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Effect of Mobility on Guard Channel Based Call Admission Control Scheme in Cellular Networks

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ABSTRACT
In cellular telephone system, some channels known as Guard Channels are used exclusively for handover calls. The impact of this is improvement in probability of successful handoffs. For efficient usage of these reserved channels knowledge of mobility patterns, channel occupancy time and rate of call arrival is required. The guard channel based call admission control scheme has some drawbacks, in particular when load is high and mobiles are moving at larger speed. As the relative speed of mobile terminals is increased which lead to more handoffs per call, the required number of reserved channels increases, this lead to less number of channels available for newly arriving calls. As a result the capacity drops. In this paper a analytical model is analyzed to study the effect of variation in mobility on system performance in terms of blocking probability of new calls, dropping probability of handoff calls and Grade of service (GoS).The studies shows that for a given value of QoS, system having cells with small radius or mobile terminals moving at high speed, has lower capacity than systems where mobiles have low mobility.

Categories and Subject Descriptors
C.2.1 [**Computer Communication Networks**]: Network Architecture and Design – *wireless communication.*

General Terms
Management, Performance.

Keywords
Mobility, Cellular Network, Call Admission Control, Handoff, Guard Channels.

1 INTRODUCTION
One of the most important and influencing feature of wireless cellular communication system is the mobility of the subscribers. Communication between base stations (BS) and mobile terminals (MT) in different locations and while on move is provided by mobility. During mobility of MT, continuous and uninterrupted services are available due to handoff [1]. It is the process of transferring a MT from one BS or channel to other. When a mobile terminal during active call moves from one cell to another, radio resources need to be transferred to new base station. Quality of service (QoS) degradation and dropping of call can take place when insufficient channels are available during transfer of call. The blocking of a handoff call is more annoying as compared to blocking of new call. Therefore handoff call must be given priority over originating new calls [4]. Various handoff priority based call admission control (CAC) schemes have been proposed, which can be broadly classified in two categories mainly Guard channel (GC) and Queuing priority (QP) schemes [2]. In this paper the analytical model of Guard channel based Call admission control scheme is analyzed for variation in user mobility. The results also gives and idea about percentage of channels reserved for handoff calls for better resource management and good QoS to the subscriber.

2 ANALYTICAL MODEL
We consider an analytical model of a single cell in a cellular wireless communication network [2]. Let C be the limited amount of channels available in channel pool. Each cell reserves ‘n’ channels for handover calls in such away that no new originating calls are admitted when number of channels in usage is greater than or equal to B = C-n channels. These channels are shared by both new call as well as handover call. Incoming handoff calls are dropped only if all resources are full i.e. when no channel is available. Both new and handoff calls are assumed to arrive as independent Poisson processes with rates λ_N and λ_H respectively. Let μ be the rate at which the mobile engage in call leaves the cell as well the rate at which an ongoing call completes services [3].

Let C (t) denotes the number of busy channels at time t, then {C(t), t≥0} is a birth-death markov chain with state transition diagram shown in figure no.1.Let P(i) represents the steady state probability that the BS is in state I The state balance equations are:

$$\begin{cases} (\lambda_N + \lambda_H) p(i-1) = i\mu p(i) & ,1 \le i \le B \\ \lambda_H \, p(i-1) = i\mu p(i) & ,B \langle i \le C \end{cases}$$

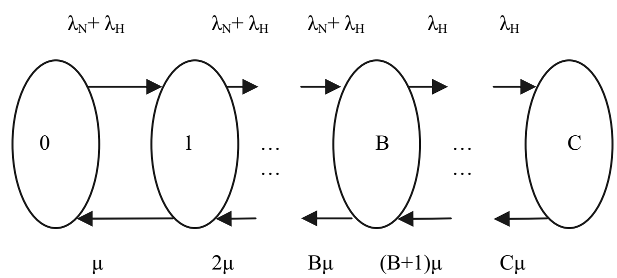

Figure 1. State Transition Diagram for the model

Steady state probability p (i) can be calculated as

$$p(i) = \begin{cases} p(0)\dfrac{(\lambda_N + \lambda_H)^i}{\mu^i i!} & , i \le B \\ p(0)\dfrac{(\lambda_N + \lambda_H)^B (\lambda_H)^{i-B}}{\mu^i i!} & , B \langle i \le C \end{cases}$$

Where

$$p(0) = \left[\sum_{i=0}^{B} \frac{(\lambda_N + \lambda_H)^i}{\mu^i i!} + \sum_{i=B+1}^{C} \frac{(\lambda_N + \lambda_H)^B \lambda_H^{i-B}}{\mu^i i!} \right]^{-1}$$

blocking probability for originating call is calculated as

$$P_b = \sum_{i=B}^{C} p(i)$$

and dropping probability of handoff call as[4].

$$P_d = p(c) = p(0)\frac{(\lambda_N + \lambda_H)^B (\lambda_H)^{C-B}}{C!\,\mu^C}$$

Grade of Service (GoS) = $P_b + 10P_d$, also

$$Load \ \ (total) = \frac{\lambda_N + \lambda_H}{\mu}$$

Relative mobility 'a' is defined as ratio of rate of handoff call generation to rate of total call generation.

$$a = \frac{\lambda_H}{\lambda_N + \lambda_H}$$

As the value of 'a' varies, the rate of handoff per call also varies.

3 NUMERICAL RESULTS

For the analysis of the proposed model, the number of channels allocated to the cell i.e. C is taken as 12. width of the page – one

4 CONCLUSION

Studying the graphs, it can be inferred that there exists a definite trade-off between blocking of new calls and handoff calls. Different percentage of channels can be reserved for handoff calls to achieve required value of P_b and P_d. As the relative mobility of MT increases, the required number of channels for handoff calls also increases as there is more handoff per call. This leads to fewer channels available to new arriving calls, resulting in drop in capacity [1]. For given value of QoS, system with MT moving at high speed has lower capacity than system where mobility is low. This scenario can well be compared with subscribers moving on a super highway.

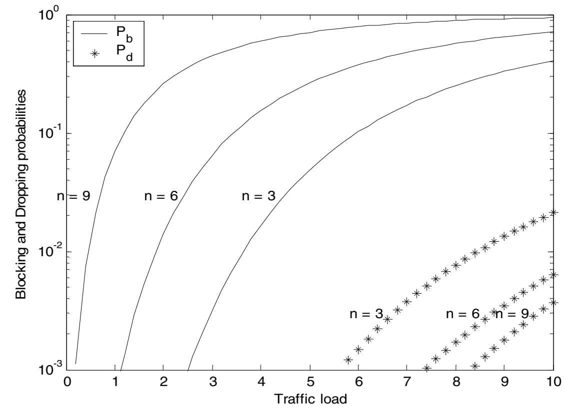

Figure 2. P_b and P_d as function of traffic load for a=0.5

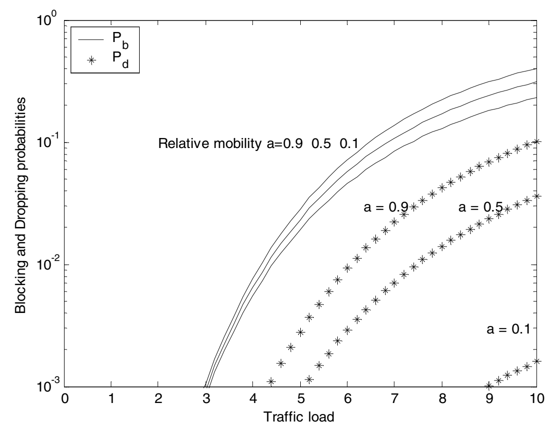

Figure 3. P_b and P_d as function of load, C=12, n=2 and a=0.5

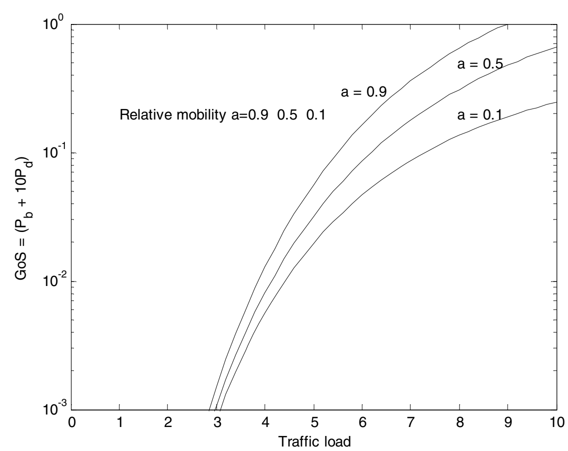

Figure 4. GoS as function of load and mobility 'a', C=12, n=2

Dynamic channel assignment strategy can be compared with this CAC technique to dynamically modify the number of reserved channels depending on requirement [5]. The situation can also be compared with traffic controlled handoff (TCH) technique where signal threshold value is varied according to handoff load.

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