Advances in Wireless and Mobile Communications.
ISSN 0973-6972 Volume 13, Number 1 (2020), pp. 1-10

http://www.ripublication.com

Study of Dynamicity of Call Management and System Resource Management Using Call Admission Control (CAC) Protocol

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Abstract

Call Admission Control (CAC) is a key element in the provision of guaranteed Quality of Service (QoS) in cellular/wireless networks. We present CAC scheme based on factors such as distributed/local control and adaptively to traffic conditions. We consider handoff prioritization with a focus on dynamic reservation schemes. We also consider multi-service networks with pricing priority criteria. Here, we solve the basic drawback of bandwidth reservation approach for different type of calls to provide better system resource utilization and guaranteed QoS. In our paper, we achieve better QoS with maximum number of executed calls and maximum resource utilization.

Keyword: CAC, QoS, resource utilization, dynamic reservation

I. INTRODUCTION

With the ever increasing demand of cellular communication services, the importance of CAC protocol is also increased. The challenge of CAC protocol is to reduce traffic congestion with varied type of voice, data and multimedia services satisfying certain Quality of Services (QoS). CAC is the process of regulating traffic volume in voice communications particularly in wireless mobile networks and in VoIP (Voice over

Internet Protocol) also known as Internet telephony. If a defined limit is reached or exceeded, a new call may be prohibited from entering the network until at least one current call terminates. This means that the audio quality of individual calls can deteriorate to a certain extent before new calls are denied entry. CAC plays a vital role for traffic regulation because the volume of traffic in communications networks is inherently chaotic or bursty and traffic bursts are virtually impossible to predict. In this situation it is a great challenge to provide users mobile communication with QoS guarantee and mobility support. In our paper, we solve the basic drawback of bandwidth reservation approach for different type of calls which in turn lead to low system resource utilization and poor QoS. Here, we introduce a simple approach which works by assigning priority to calls of different type and allowing calls to go in processing state after checking for its priority and after checking the available resource to manage that calls. This way we calculate the total system resource usage by different types of calls after the network admin queries. At the same time, network admin can check how many calls of different types run at a particular interval of time. Handoff calls get higher priority over the new calls. One who is already on call may be talking about some important topic which if get disconnected would give a serious impact on the caller personal or business life compared to new call. More preference has to be given to customers who pay more to get better service without affecting the remaining customers who pay normal amount. This paper is organized as follows. In section II we describe related works. In section III we describe our proposed works. Software used for implementation is given in section IV. Section V presents the simulated result. We discuss the simulated result with graphical representations in section VI. We conclude our paper in section VII.

II. RELATED WORKS

CAC plays great role to support seamless mobility. It can be defined as a process for managing the arriving traffic at the call, session or connection level based on some predefined criterion. The scheme makes the decision based on past experiences whether to accept or reject the call. In paper [1] a fraction of total channel in a cell is reserved exclusively for handoff call where handoff call should get priority over new call. Here static reservation scheme provides poor resource utilization. The scheme [2] considers time period (T) which must not be very small not very large. The paper [3] distributes the newly accepted calls over time which leads to a more stable control. The scheme reserves a non-integral number of guard channels.The paper [4] reduces the new call blocking probability, increases the total carried traffic and keeps the forced call termination probability almost unchanged, independent on type of cellular structure. It can adapt itself to any dynamic fluctuations of a mobile traffic. The scheme [5] provides multiple connection level QoS for handoff calls of different types and maximize the bandwidth utilization via stochastic control. The scheme uses of fictitious stochastic control. The paper [6] is based on Guard Channel (GC) scheme for voice traffic and movable boundary scheme to dynamically adjust the number of channels for voice and data traffic. The scheme does not consider multimedia traffic. The power controlled CAC scheme [7] controls user classes with different priorities as well as service classes with different QoS constraints. The scheme prevents QoS deterioration in the active links and accepts the new users if and only if all users can be supported at their required QoS. The paper [8] provides different call admission /rejection ratios to different types of traffic according to their priority without sacrificing the channel utilization. The paper considers non-preemption and constant bandwidth for a class during the life time of the call. The extension of Fractional Guard Channel (EFGC) scheme [9] satisfies the hard constraint on handoff failure probability and service differentiation with proper bandwidth utilization. This scheme is insensitive of traffic load. It does not consider multiple classes. The combination of CAC and adaptive bandwidth allocation scheme [10] is able to reduce handoff connection dropping probability for active users of real time services to zero level. It also provides a low new connection blocking probability which translates into high resource utilization. Non real time traffic suffers because high priority is given for real time traffic. The paper [11] provides the stationary distribution of number of calls with different bandwidth requirements, different request call holding time, different call residence time which has a product form and then apply the result for each class of calls to obtain the grade of service in mobile network. The scheme [12] classifies Markov chain models into two categories: symmetric and asymmetric. This scheme obtains a product form solution to evaluate symmetric schemes and proposes a novel performance evaluation approximation method with low computational cost for asymmetric schemes. Here, adaptively adjust resources allocated to multiple service classes in real time is not considered. The paper [13] simulates the performance by considering the priority of the on-going connections and the performance evaluation shows that the proposed system has a good behavior in keeping the QoS of on-going connections. This proposed scheme only gives priority on ongoing connection without giving priority on requesting connections. The paper [14] proposes a price based-mechanism using fuzzy logic techniques which operates at the optimal load value or below, thereby meeting QoS requirements and maximizing the operator revenue. The scheme [15] provides the effects of pricing incentives in order to control the number of users requested access. The results explain that by setting a suitable price it not only can reduce new call blocking probability but also can increase the total revenue in the system, although some calls have given up because of changing price. Here, a fuzzy approach is used to model the current traffic load. This paper [16] restricts the new and handoff calls arrived to system by finding the optimal threshold number of new and handoff calls. The numerical analysis shows that required call-level QoS for both voice and data calls is provided and upper bound of data response time is guaranteed to data calls. Computing price for handover traffic is not considered here..

III. OUR PROPOSED WORKS

Bandwidth is a very much scarce resource. Operators earn revenue by using last bit of bandwidth purchased. So bandwidth reservation is a critical issue in CAC scheme. Bandwidth can be statically and dynamically reserved. But dynamic bandwidth reservation scheme utilize the available bandwidth efficiently to provide QoS guarantee with reduced new call rejection and handoff call blocking. We consider two most important services voice and data in our paper. Voice traffic is delay sensitive and requires real time transmission. It can tolerate some data losses. On the other hand data traffic is not so delay sensitive but they are very sensitive to packet loss and error rates. Voice calls are always given priority over data traffic in cellular networks as voice calls are more delay sensitive. In case of reserving bandwidth, a situation may arise where the bandwidth reserve for a particular call is not fully used, while there are more than exceeding limit of other type of call is in waiting. Thus to utilize the full bandwidth of system effectively, we use the concept of dynamic bandwidth allocation. We implement a system where we set priority for calls, because of which a new call entering to the system would be checked accordingly and allowed for processing. Whenever a new call comes in it is checked with priority table and if its priority is higher it is allowed and if not then the system checks that whether there is bandwidth available for allowing this call. This way of processing the calls allowed us to manage the processing capacity effectively and utilize all system resources as per requirement. In case of same priority calls the one which came first is processed first. Thus, we achieve the dynamicity of the call management and system resource management. We add few button to demonstrate that how calls are being processed. In real life situation we would replace the "button press incoming call" with the real life device which manages or receives incoming call with its call type. Here, when user presses the set button an over limit is set and in GUI blue boxes are generated according to over limit. This blue box would get replaced by other color boxes when new call comes in processing state. When calls get ended and if there is no call in waiting state to occupy that empty call process that would be filled again by blue box. The over limit for a call to be in processing state is set to 10 second. In real life situation this over limit of time is approx 90 minute after which call gets automatically ended. Here, this over limit is managed dynamically, so in later stage this can be changed accordingly. Here, a call is allowed to go in processing state after it is compared with the priority table which is dynamically set at the run time. There are four drop down boxes, each has a priority level and presses the "set priority button". After pressing the priority button we store the priority to a table and next time whenever a new call is entered into the system it is first checked with the priority table and then allowed to move on. No two call type would have the same priority and there are only 4 types of calls are chosen to demonstrate the scenario. Next time if user wants to change the priority in which the call is processing, the user changes the priority order in dropdown and the priority table is updated. Different types of calls in progress dynamically is shown in figure 1 and prioritized different types of calls is shown in figure 2.

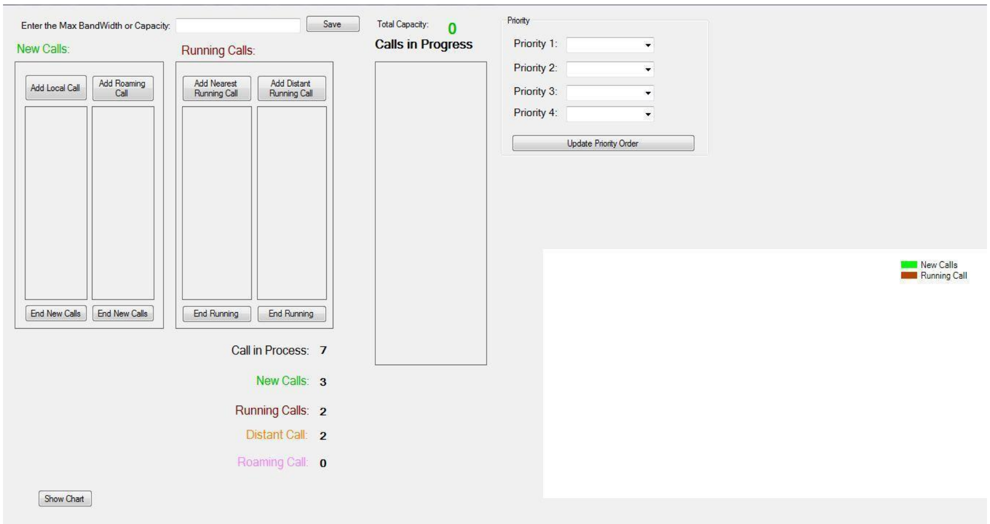

Figure1. Different types of calls in progress dynamically

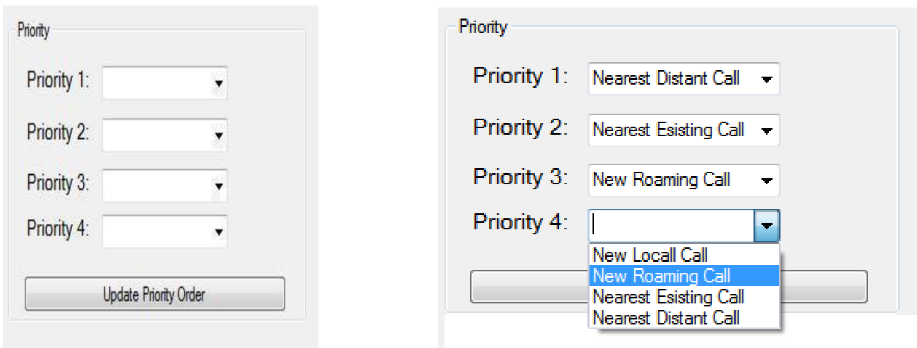

Figure 2. Prioritized different types of calls

IV. SOFTWARE USED FOR IMPLEMENTATION

The application is made on .Net framework, using C# language. It is a Windows based application which runs on windows machine on .Net Framework 4. The application is made by considering each new call an Object of a call class where the call type and thread for call processing are the property of the class. The classes are shown in figure 3. Each time when the call is checked for its priority, the respective thread is run for it. After the thread is stopped, the time elapsed is noted for further processing for graph generation

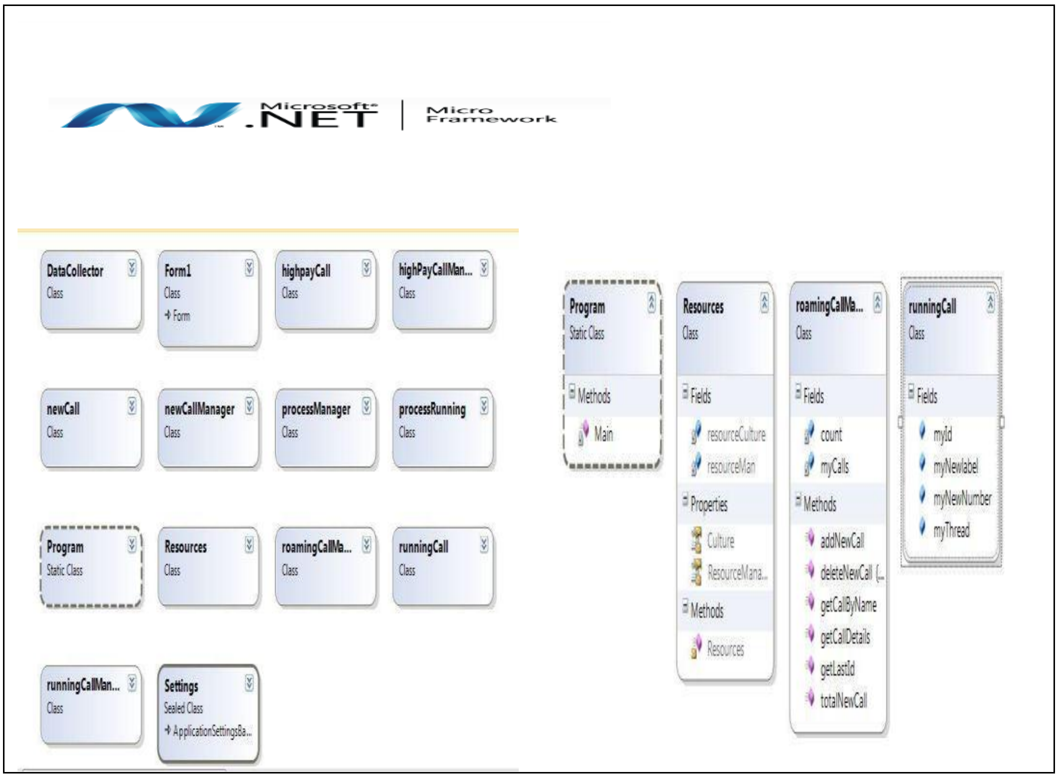

Figure3. Different classes and .Net framework

V. SIMULATED RESULTS

Here, we consider two groups of call, new call and existing call. New call is the call where a user tries to dial for first time. If the bandwidth is available then the user is allowed to connect its call or else will be in waiting stage or asked to try later, since the server is busy. Here, we also consider two subcategory of new call, new local call and new roaming call. Existing calls are those calls which are coming due to the tower shifting of a user who is in running state, who is continuously changing its area, thus changing previous tower with the new one. Thus, this call is most important since a user is on the call and should not be interrupted by tower shifting. But a situation may occur that the tower to which this call is shifting has no free space and thus this call would go in wait state. Nearest existing call is the call which is connecting from the nearest location to the tower and distant existing call is the call which is connecting from the distant location to the tower. Here, when a new type of call is created it comes with the call number so that we can differentiate that which call is coming earlier and which is coming last. In call management techniques calls enter to the system manually by pressing relevant button which helps to generate new calls or calls of different type. There are four buttons which are responsible to create four types of calls i) add new call ii) add roaming call iii) add nearest running call iv) add distant running call. The call which is coming to system is processed or checked for its priority first (FIFO property is used here). We have chosen different color boxes to demonstrate different types of call i) add new call --GREEN ii) add roaming call ---PINK iii) add nearest running call – RED iv) add distant running call –ORANGE. Running of different types of calls is shown in figure 4.

Figure 4. Running of different types of calls

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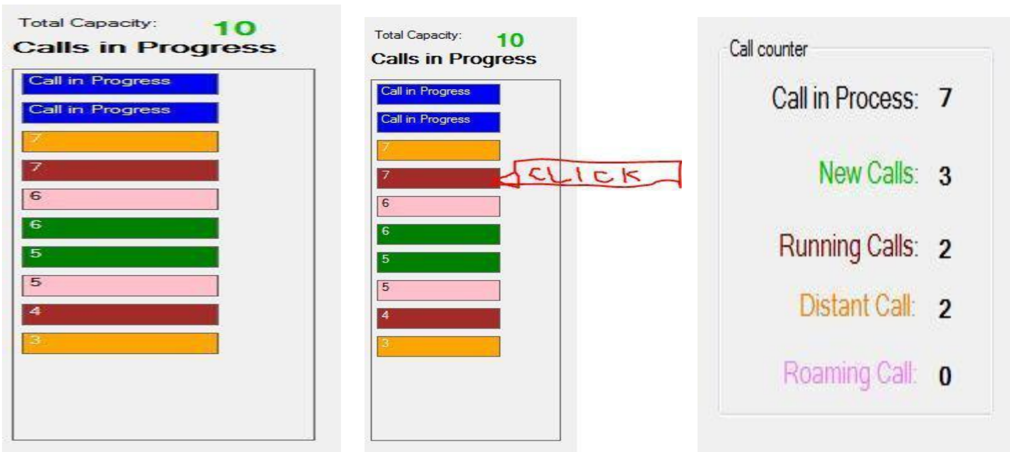

Figure 5. Controlling of Different types of calls

Controlling of different types of calls is shown in figure 5. Here, after checking with priority table respective call is taken to processing state. The blue color box which identifies ideal state of a call is replaced with relevant color box to that type of call which is taken after processing. A counter is added to the box which shows the time elapse of the call. The call would get automatically disconnected after the defined over limit period. But a situation may occur when the user itself disconnects the call before the over limit to the call. This situation is achieved by clicking on the box which shows running call. When call gets end, the box gets replaced by blue box. The respective call time is stored for system usage graph generation. In the call management application, we implement this in such a way that we keep track of how much calls are being executed among those how many are running new calls, existing calls, roaming calls and distant calls. Call counter gives the current count of calls which are being executed. Also few counters are there which shows how many calls are in waiting state.

VI. DISCUSSIONS WITH GRAPHICAL REPRESENTATIONS

We get two graphs from simulated results. Figure 6 shows that at each second of time interval of the processing time how many calls of different types are executed or are in running state. Figure 7 shows how much of the total system resources are used during whole time interval and how much of the total system resource are in idle state which is shown in a pie chart. In this pie chart, four sections are shown which measures the percentage of the system used by the calls during total runtime. Each type of call is executed for a particular interval of time which depends on maximum allowed time limit or disconnection of user calls. Thus a pie chart is generated with the share of each type of call at that session of total system usage.

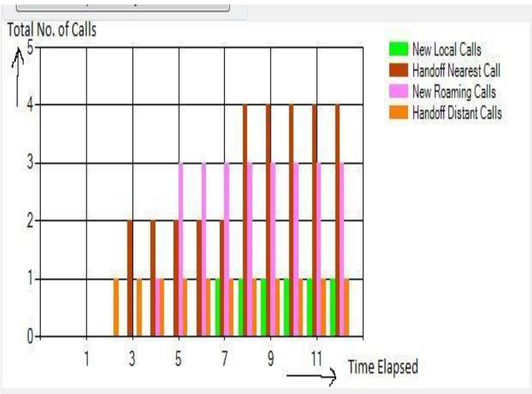

Figure 6. Time vs number of executed call

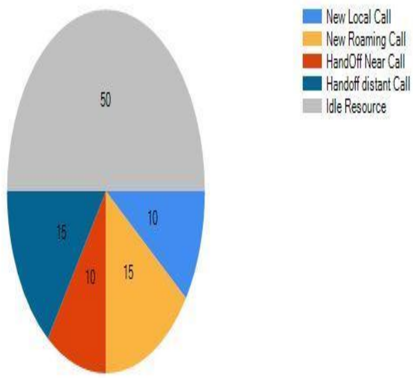

Figure 7. Total system resource usage

At the same time the total system resource which are not used or are idle is calculated with the following formula.

Total system resource available for the given time period= total time elapsed * total capacity.

Percentage usage=(total time for a particular type of call / total system resource)* 100

Total idle state = adding total times of all type of calls - total system resource.

VII. CONCLUSION

In our paper, we provide thorough discussion about knowledge of application control to support dynamicity of call management and system resource management using CAC protocol. We achieve better QoS with maximum number of executed calls and maximum resource utilization. We use "click to call end" to demonstrate the call disconnection by user end concept at the processing box but in real life user would cut the call.

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