and the distance of MT from HA is greater than that of MT from the GFA. Again, the handoff failure probability "HF"(say) is increased with the increase in handoff signaling delay S(say). Hence, we may say that,

$$HF \propto T$$

Accordingly, an adaptive measure is to be taken so that the delay in Handoff signaling is not happened and at the same time the value of 'L' should be kept as zero i.e.

L = 0 (assumed).

Again from the work [1] it is assumed that successful Handoff initiation is directly proportional to distance 'd'(say) . But false handoff initiation is independent of distance 'd' and it is inversely proportional to cell size

"a" = (radius of cell) [11], Here 'd' denotes the distance from 'p' to side of assumed hexagonal cell and the related value of 'd' depends on both radius 'a' of the proposed circular cell and side of assumed hexagonal cell[1] Accordingly, a relationship between 'a' and 'd' maybe represented as follows:

$$d = \frac{(2-\sqrt{3})}{2}.a \qquad (2)$$

It is revealed from equation (1) and (2) that false Handoff probability is dependent both on circular cell radius and variable values of 'L' when hexagonal cells are overlapped. Hence here 'L'=0 as there is no overlapping of assumed hexagonal cells and as such there will be always seven (7) free channels out of twelve (12) during false Handoff initiation (Fig.4).

As there is no overlapped hexagonal cells, the equation of 'L'$\neq$ 0 does not arise at all in our proposed work. The relationship between false Handoff initiation probability and variable values of 'L' is shown graphically in Fig.4.

In our proposed work there is no chance of overlapping of assumed hexagonal cells each having more than one antenna applying distributed antenna system technology If overlapping of hexagonal cells occur incidentally, some modern mechanisms like specific algorithm based BMBHO, G.P.S. for minimizing the number of access points to be scanned by mobile node during each handoff procedure and area concept algorithm already introduced in the system, may obviously decrease the scanning delay to a greater extent, data loss, cost, probability of false handoff initiation, handoff failure, handover latency and thereby reducing the forced call dropping probability to zero, Simultaneously, the proposed system may increase the mobile nodes throughput and efficiency of the entire system to a greater extent.

Information based on GPS with the help of trajectory of motion of Mobile node(MN) and the positions of neighbouring access points and area concept algorithm is used in the proposed method with a view to minimize handoff failure effectively [12].

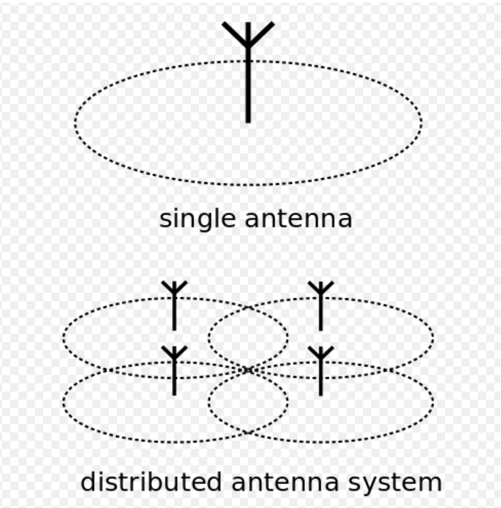


Fig 5. A diagram contrasting a single antenna configuration with das (distributed antenna system).

In the proposed work, distributed antenna system technology[13] has been used by increasing the number of antenna with a view to provide better coverage over same geographical area and improve the reliability along with minimization of radiation level and thereby decrease in overall power consumption[14] resulting in perfect coverage over the concerned area as shown in Fig 5.

It is also revealed from the previous work [1] that handoff failure probability is directly proportional to handoff signaling delay. So, we may say that handoff signaling decomposition is introduced to make the neighbor cells aware of resource demands and quality of service requirements of mobile terminal before the actual Handoff time. Network preparation algorithms are executed according to call admission control and the handoff preparation algorithms is activated during actual Handoff time. Hence, actual Handoff failure probability is minimized. The call requests are allowed in progress to continue as the MT moves between cells during handoff. A new MT improves the quality of service in cellular network system by taking care of handoff call requests whose dropping is prevented by a controlled dropping ratio until a pre-specified target number of new cells or channels are blocked. Handoff dropping probability and new call blocking probability are reduced with the help of new call admission algorithm [15] The purpose of blocking new call requests is to reserve bandwidth for handoff calls. But during heavy traffic jam there maybe acute shortage of channels or new cells resulting in new call droppings which may be prevented by the application of Hybrid channel allocation (HCA) strategy the purpose of which is to work efficiently and to maintain a minimum S/T ration. During successful handoff movement of MT from one cell to another may be interrupted due to interference of co-channels, heavy traffic and path loss which may be solved by HCA with the help of mobile switching center (MSC).

IV. RESULT AND DISCUSSION

Probable factors responsible for handoff failure probability resulting in unsuccessful handoff are analyzed and described in depth during the course of study and it is revealed that MT speed, handoff signaling delay, values of 'L' are directly proportional to handoff blocking probability. On the basis of these findings, a consonance of mechanisms is being proposed that may reduce the data loss, scanning time, cost, handoff failure to a certain minimum level and thereby reducing, forced call dropping probability to zero. Algorithm based BMBHO help MT to choose the best satellite for successful handover resulting increase in call quality. It also transpires from our proposed consonance of mechanisms that scanning duration of data packets of handoff may be decreased to a great extent with the help of minimizing number of access points(AP), location of neighboring APs, trajectory movement of MN which would select the most effective and potential AP used for lowering the number of channels to be scanned in very short time. Another associated but major problem i.e. electromagnetic radiation is produced automatically due to the use of single big antenna. To solve this single antenna emitting electromagnetic waves at high power, maybe replaced by low power antenna to cover the same geographical area resulting in remarkable reduction in total electromagnetic radiation and the power per antenna is reduced. As a result, the overall power levels may be reduced. It transpires from the equation no.2 that initiation of handoff failure is indirectly proportional to radius of the assumed circular cell.

Successful handoff initiation is directly proportional to 'd', value of which is dependent on radius of the assumed circular cell and length of side of proposed hexagon. The false handoff initiation does not depend on 'd' but it depends on values of 'L'.

When L=0 the false handoff initiation does not depend on cell size and it is 7/12 which is constant. If overlapping of proposed hexagonal cell occurs, false handoff initiation will depend on cell size and L≠0 while its value will not remain as constant.

Hence, probability of handoff failure is inversely proportional to cell size while L≠0 and $H_a \neq \frac{7}{12}$

Normally handoff preparation algorithm is activated during handoff process to prevent handoff failure. The dropping of handoff call requests is generally prevented by controlled dropping ratio until a pre-specified number of new cells or channels are blocked.

Handoff dropping probability and new call blocking probability are reduced to a great extent with the help of new call admission algorithm. Recently new call dropping is being prevented with the application of hybrid channel allocation strategy during heavy traffic jam while successful handoff is in progress.

V. CONCLUSION AND FUTURE WORK

It is concluded that there is ample scope for undertaking further research work to prevent probability of handoff failure and to ensure availability of instant free channels or cells for new call requests while handoff is in progress keeping in mind the heavy traffic jam, interference of co-channels and path loss. If overlapping of hexagonal cells occurs, false handoff probability will depend on cell size resulting in non constant value of $H_a \neq \frac{7}{12}$ which brings further study.

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