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Congestion Control in Mobile Network by Prioritizing Handoff Calls

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Abstract

The demand for wireless cellular services continues to increase while the radio resources remain limited. Thus, network operators have to continuously manage the scarce radio resources in order to have an improved Quality of service for mobile users. This paper proposes how to handle the problem of congestion in mobile network by prioritizing handoff call, using the guard channel allocation scheme. A specific threshold value for the time of allocation of channel in the algorithm is determined. The scheme is simulated by generating various data for different traffics in the network as a replica to real life. The result is used to determine the probability of handoff call dropping and the probability of the new call blocking as a way of measuring the network performance.

Keywords: Channel, Mobile Cellular Network, Handoff, Call block.

1.0 Introduction

Congestion control in wireless networks has been investigated extensively over the years and several schemes have been implemented, to improve the performance of wireless network. Thus, it is highly essential that the problem of congestion control is eradicated in wireless technology.In wireless mobile networks, Quality of Service (QoS) refers to the measurement of a system with good transmission quality, service availability and minimum delay.It is the capability of the cellular service providers to provide a satisfactory servicewhichincludes voice quality, signal strength, low call blocking and dropping probability, high data rates for multimedia and data applications etc.The convenient of use and freedom to move anywhere at any time make the cellular wireless networks popularamong the users. Mobility of the users also pose a challenge to the network engineers for achieving the desired. As a mobile station (MS) moves from one cell to another, its ongoing call is handed-off from the old cell to a new cell. This requires that the call is accommodated by the new cell, since dropping a handoff call is more annoying than blocking a new call from user's perspective. The increase in demand for wireless communication system necessitates the need to managethe incoming new calls and handoff calls more efficiently. In wireless and cellular communication systems, handoff is animportant aspect that affects QoS due to the mobility of the mobile device. The major problem is the making of suitable decision on the available channel, at a particular time, either to be assigned to the new or the handoff call when such an assignment is to be made. In this paper, the channel assignment problem is dealt with the main objective of minimizing both the handoff calls and the new calls. Also, by prioritizing the handoff calls over the new calls when few channels are available, in order for the users to complete their communication session successfully.
Different channel assignment model have been applied by the researchers to provide better QoS, this include; the Static Channel Assignment (also known as Fixed Channel Assignment (FCA)), the Dynamic Channel Assignment (DCA) and the Hybrid Channel Assignment (HCA). FCA is done based on the forecast traffic to meet the immediate future demand. In the DCA, the process of sharing channels is adaptive and varies in accordance to the changing demands. Thecombination of the SCA and DCA lead to Hybrid Channel Assignment, of which a number of channels are pre-assigned and some channels are reserved for online assignment upon request. Thus, the paper reviews various channelassignment models to provide an optimal channel assignment technique in order to control congestion problems in wireless communication field.

2.0 Literature Review

Channel Assignment -The channel assignment schemes in general can be classified into three categories: fixed channel assignment (FCA), dynamic channel assignment (DCA), and the hybrid channel assignment (HCA). In FCA, the set of channels are

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permanently allocated to each cell based on a pre-estimated traffic intensity. In DCA, there is no permanent allocation of cha nnels to cells. Rather, the entire set of available channels is accessible to all the cells, and the channels are assigned on a call-by-call basis. DCA allows the number of channels in a cell to vary with the traffic load,increasing channel capacity with little costs. One of the objectives in DCA is to develop a channel assignment strategy, which minimizes the total number of block ed calls [1]. FCA scheme is simple but does not adapt to changing traffic conditions and user distribution. These deficiencies are overcome by DCA but FCA out performs most known schemes in DCA under heavy load conditions [2] . To overcome th e drawbacks of FCA and DCA, HCA was proposed in [3],which combines the features of both FCA and DCA techniques. In HCA one set of channels is allocated as per the FCA scheme, and the another set is allocated as per the DCA scheme.
There are different approaches that are applied in handling both the new call and the handoff call. Handoff (also called Hando ver) is the mechanism that transfers an ongoing call from one cell to another as a user moves through thecoverage area of a ce llular system [4]. Handoff could also be described as the process of continuing with the ongoing call even when the user is m oving from one cell to the other, or one sector to the other sector in the cell without drop. This process is one of the essential means that guarantees user mobility in a mobile communication network. Handoff is also referred to as the procedure that tra nsfers an ongoing call from one cell to another as the user's moves throughthe coverage area of cellular system in [5]. The ha ndoff area is the area where the ratio of received power levels from the current and the target base stations is between the han doff and the receiver threshold[6-8]. An adaptive algorithm for call used admission control on the concept of guard channel was proposed in [9], it considered theblocking probability of handoff call with hard constraint. Whenever new call request or handoff request arrives, the base station will check to see if there is a channel available in current cell. The call will be connec ted if there is a channelavailable and it will be dropped if there isn't any channel left. So handoff request and new call request are dealt withequally. The cell doesn't consider the difference between Handoff request and new call request. It assigns the ch annels to BS by First Come First Serve basis in [10] and [11]. The Quality of Service is not satisfied because the handoffbloc king rate is as same as new call blocking rate. The so called "Guard-channel" (GC) concept offers a means ofimproving the p robability of a successful handoff by reserving a certain number of channels allocated exclusively for handoff requests. The r emaining channels can be shared equally between handoff requests and new calls [12,13]. Guard channel policy provide som e kind of priority to the handoff call over the new call [14] and this is one way toreduce the handoff failure rate is to prioritize handoff calls since less number of channels are available for new calls [15].

3.0 System Description

This paper considers guard channel allocation technique in wireless cellular network and channel allocation as two key syste m resources that have direct influence on the performance of the mobile network. Performance comparison of both the propos ed work and traditional methods is measured.

(a) System Model:

The guard channel is a priority scheme that reserves some amount of channels for handoff calls.That is, in guard channel sche me, larger number of the total available channels in a cell are reserved for handoff calls only. Thus, the originating calls woul d make use of less number of the available channels as indicated in Figure 1.

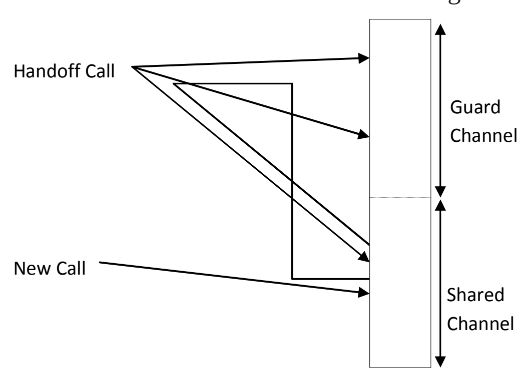

Figure 1: Proposed Guard Channel

In the guard channel, priority is given to handoff requests by reserving fixed number of channels. The remaining channels are shared by both originating calls and handoff requests.When there is no idle channel for the handoff call, the set of share chan nels (for both the new call and the handoff call) would be assigned only to the handoff call,while the newly arrived call woul d be blocked.
In [16], a fault-tolerant channel acquisition algorithm which tolerates communication link failures and node (MH or MSS) fai lures was proposed; this was integrated with a channel selection algorithm. In these algorithms, a borrower needs to consult with its interference neighbors in order to borrow a channel. Thus, the borrower fails to borrow channels when it cannot com

municate with any interference neighbor. In real-life networks, under heavy traffic load, a cell has a large probability to exper ience intermittent network congestion or even a communication link failure. They made use of timers in their work to deal wi th MSS or communication link failures. The selection of the timeout value affects the system performance. If the timeout val ue is too large, a handoff may be dropped due to the long delay. If the timeout period is too small, there may be less opportun ity for the channel selection algorithm to choose achannel which can maximizechannel reuse. The timeout value also depends on the applications. For example, a handoff request can tolerate muchless delay than a new call request. (Under normal condi tion (no network congestion), the average one-waycommunication delay between two MSS's is 2 ms, which covers the trans mission delay, the propagation delay, and the message processing time [17,18].
We assumed that both types of calls arrives according to Poisson arrivals. The arrival rate of both the handoff calls and the or iginating calls are λ1 and λ2 respectively. The following parameters are defined as follows:
h_1 - handoff calls
h_2 - originating calls
λ - Mean arrival rate
λ_1 – Arrival rate for originating calls.
λ_2 – Arrival rate for handoff calls.
N- Fixed number of channels in each cell.
H- Channel Holding time H, that is the entire duration that a channel is allocated when a subscriber request for service.
µ-Frequency of the allocation of N to a subscriber.
At a particular cell, the total traffic intensity for the handoff calls and the originating calls is given as;

$$a = \frac{(\lambda 1 + \lambda 2)}{\mu} \quad (1)$$

Thus, traffic intensity for handoff call (b_1) is;

$$b_1 = \frac{\lambda 1}{\mu} \quad (2)$$

and the traffic intensity for originating call (b_2)is;

$$b_2 = \frac{\lambda 2}{\mu} \quad (3)$$

where λ is the total call arrival rate.
The waiting time of handoff call for channel allocation is given by:

$$W_1 = \frac{\rho}{\lambda 1(1-\rho)} - \frac{\rho}{\lambda 1} \quad (4)$$

Also, for new call, the waiting time for channel allocation is:

$$W_2 = \frac{\rho}{\lambda 2(1-\rho)} - \frac{\rho}{\lambda 2} \quad (5)$$

(b) System Algorithm
The algorithm used in this research work set the threshold value of the time of allocating channels to either the handoff calls or new calls as t= 2 ms. The system flowchart is shown in Figure 2.

4.0 Results and Discussion

The behaviour of the proposed model could be predicted through the use of simulation method. The result obtained would be the duplicate of the situation of the real-life network. Also, the necessary QoS parameters such as: new call dropping and han doff call dropping would be estimated. This attempts to explain observed behaviour using a set of simple and understandable rules. These rules can be used to predict the

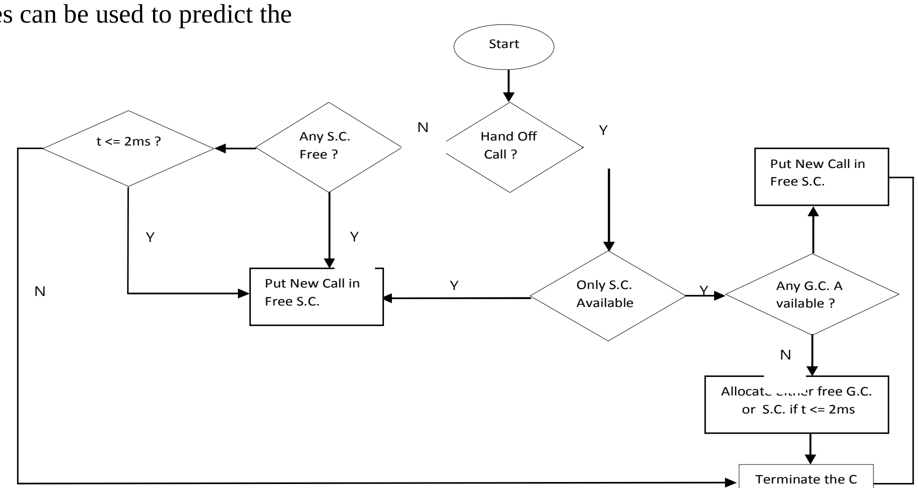

Figure 2: System Flowchart

outcome of experiment involving the given physical situation. C++ will used to write the simulation program to implement th e system characteristics with all the necessary QoS parameters to determine the various call blocking and call dropping proba bilities.
The simulator generates different data, which will act as the rate at which different traffics enter a real life network, an indicat ion of the system state. This would be used in calculating the different probabilities i.e new call blocking probability and han doff call dropping probability. The performance analysis of the system is carried out, shown in detailed graphs, under differe nt scenarios to testthe efficiency of the system. Performance metrics include the new call blocking probability, handoff call dr oppingprobability, and buffer size. These metrics would represent the number of new calls and handoff calls blocked by thesy stem at any point in time. Network resource utilization is often a good indicator of efficiency in systems whereresources may become congested even though others are ignored. Finally, the effect of buffer size on handoff callblocking probability is also investigated with appropriate documentation for effective deployment of the scheme.

5.0 Conclusion

This research applied the guard channel techniques for prioritizing handoff calls over the new calls to control congestion in m obile phone. The intention of the work is to reduce both the blocking and the dropping probabilities. The paper work aims to wards improving the quality of service of the handoff generally, since the dropping of handoff frustrates the user more than th e blocking of the newly originated calls.

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