Bandwidth Sharing of Low Priority Services for Efficient Call Admission Control in Cellular Networks

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Abstract. We propose a novel call admission control scheme to support the multiservice of cellular networks particularly under heavy loaded cell condition. The key idea of our strategy is that the services which underutilize their assigned bandwidth because of their *think time* are dynamically grouped and forced to share the bandwidth in round robin especially when the resource availability is unfavorable. We present the simulation results that show our proposed scheme outperforms a conventional bandwidth reconfiguration strategy in terms of call blocking probabilities.

1 Introduction

We propose a novel call admission control scheme to remedy the bandwidth under–utilization problem of low priority services. In particular, even with the bandwidth adaptation capability [1][2][3][4][5], it is inevitable to allocate low priority services certain portion of bandwidth, however most of which are not fully utilized because of the traffic characteristic of the services though. For example, the most bandwidth allocated for WWW service is wasted because of the presence of user think time, the time period until clicking to access other pages

The key idea of our proposed strategy is that the services which do not fully utilize their assigned bandwidth are grouped into a set, and then forced to share the bandwidth in round robin with others in the same group rather than being allocated separate bandwidth, thus benefiting *bandwidth-efficient* services, which are generally real–time and, at the same time, have higher priority than others.

We assume in this paper the services belong to one of four classes of services which were recommended in UMTS domain as follows : *conversational class* (class 1) for voice or video conference traffic, *streaming class* (class 2) for real–time video streaming, *interactive class* (class 3) for WWW or database access, and *background class* for email or downloading. The class 1 services have the highest priority, while the class 4 the lowest.

This paper is organized as follows. Section 2 discusses our proposed call admission control strategy in detail and presents the algorithm flow chart. Section 3 shows the simulation results for the performance analysis of our proposed scheme. Section 4 concludes this paper.

2 The Proposed Call Admission Control Scheme

The proposed call admission control scheme is motivated by the fact that the traffic pattern of class 3 or 4 services, e.g., WWW surfing or database access contains a large portion of “think time”. It is the time duration elapsed between the completion of the transfer of the previous request and the beginning of the transfer of the current request [6]. In our scheme, we exploit this wasted think time to benefit the admission of higher priority services, i.e., class 1 or 2. The proposed scheme is devised to target the situation when the cell is not able to accept incoming high priority services because of a large number of existing low priority services.

The scheme works as follows. When the class 1 or 2 services request the admission to a cell, but there is insufficient bandwidth remaining, the existing class 3 and 4 services hand over their bandwidth in order to accept those requests. Instead, they form a bandwidth–sharing group in which they are able to continue their services by sharing the bandwidth in round robin. The bandwidth allocated to the group is much smaller than the total sum of the bandwidth owned by each group members. Because of the intermittent presence of the think times, the actual bandwidth usage times of each service may not overlap so often, thus their services are able to proceed without noticeable service degradation even with the round robin sharing.

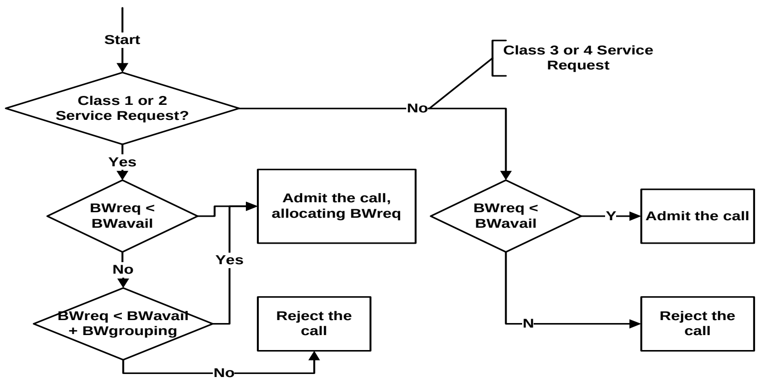

Fig. 1. The algorithm flow chart of our proposed scheme

Group Formation The group formation proceeds in three steps. At first, the amount of bandwidth to be collected, $BW_{collected}$, is calculated as

$$BW_{collected} = BW_{requested} - BW_{available} \tag{1}$$

where $BW_{requested}$ is the bandwidth amount required by ingress high priority service, $BW_{available}$ is the bandwidth available in the cell. Secondly, it is determined which low priority services should be included in the group by deciding c in the below equation.

$$min\{c : \sum_{i=1}^{c} BW_i \geq BW_{collected}\} \quad (2)$$

where BW_i is the bandwidth owned by low priority service i. The group formation is aborted unless c satisfying the above equation is found. Finally, once c is determined, the group is formed by including $service_1$ to $service_c$. Then, the group is assigned with the bandwidth of which amount is

$$max\{BW_i : 1 \leq i \leq c\} \quad (3)$$

which ensures that, once a service in the group possesses the turn to use the bandwidth, it proceeds without latency caused by the lack of the bandwidth.

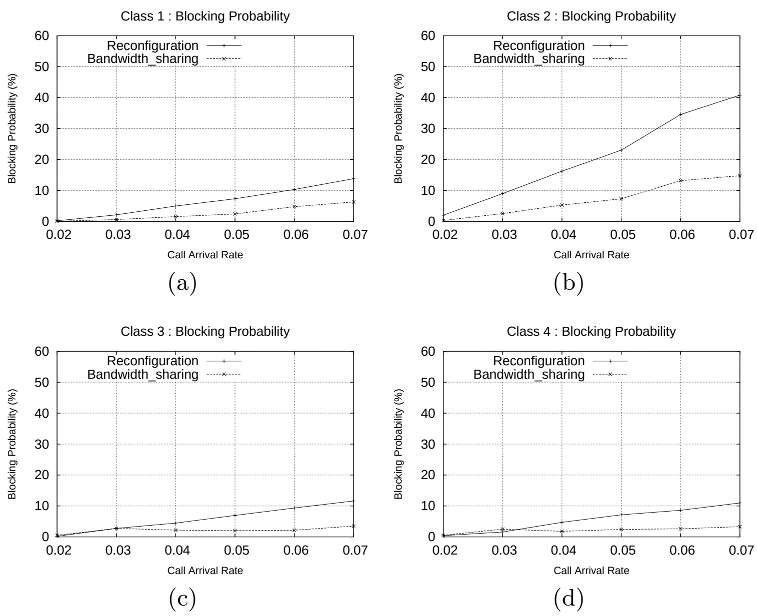

Fig. 2. Blocking probabilities of new and handoff calls (a) class 1 (conversational) (b) class 2 (streaming) (c) class 3 (interactive) (d) class 4 (background)

Figure 1 shows the flow chart of our proposed call admission control scheme. Note that our scheme is triggered only for the admission of class 1 and 2 services when there is insufficient bandwidth remaining in the cell.

3 Simulation and Performance Evaluation

We use a simulation map consisting of 19 hexagon-shaped cells, each of which has 2 Km radius, supporting up to 2 Mbps. The boundaries of the cells located at the borders of the map are wrapped around. As the radio propagation model in the simulation, we assume both the path loss and the shadowing model.

Mobile users in the simulation can have up to four services during their life time. The required bandwidth for each service class is: 16 Kbps, 32 Kbps, 8 Kbps, 16 Kbps for class 1, 2, 3, 4, respectively. The arrival rate λ of mobile hosts in the simulation follows the exponential distribution. The simulation results are collected for λ being incremented by 0.01 from 0.02 to 0.06.

Figure 2 compares the blocking probabilities, with the corresponding results of the reconfiguration strategy[1]. For all class services, the blocking probabilities were decreased, which demonstrates that our proposed scheme can admit more users than the reconfiguration strategy.

4 Conclusions

We proposed the call admission control scheme to prioritize class 1 and 2 services by having class 3 and 4 services be grouped into a bandwidth–sharing set particularly when the bandwidth of a cell is insufficient. Our proposed strategy was motivated by the fact that, in the case of interactive services like class 3 and 4, a large portion of assigned bandwidth is wasted because of the user think time. The simulation results were also presented.

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