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Minimisation of blocking probability for Handoff in ATM networks

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ABSTRACT

In today`s global scenario the demand of Wireless communication service is growing rapidly. In order to serve a high user population in a limited spectrum, using dense grids of microcells and picocells is one of possible schemes. While small cells relieve the capacity problem, frequent movements of mobile users across cell boundaries pose a big network control challenge: handover In personal communication networks (PCN) supporting network-wide handovers, new and handoff requests compete for connection resources in both mobile and backbone networks. Due to limited range of transceivers, mobile users can communicate only with base station that reside within the same microcell at any instant of time. The number of handovers during a call will increase, as the cell radii decreases, thus affecting Quality of Service (QoS). As the handoff rate increases, bandwidth management and traffic control strategy (call admission control, handover procedures etc) become more challenging problems in wireless ATM networks. Thus in a wireless environment, we need to consider two additional QoS parameters; dropping probability of handoff calls and blocking probability of new calls. Handoff calls require a higher congestion related performance i.e., blocking probability relative to new calls because forced call terminations due to handoff call blocking are generally more objectionable than new call blocking. In general, most of the previously proposed schemes for radio channel allocation in cellular networks reduce handoff call blocking probability substantially at the expense of increasing the new call blocking probability by giving higher priority to handoff calls over new calls in admission control. This reduces the total admitted traffic and results in inefficient utilization of wireless channels. The tradeoff between the new and handoff calls blocking probabilities should be defined. In this paper, a modified Hybrid scheme has been proposed for handover in ATM-based PCN, which combines reservation and queuing schemes for handoff calls. Also , the scheme assigns the handoff reserved channels to new calls depending on the locality principle in which the base station with the help of location estimation algorithm in the mobile location centre predicts the position of the mobile terminal. Here the FIFO and Measurement Based Priority Scheme (MBPS)queuing scheme are used. Thus the modified Hybrid Scheme is designed to have a remarkable reduction in forced termination Probability (FTP) along with to improve channel utilization while satisfying the QoS of the calls.

Introduction

Mobile communications have evolved and created a significant impact on the way of work and communication. The convergence of mobile communications, computing and ATM gave rise to wireless ATM networks. Wireless ATM networks provide seamless integration with ATM-based B-ISDN networks. The wireless ATM can be viewed as a solution for next generation personal communication networks (PCN) that support integrated data transmission i.e., voice and video with guaranteed QoS requirements.

Future wireless networks will provide ubiquitous communication service to a large number of mobile users. The design of such networks is based on a cellular architecture that allows efficient use of the limited available spectrum[2]. The cellular architecture consists of a backbone network with fixed base station interconnected through a fixed network, and of mobile units that communicate with the base stations via wireless link. The geographic area within which mobile units can communicate with a particular base station is called a cell. he mobile units communicate with each other, as well as with other networks, through the base stations and the backbone network. A set of channels is allocated to each base station. Neighboring cells have to use different channels in order to avoid interferences.

When a mobile unit initiates a call, it must first obtain a channel from one of the base stations that provides the strongest signal strength. If a channel is available, it is granted to the user. In the case that all the channels are busy, the new call is blocked, called as new call blocking. The user releases the channel either when the user completes the call or the user moves to another cell before the call is completed. The movement from one cell to another, while a call is in progress is called handoff. During handoff, the base station in the cell, to which the mobile unit moves is required to allocate a channel. If the base station has no idle channels, it may drop the handoff request and can cause Forced termination of a call in progress. From the subscribers point of view, forced termination due to handoff calls is less desirable than blocking of a new call. Therefore, the QoS of handoff calls must be guaranteed while allowing high utilization of wireless channels. QoS in cellular networks is mainly determined by the new call and handoff blocking probabilities.

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A hybrid queuing scheme has been proposed for handoff in ATM-based PCN, which combines reservation and queuing scheme for handoff calls. The rest of the paper is organized as follows. Section 2 discusses various channel assignment scheme. In section 3 we present a formal representation of our scheme. Analytical modeling of this scheme is given in section 4, followed by simulation in section 5. Finally, conclusions are given in section 6.

Channel assignment schemes.

Many schemes have been proposed in the literature. These schemes vary in the way of handling new and handoff calls.

The fully shared scheme (FSS)[5,6] is employed by typical radio technologies that have been proposed for personal communications services. In FSS, the BS handles the call requests without any discrimination between handoff and new calls. All available channels in the BS are shared by new and handoff calls. Thus, it minimizes

Rejection of call requests and has the advantage of efficient utilization of wireless channels. However, it is difficult to guarantee the required handoff blocking probability, which is not desirable.

The Guard channel scheme(GCS)[1,5,6] reserves, a number of wireless channels, called guard channels are exclusively reserved for handoff calls and the remaining channels are shared equally between handoff and new calls. The drawback of GCS is a reduction in the total carried traffic because less channels are granted to new calls. The demerits become more serious when handoff requests are rare. It may bring about inefficient spectrum utilization and increased blocking probability of new calls.

The Dynamic channel reservation scheme (DCR)[5] defines a value called threshold, less than the number of radio channels in the cell. The radio channels within the threshold are shared fairly between handoff and new calls. The remaining channels beyond the threshold are reserved preferentially to handoff calls, but unlike GCS, they can be allocated to a new call instead of immediate blocking. But this algorithm does not maintain satisfactory results in case of fluctuations in mobility. An modified DCRS[6] is dynamically adaptive channel reservation scheme, which reserves a number of channels called guard channels of handoff calls. But, here, if a new call arrives and if there is no foreseen handoff in the neighboring zones, a guard channel is assigned to the new call. This scheme satisfies the desired handoff blocking probability, reduces the blocking probability of new calls, and maximizes the channel utilization in wireless network.

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Hybrid queuing scheme

Given the resources i.e., channel and bandwidth that has to be allocated to the new and handoff calls, blocking occurs during call admission controls, without prioritized allocation scheme, handoff and new call would have the same blocking probability.

This scheme, reserves a number of channels, named guard channels, for handoff calls. The rest of the channels are shared by new and handoff calls.

As shown in figure (1) if a new call arrives and if it does not find a free shared channel, the schemes checks the MS measurement (where, in every cellular wireless system, measurements between the mobile station and the base station (BS) are recorded, where during the downlink, the MS measures the signal strength of its own cell and strength of the neighboring cell. On the same basis BTS-Base Transceiver Station also measures the quality and strength on the uplink. This process is known as locating the MS) and if there is no foreseen handoff in the first neighboring zone, a guard channel is assigned to the new call. If another new call arrives, another guard channel is assigned, if there is no foreseen handoff in the second neighboring zones and so on. They are covered by each neighboring zone depends on the importance of the handoffs over new calls. If handoff calls are more important then larger areas will be set to neighboring zones. If handoff calls are less important, then smaller areas will be set for the neighboring zones.

Handoff calls are admitted if any channel is free. If all the channels are occupied, the handoff calls are queued. Using FIFO and measurement based priority scheme (MBPS) queuing scheme[1,3]. Handoff requests are blocked only if it is waiting in the queue for free resources and the tolerance time period gets elapsed before granting a free resource.

Thus the hybrid queuing scheme combines the DACRS[6] and Queuing scheme[1,3].

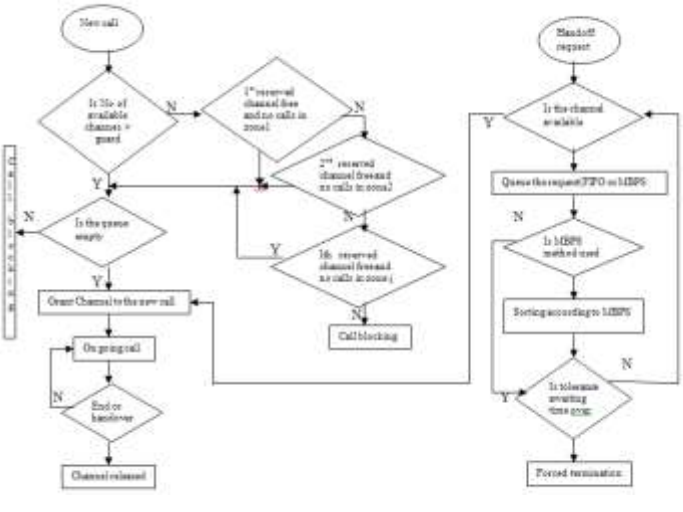

Figure 1. Call Processing flow diagram

Analytical model:

We consider a homogenous system[4,6], with the call arrival rate of new calls λ per call which forms a poisons process. The call holding is exponentially distributed wit mean $1/\mu$ and the dwelling time of a call in a cell is exponentially distributed with mean 1/h where the handoff rate is 'h'.

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Let us consider a 8/5/3 cellular system, i.e., there are 8 channels, of which 5 are shared channels and 3 are guard channels. As there are 3 guard channels, three neighboring zones should be defined as shown in figure (2). There are 9 states for the system as shown in figure(3) in which state '0' means no channel is busy and state 9 means all the 8 channels are busy.

But the new and the handoff calls compete equally for accessing the shared channels i.e., rate of switching from state k to k+1 is equal to handoff and new call arrival rate λ_h and λ_n respectively, while for accessing the guard channels, handoff calls have no condition to access and the new call can access the guard channel with a probability of having no active calls within the zone i denoted by α_i.

Thus, $\lambda_c = \lambda_n + \lambda_h \quad 0 \le k \le 5$

$\lambda_i = \alpha_i.\lambda_n + \lambda_h \quad 5 \le k < 8$

and i=1,2,3

If β_i is the probability that at least one call is available in the neighboring zone i,

then $\beta_i = 1- \alpha_i$

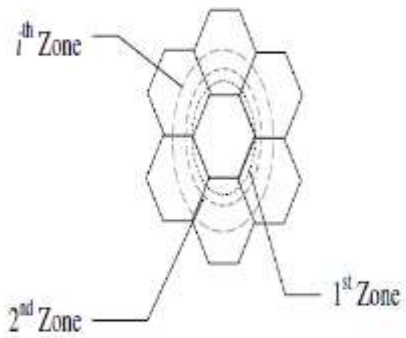

Figure 2. Guard channel zones

Simulation parameters

The simulation parameters to be used are as follows,

1. Number of cells : N = 30
2. zone percentage: γ_i =25% , 50% , 75%
3. Number of radio channels in each cell : 8
4. Number of radio guard channels in each cell : 3
5. New call arrival rate : λ_n = 0.1-

If π_i denote the probability that the system is in state i, then, the blocking probability is related to β_i and system being in states 5,6,7 and 8, while the dropping probability of system is being in state 8

$$\text{Thus } P_n = \sum_{i=1}^{3} \beta_i \pi_{i+4} + \pi_8 \quad \text{where i= 1,2,3}$$

$$P_h = \pi_8$$

As each zone is defined as the percentage of the area of all six neighboring cells, denoted by γ_i i.e.,γ_i = total area of zone$_i$/total area of 6 neighboring cells

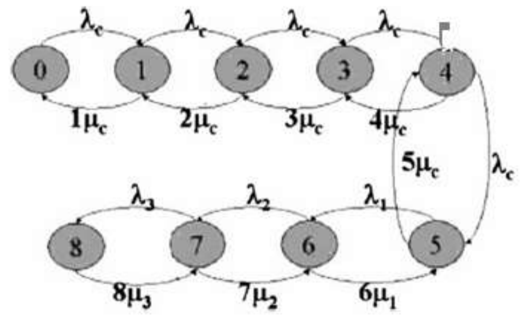

Fig. 3. An 8/5/3 cellular system model.

6. Call service rate : μ : 0.1-0.9
7. Offered load : ρ = 0.1-1
8. New call holding time: t_n = 60s
9. Handoff call holding time:t_h=30s
10. Maximum tolerance time in the queue : t_q = 10s

Conclusion:

In this paper we have proposed a hybrid queuing scheme for handoff calls which adapts the resource access priority via reservation and bandwidth adjustments in response to changes in signal strength and quality of calls in neighboring cells. The proposed hybrid scheme is expected to satisfy the desired handoff blocking probability by combing both queuing and reservation scheme, also to reduce the blocking probability of new calls, and maximize the channel utilization in wireless networks.

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