Dynamic Call Admission Control by channel transfer along with QoS maintenance in wireless networks

Nitish Arora, Abhishek Gupta

***Abstract*—In this paper we investigate a Dynamic Call Admission Control (CAC) scheme with low complexity for practical purpose. The paper analyzes the QoS in terms of call blocking probability (connection level) and also packet loss probability (packet level). Excessive amount of idle channels are also used for increasing the bandwidth for the incoming calls and hence a certain amount of these channels are isolated without increasing the probability of an incoming call being blocked, hence further increasing the QoS. The algorithm is simulated in MATLAB and the results show that due its less complex and flexible nature and better results than the current Static Dynamic Call Admission Control scheme, it can be of practical importance when applied to heterogeneous networks.**

***Index Terms*—Dynamic, Excessive Idle channels, QoS**

I. INTRODUCTION

The want in today's world is connectivity, that too wirelessly. As the demand for wireless communication increases, the load on the channels increases directly. Considering the limited amount of resources available, like bandwidth, the requirement of the hour is to reuse and maximize the available resources. One important method in doing so is Dynamic Call Admission Control.

To admit a call, not only the required amount of channels should be available, which vary from video or voice or data call, but the quality of service (QoS) should also be maintained. QoS is measures in terms of connection level, like call blocking probability (Pb) and Call dropping probability (Pd), and packet level, which includes packet loss probability. The target is to keep the blocking and dropping probability (Pb and Pd) as well as the packet loss the least, which would allow the maximum amount of calls to connect with the required QoS.

With the exponential increase in the demand for wireless communication, it is important that the QoS is not compromised in any ways. With the increase in traffic it soon became a reality that the then current static dynamic call admission control protocols used were not efficient and were leading to a higher and higher values of blocking probabilities. The need then came to vary the channels in and among the cells so as to get the highest amount of calls to go through without reducing the QoS. That was when the research into dynamically allocating channels was started.

Recent researches have been going on in the field of Dynamic Call Admission Control (DCAC) schemes both in connection level and packet level areas. Some include queuing up the handoff calls till the required number of channels become available [2]. This leads to a fall in QoS. Some consider having variable guard channels [3],[4] which is a better strategy than having fixed guard channels for the handoff calls [5], but having guard channels is less feasible when very high speed are required. Throughput based CAC have also been considered but they admit calls based on the current load only which can lead to call being rejected even in the availability of channels [6].Various power based threshold methods have also been researched [7] [8], but these have different priorities for voice, video and data calls.

In our scheme we provide adequate connection level and packet level QoS. The current idle channels, with a safe margin kept for the incoming calls can be further used to give increased bandwidth to the new calls or provide separate error checking channels thereby increasing the QoS. The aim of the algorithm is to optimize and allocate the channels for new and handoff calls dynamically, with priority given to handoff calls, while also utilizing excessive idle channels to boost the QoS while also ensuring the required amount of connection level and packet level QoS is maintained.

The rest if the paper includes the following:

- Section 2 describes the algorithm in detail along with all the consideration.
- Section 3 explains the functioning of the program implemented and presents the result.
- Section 4 gives the significance of the result along with the conclusion.

II. THE PROPOSED ALGORITHM

The algorithm required a pre decided designation of the number of channels assigned to handoff and new calls respectively initially. A threshold value is assigned to each,

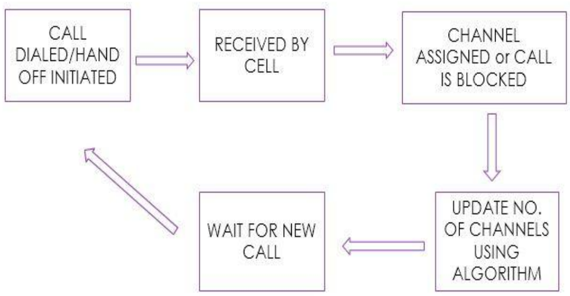

Fig: Placement of the algorithm in the flow cycle

the new call channels as well as the handoff call channels, denoted as Thresh_new and Thresh_hand. For the best result the value of thresh hold is kept at 70% to the maximum available channels for the category, hence it would vary as and when the number of channels in the category are adjusted.

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All the variable including the threshold and the total number of channels of each category are to be positive integers only.

Thresh_new = 0.7*total_new … (1)

Thresh_hand = 0.7*total_hand … (2)

In a fixed channel capacity, the number of channels in each category can only be varied by taking the required channels from the other category. Hence if in case of excessive new calls coming in channels could be borrowed from the handoff category if the channels currently in use by handoff is less than its threshold (Thresh_hand).

A call is admitted only if the channels are available in its particular category to admit the call. Otherwise the call is rejected or dropped and the respective dropping probability is updated.

Pb = calls_blocked / call_log_new … (3)

Pd = calls_dropped / call_log_hand … (4)

Different cases arise in our algorithm. First, when a call ends and the total channels currently in use in a category are less than its current threshold (like, B_occ_new < Thresh_new), in such a case the channels would be assigned to a category of 'excessive idle'. These idle channels can be used to either increase the bandwidth of the next incoming call (voice or video calls) or provide an error checking channel (data traffic). Alternatively if channels are available in this category and channels are required due to either the new call or handoff call used channels are going above threshold, then these would be used for increasing the total available channels in a category.

Secondly, if a call arrives resulting in the total number of channels going up than the threshold (like, B_occ_hand > Thresh_hand), in such a case first the algorithm will see if there are channels available in the excessive idle category and reclaim them and if not then it could borrow channels from the other category if in the other category the channels currently in use is lower than its threshold (i.e. B_occ_new < Thresh_new). If channels are taken and the total number of channels increase, the threshold value of both the category are again updated according to algorithm which is 70% of the total channels of the category. The number of channels borrowed from the other category is proportional to the number of channels above the threshold that are currently occupied (taken as L and K in the algorithm in fig 2.). If the channels cannot be taken from either of them, the call is admitted and the channels currently in use is updated, but the total channels do not increase and hence the margin for the new calls reduces.

Thirdly, if a call arrives in either category and there are not enough channels to accommodate such a call, the call blocking probability, Pb (which is in case of new calls) or call dropping probability, Pd (which is in case of handoff calls) is updated.

Using the blocking and the dropping probability, the packet loss is calculated.

The aim of the algorithm is to dynamically vary the channels of each category such that the call rejection probability can be kept the least and also that the packet loss is kept to satisfactory minimum.

```
if(new call arrives)
    if(B_occ_new + B_new_incoming <= B_new_total)
        admit call;
        if(idle_channels!=0)
            increase bandwidth;
            B_occ_new=B_occ_new+B_new_incoming;
        if(B_occ_new > Thresh_new)
            if(idle_channels!=0)
                idle_channels=idle_channels-K;
                B_new_total=B_new_total+K;
            elseif(B_hand_total <= Thresh_hand)
                B_hand_total=B_hand_total-K;
                B_new_total=B_new_total+K;
        elseif(B_occ_new < Thresh_new)
            idle_channels=idle_channels+L;
            B_new_total=B_new_total+L;
    else
        reject call;
        update Pb;

if(handoff call arrives)
    if(B_occ_hand + B_new_incoming <= B_hand_total)
        admit call;
        if(idle_channels!=0)
            increase bandwidth;
            B_occ_hand=B_occ_hand+B_new_incoming;
        if(B_occ_hand > Thresh_hand)
            if(idle_channels!=0)
                idle_channels=idle_channels-K;
                B_hand_total=B_hand_total+K;
            elseif(B_new_total <= Thresh_new)
                B_new_total=B_new_total-K;
                B_hand_total=B_hand_total+K;
        elseif(B_occ_hand < Thresh_hand)
            idle_channels=idle_channels+L;
            B_hand_total=B_hand_total+L;
    else
        drop call;
        update Pd;
```

Fig 2: The Algorithm

III. EXPERIMENTAL OUTPUT

The algorithm was implemented in MATLAB. Three different type of traffic were considered, video, voice and data, all occupying varying amount of channels. Having a fixed channel capacity 500 channels were each assigned to handoff calls and new calls at the time of initialization. The threshold were kept at 70% of each i.e. 350 for both new and handoff calls at the starting. Table I gives the channels required for the different types of calls.

The threshold was kept at 70% so that adequate number of channels are present in reserve, such that even when there is a burst of calls, there are channels available to accommodate them rather than the calls being rejected since the channels were present in the idle category and were being used to increase the bandwidth.

Type of call	Data	Voice	Video
Channels required	1	2	4

I: Types of calls and the channels required by them

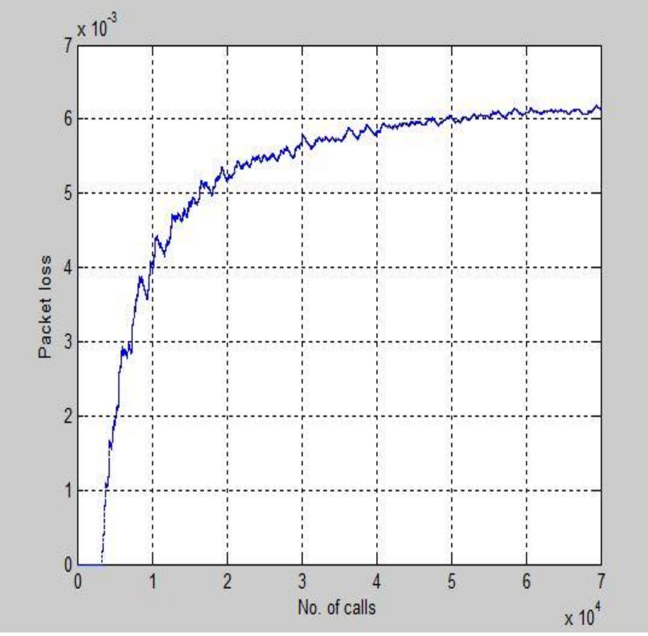

Fig 3: Packet loss

The algorithm for dynamically changing the numbers of channel in each category comes into play at the start or the end of each call. It analysis the number of channels in each category with respect to their threshold and then a decision is made if the number of channels are to be increased or decreased. Fig.3 shows the packet loss after the simulation. It starts with 0 since all the channels are considered as empty at the start of the simulation.

The target of call blocking, Pb, is kept at 0.1. The program is then implement for 70000 calls (could be either handoff or new call which is chosen by the program itself randomly.)

Fig. 4 show the call blocking probability, which is 0.062, which is considerably lower than what is obtained with static call admission control or even with guard channels.

Varying amount of idle channels are present at different time of the simulation. A record is kept of them and seen for how long a channel remains idle in terms of average call duration. This represents an increase in QoS by the increase in bandwidth.

The important values at the end of the simulation are presented in table II which are in limit for the practical implementation of the algorithm.

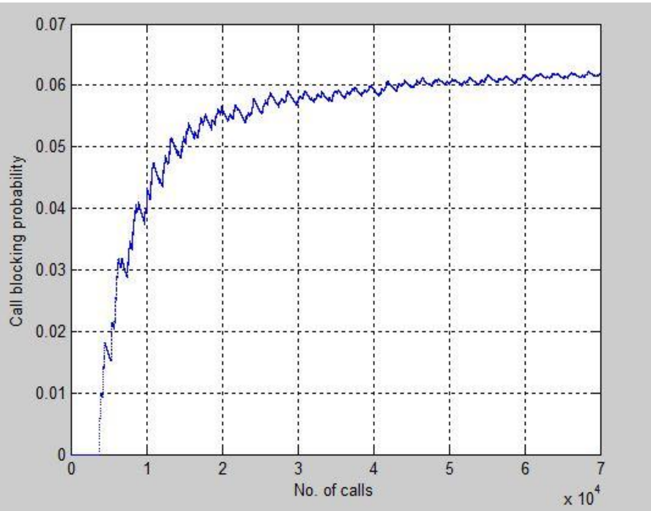

Fig 4: Call blocking probability

Parameter	Value
Call Blocking probability	0.062
Packet loss	0.006
Avg. duration of idle channel	2.672

II: Values at the end of simulation

IV. CONCLUSION

We are able to achieve the required target of packet loss and call blocking probability. Since the priority for handoff channels is always higher, the dropping probability would always be lower. As demonstrated the usage of the excessive idle channels that are available when the load is not heavy can be used to increase the bandwidth and QoS. The result makes it a viable option for practical usage.

Future work can be done to bring down the call dropping probability, Pd while also lowering the sophistication of the algorithm.

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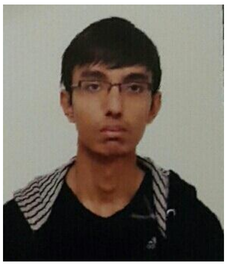

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