Minimization of Call Blocking Probability by Using an Adaptive Heterogeneous Channel Allocation Scheme for Next Generation Wireless Handoff Systems

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Abstract

Nowadays IEEE 802.11 based wireless local area networks (WLAN) have been widely deployed for business and personal applications. The main issue regarding wireless network technology is handoff or hand over management. The minimization of handoff failure due to call blocking is an important issue of research. For the last few years plenty of researches had been done to reduce the handoff failure. Here we also propose a method to minimize the handoff failure by using an adaptive heterogeneous channel allocation scheme.

Keywords: *IEEE 802.11, Handoff failure, GPS (Global Positioning System), Channel allocation, Neighbor APs.*

1. Introduction

For last few years handoff becomes a burning issue in wireless communication. Every base station has a limited number of channels. Thus a proper channel distribution is required to perform the handoff successfully.

1.1 Handoff

When a MS moves out of reach of its current AP it must be reconnected to a new AP to continue its operation. The search for a new AP and subsequent registration under it constitute the handoff process which takes enough time (called handoff latency) to interfere with proper functioning of many applications.

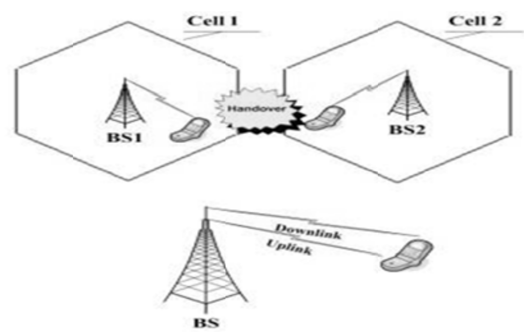

Figure 1. Handoff process

Three strategies have been proposed to detect the need for hand off[1]:

*mobile-controlled-handoff (MCHO):*The mobile station(MS) continuously monitors the signals of the surrounding base stations(BS)and initiates the hand off process when some handoff criteria are met.

network-controlled-handoff (NCHO):The surrounding BSs measure the signal from the MS and the network initiates the handoff process when some handoff criteria are met.

*mobile-assisted-handoff (MAHO):*The network asks the MS to measure the signal from the surrounding BSs.the network make the handoff decision based on reports from the MS.

Handoff can be of many types:

Hard & soft handoff: Originally hard handoff was used where a station must break connection with the old AP before joining the new AP thus resulting in large handoff delays. However, in soft handoff the old connection is maintained until a new one is established thus significantly reducing packet loss .

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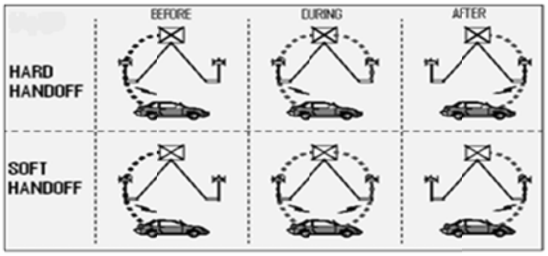


Figure 2. Hard handoff & Soft handoff

In NGWS(next generation wireless system),two types of handoff scenarios arise: horizontal handoff, vertical handoff[2][3].

- *Horizontal Handoff:* When the handoff occurs between two BSs of the same system it is termed as horizontal handoff. It can be further classified into two:

- *Link layer handoff* : Horizontal handoff between two BSs that are under the same foreign agent(FA).

- *Intra system handoff* : Horizontal handoff between two BSs that belong to two different FAs and both FAs belong to the same gateway foreign agent (GFA) and hence to the same system.

- *Vertical Handoff* : When the handoff occurs between two BSs that belong to two different GFAs and hence to two different systems it is termed as vertical handoff .

Call admission control (CAC) and network resource allocation are the key issues of concern. CAC determines the condition for accepting or rejecting a new call depending upon the availability of sufficient network resources. On the other hand, the network resource allocation decides how to accept incoming connection requests. This is where we are going to apply our method.

1.2 Channel distribution

IEEE802.11b and IEEE802.11g operates in the 2.4GHz ISM band and use 11 of the maximum 14 channels available and are hence compatible due to use of same frequency channels. The channels (numbered 1to14) are spaced by 5MHz with a bandwidth of 22MHz, 11MHz above and below the centre of the channel. In addition there is a guard band of 1MHz at the base to accommodate out-of-band emissions below 2.4GHz. Thus a transmitter set at channel one transmits signal from 2.401GHz to 2.423GHz and so on to give the standard channel frequency distribution.

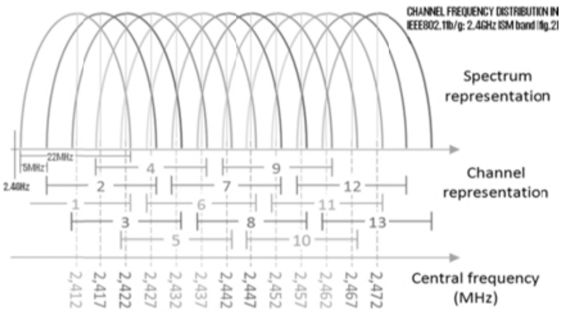


Figure 3.Channel distribution

Many dynamic allocations of channel have been proposed by different authors and all these mechanisms will improve the performance of wireless network. However for practical reason channel allocation is done in a static manner.

In section II we take you through the various works that have already been done to achieve this and in section III We introduce a new method to minimize the call blocking probability by using an adaptive heterogeneous channel allocation scheme for next generation wireless handoff system. This is followed by performance evaluation of our proposed technique using simulations in section IV after which in section V we propose a few areas in which further improvement can be made. Finally, we provide an extensive list of references that has helped us tremendously in our work.

2. Related works

In last few years, many researches had been done to develop a user friendly channel allocation. The simplest way of channel allocation is “Guard channel” allocation where the handoff call is given more priority than the new calls by reserving a fixed number of channels for them[1]. In [2], only the new voice calls are buffered in queue whereas in [3], both new call and handoff call are allowed to be queued. Author of [4] proposed a handoff scheme with two level priority reservation. Higher priority is given to the handoff call because termination of ongoing call is more annoying than the new one [5]. All of the above researches are based on voice cellular system. But due to the rapid development in wireless communication, the effect of non-real-time service needs to be taken in consideration [6]. Author in [7] proposed a method where only data service handoff requests are allowed to be queued where as a two dimensional traffic model for cellular mobile system is proposed in [8]. Some algorithms also proposed for multimedia users with fixed bandwidth requirement in [9], [10], [11], [12]. In [13] author used a two dimensional Markov chain to propose a new approximation approach that reduces the computational complexity. Authors of [14], [15] propose a dynamic channel allocation i.e. no fixed channel among the cells where all channels are kept in a central pool and will be assigned dynamically when the new calls will arrive. For choosing any one channel from the pool where more than one channels are available, a new method is proposed in [16]. In [17], authors proposed a non-preemptive prioritization scheme for access control in cellular networks where as a dynamic buffering is used to minimize the traffic congestion in mobile networks [18].

3. Proposed Works

In case of queuing systems the channels registered for hand-off calls alone and the space for both new generating calls and hand-off calls are fixed in nature. We require the demarcation between these two spaces to be adaptive to the requirements of the nature of the area in which these cells belong.

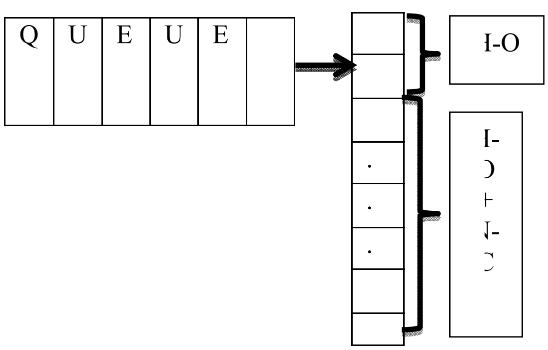


Figure 4. Queue

H-O => Channels reserved for Hand-off only.
H-O+ N-C=> Channels reserved for Hand-off and New-calls generated within the hexagonal cell.

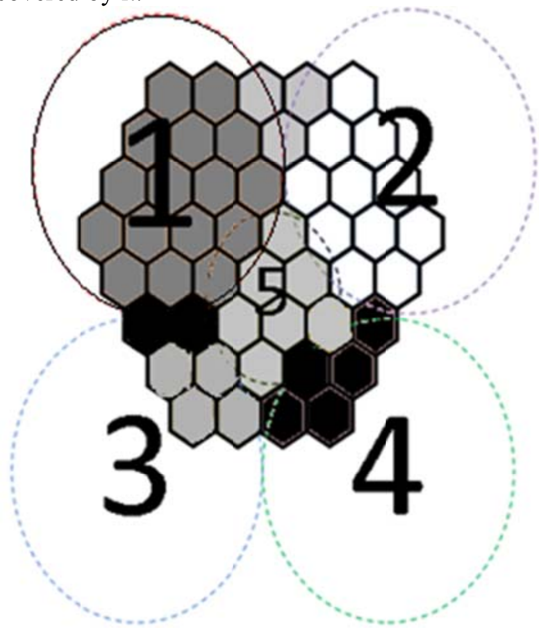
Now the total number of channels in a particular cell is divided among the different types of calls like new calls, hand-off calls, data calls etc. In our case we are mainly interested with new calls and hand-off calls. If we can devise a method for an optimized and systematic way of dividing the number of channels channel into channels reserved for hand-off and those for new-calls and hand-off both we can reduce the call blocking probability or in other sense the hand-off failure.

Here we assume two kinds of arrival rates: a) λ_{n-c} : arrival rate of new-calls b) λ_{h-o}: arrival rate of hand-off calls.

Although call termination rates (μ_{n-c} and μ_{h-o}) play an important role in determining the call blocking probabilities and thereby in determining the hand-off failure probability, but in our case for determination of the fractions of total channels devoted to only Hand-off and that to both hand-off and new calls are calculated only on the basis of the call arrival rates and their types.

Here we assume some discrete fractional allocations based upon the type of call arrival and their rates.

In this paper the demarcation lies on the previous call arrival rate history of an area that is the hexagonal cells covered by it.



AREA ID	COLOR	RELATION
1		$\lambda_{n-c} << \lambda_{h-o}$
2		$\lambda_{n-c} < \lambda_{h-o}$
3		$\lambda_{n-c} > \lambda_{h-o}$
4		$\lambda_{n-c} >> \lambda_{h-o}$
5		$\lambda_{n-c} = \lambda_{h-o}$

Figure 5. Cell Cluster

For the yellow, violet and orange colored cells, the values of λ_{n-c}, λ_{h-o} are not well-defined ie. they may be varying widely with time and so no definite relation can be ascertained.

In this case we assume that to be partitioned in to some sub-divisions which have different relations between λ_{n-c}, λ_{h-o} and hence the subareas covered by the hexagonal cells can be assumed to be heterogeneous. Till date most of the present work in the literature is based upon homogeneous cells and uniform nature of subareas covered by those homogeneous cells.

Our scheme proposes different channel allocation schemes for the different cases as shown above.

When $\lambda_{n-c} << \lambda_{h-o}$, it is evident that the channels allocated for (H-O+N-C) as denoted earlier should be much greater

than that for only H-O . So we can assign some discrete weights to represent this fraction. This will ensure that the blocking probability is as minimum as possible.
The total number of channels may be determined by the following expression.

Let,
C_T=total number of channels;
C_{H-N}= number of channels reserved for both hand-off and new calls generated within the cells;
C_H= number of channels reserved only for hand-off.
W_{H-N}=weightage on C_{H-N}
W_H=weightage on C_H
Here we assume $W_{H-N}+ W_H=1$.
Determination of the values of W_{H-N}, W_H.
$W_{H-N}= \lambda_{n-c} / (\lambda_{n-c}+\lambda_{h-o})$ …………………….. (1)
$W_H= \lambda_{h-o} /(\lambda_{n-c}+\lambda_{h-o})$ ………………………….(2)
Equation (2) is not so significant in this case because suppose for the case $\lambda_{n-c}=0$, it doesn't really make any effect if we take

$W_{H-N}= W_H$ 1…………………………………….(3) as hand-off calls will be processed in any case.

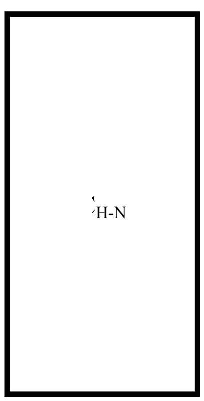
Thereby

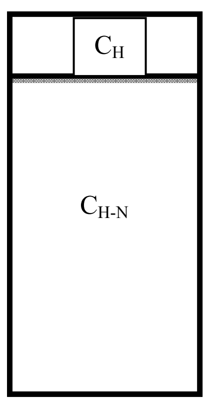
$C_{H-N}= W_{H-N}*C_T= \lambda_{n-c} / (\lambda_{n-c}+\lambda_{h-o})*C_T$ ………(4)

$C_H= W_H*C_T= \lambda_{h-o} / (\lambda_{n-c}+\lambda_{h-o})*C_T$ …………….(5)

Which reaffirms our assumption that: $C_T=C_{H-N}+C_H$ ………………………………………….(6)

Now channel allocation can be as varied as the following:





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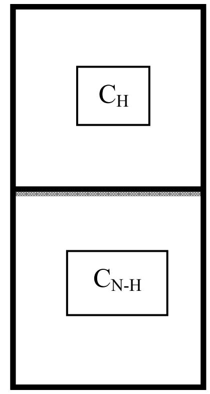

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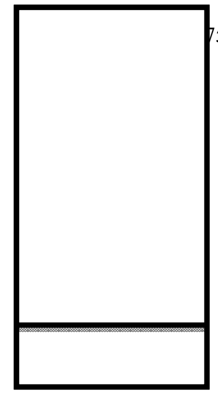

4

1 represents $\lambda_{n-c}= \lambda_{h-o}= 0$
2 represents $\lambda_{n-c} >>\lambda_{h-o}$
3 represents $\lambda_{n-c}= \lambda_{h-o}\neq 0$
4 represents $\lambda_{n-c} << \lambda_{h-o}$(although this case is not important)

4. Simulation Results

We simulate our proposed method by using the above conception. For justifying the practicability of our method in real models we made an artificial environment where we are going to apply our method. At first we have consider a case where the number of channels reserved for both hand-off and new calls are much greater than the number of channels reserved for handoff calls(25%). Corresponding result is shown in Figure.6. Where we can see up to 25% of the channel, handoff probability is maximum and no call dropping occurs at here.

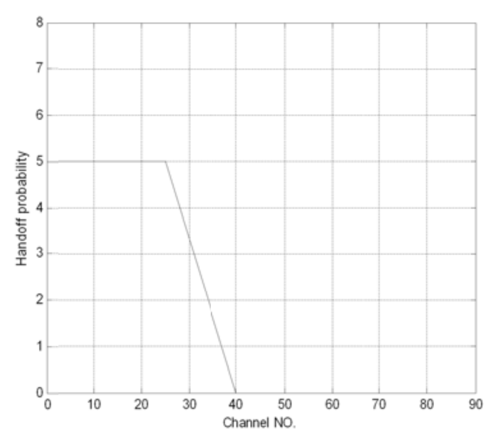

Figure.6

Next, we consider a case where the number of channels reserved for both the hand-off and new calls are equal to the number of channels reserved for handoff calls(50%) and the simulation result shown in below. Here we can see up to 50% of the channel allocation there is no call dropping probability.

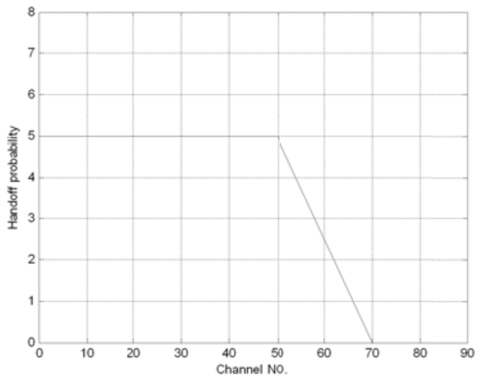

Figure.7

At last, we consider the number of channels reserved for both hand-off and new calls are much smaller than the number of channels reserved for handoff calls (75%). Here also we can see up to 75% of the channel allocation there is no call dropping probability.

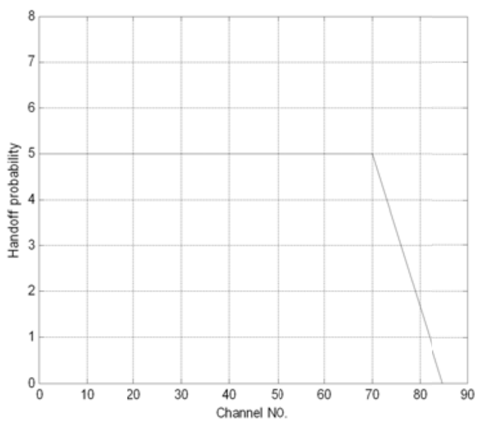

Figure.8

5. Conclusion

Our proposed method aims at reducing handoff time by reducing the number of APs to be scanned which is accomplished by fitting a trend equation to the motion of the MS. This in turn reduces the number of channels to be scanned which brilliantly reduces the handoff failure as is clear from the simulation presented in the above section.
However the proposed algorithm may prove erroneous if the motion of the MS is too much random to be used for prediction purposes. Future works in this field may include research on more refined algorithms regarding channel allocation. Error estimation method may also be improved. It is worth mentioning here that although the proposed work has been presented considering honeycomb structures yet our algorithm would work in a similar manner for other cell structures and neighbor AP locations. Minor changes would be introduced depending on the network topology.

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