A SURVEY ON RESERVATION BASED CALL ADMISSION CONTROL ALGORITHM IN CELLULAR NETWORK

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Abstract— *In cellular networks, call admission control (CAC) has a direct impact on quality of service(QoS) for individual connections which in turn affects overall system efficiency. Traditional reservation based schemes are not efficient for handoff rates, as the reserved bandwidth may not be utilized effectively in low hand-off rates. Therefore, we propose channel borrowing approach in which new calls can reserve bandwidth depending on its priority. Later, if handoff calls arrives and all the channels are busy, it will pre-empt the service of a borrower call if there exists. In addition the focus is also to reduce the call dropping probability(CDP) and increase the total system capacity and performance; Hence the QoS of the system can significantly be improved especially in high mobility environment.*

Keywords— Handoff, CDP, QoS, CAC

1. INTRODUCTION

The upcoming wireless cellular infrastructure such as third Generation (3G) and fourth generation(4G) are deemed to support new high speed services with different Quality of service(QoS).Vehicular networks are introduced to provide communications for safety applications such as collision avoidance, hard braking warnings, accident reporting, intersection announcements, etc. Safety applications often require fast message exchanges but do not use much bandwidth where vehicles are enabled to communicate with one another, i.e., vehicle-to-vehicle or vehicle-to-roadside communications. (Halabian, Rengaraju, Lung, & Lambadaris, 2015)

The goal of the CAC mechanism is to regulate the admission of new users, while controlling the quality of current connections without any call drops. In the traditional mobile networks, e.g., cellular and vehicular networks, CAC schemes have been designed to handle the voice traffic. In the design of CAC schemes, the most common QoS parameters for performance evaluation are call blocking probability (CBP) and call dropping probability (CDP). Call blocking means denying new calls due to insufficient bandwidth in the network or the QoS requirements. Call dropping means dropping an existing call during a hand-off process due to users' mobility (vehicular or pedestrian). Forced termination of a call in progress is more frustrating than blocking a new call. As a result, hand-off calls are treated differently by being given a higher priority over new calls in cellular/vehicular networks. Particularly, we may either reserve certain amount of channels from the total available channels in a cell for hand-off calls or dynamically allocate channels for an individual cell, based on the time-varying status of vehicular traffic. The amount of channel reservation for handoff calls is mostly based on users' mobility pattern, i.e., using vehicular traffic modeling that aggregates variables such as traffic density, mean speed, etc.

2. RELATED WORK

There has been a great research on CAC design and schemes in the literatures. In this paper, few important points are highlighted from previous papers. CAC schemes can be classified based on various design options. Each design option has its own advantages and disadvantages, as discussed below.

Sanjeev kumar et.al(Kumar, Kumar, & Pandey, 2014) has described a survey of different CAC schemes used for mobile multimedia networks using soft computing techniques like artificial neural networks, fuzzy logic, and genetic algorithms.

Kohonen's self organizing map (SOM), counter propagation network (CPN) can be used to improve the QoS mechanism which is also suitable for CAC with limited resources/bandwidth; and it has the advantage such as less call blocking and dropping probability, less bandwidth consumption and better resource utilization etc.

G. Nantha Kumar et.al (Technology, Kumar, Mahalingam, & Nadu, 2014) Robust Call Admission Control algorithm is proposed in this article, which tries to increase the throughput, and shows deduction in delay occurs in wireless heterogeneous networks. Here, the Call Admission Control plays a key role in providing guaranteed QoS in the communication links between heterogeneous networks. The aim of algorithm is to simultaneously provide priority based on transmission and space.

S.P.V.Subba Rao, et.al (Akyildiz & Wang, 2004) In this paper, a novel Call Admission Control algorithm for wireless cellular networks is proposed. The call admission control algorithm is based on power control. It determines the optimum number of admission users with optimum transmission power level so as to reduce the interference level and call blocking.

Ramesh Babu H.S, et.al (S & Satyanarayana, 2010) In this paper, the call blocking probability of the system for both the aggregate and individual traffic gets increased as the utilization rate gets increased , so by the use of their proposed fuzzy logic CAC , the call probability is reduced to almost 20%.

Yuzhe Zhou , et.al (Zhou & Ai, 2014), In this paper, the very trending broadband communication for high speed train is discussed in which the bottleneck problem of handover , and so to address and solve this issue a DEA (Data Envelopment Analysis) is borrowed to evaluates six typical methods or system models of handover. Their evaluation result suggests that RoF(Radio over Fiber) model is the best appropriate system to support high mobility communications.

Transmission can be opted by two ways either voice or data communication, but in cellular networks always the priority is voice in case of network traffic. So, in this paper, (Liu, Zhou, Pissinou, & Makki, 2007) a novel cal admission control algorithm is introduced that supports both voice and data and also on congestion , priority is given to voice traffic.

One of the important flexibility in using CAC scheme is that ,one can choose the design of scheme. In this paper author ,(Ahmed, 2005) has given some parameters of design choices, like Centralization Information scale, Service dimension, optimization , decision time , information type , considered link, information granularity. For example, information scale can be global, local, or semi-local.

Dusit Niyato and Ekram Hossain , (Niyato & Hossain, 2005) have discussed different CAC schemes and the issues related to different approaches for the call admission control. To approach an CAC scheme there are different challenges like heterogeneous environment , multiple types of services , adaptive bandwidth allocation and cross layer design.

The approaches related to different issues are guard channel, fractional guard channel, collaborative, non-collaborative, mobility based , pricing-based. Dependent on these different issues and approaches described in this paper one can make an conclusion on which CAC scheme should be used prior to the application.

3. SYSTEM FRAMEWORK

This section includes discussion on common architecture for Call admission control scheme called Novel based 4G wireless networks, admission control architecture.

A. *Call Admission Control Architecture in heterogenous networks*

This CAC module is two-tier architecture. In this architecture, CAC module is divided into two sub modules: one for the wired part and other for the wireless part.

1) *Wireless module:*

In this CAC needs to handle multiple classes of calls which also includes vertical handoffs from other type of networks. So, in this ABA (Adaptive bandwidth Allocation) is used to effectively utilize the bandwidth from resources. The base station serves two types of calls, voice and data, and both these types of calls share a common pool of channels. Under light load conditions,a data call is allocated as many channels as the user requests. Under heavy load conditions, each data call will receive at least one channel to maintain the connection(Niyato & Hossain, 2005).

To minimize the handoff call dropping probability, thresholds $k_{v,}\, k_{d,}\; k_{vd}$, C_d are set for voice , data , voice or data calls respectively as shown in Figure 1. This threshold helps to prioritize the calls over the handoff or network traffic condition

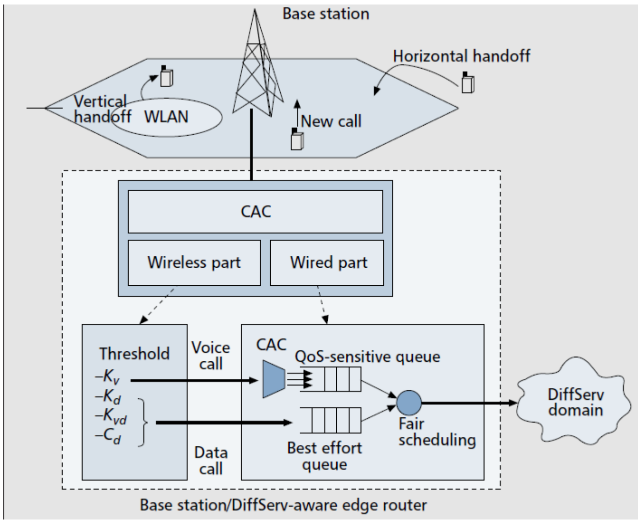

Figure 1: System model for the CAC scheme

2) *Wired module:*

In this system , CAC must ensure that the wired network can maintain the QoS of traffic from wireless users i.e., already transmitted through wireless links at the desired level. Both the call packet level performance requirements should be satisfied in the wireless part.

As shown in Fig.1, the DiffServ-aware edge router has two transmission queues: QoS and best effort (BE) with size U and V packets, respectively.

The QoS queue is used for voice packets, while the BE queue is used for data packets. A CAC mechanismis applied at the QoS queue to guarantee packet-level QoS.

B. Call Admission Control procedure:

CAC is one of the algorithms which decides whether an incoming call can be accepted or not. It also decides which of the available radio access networks is most suitable to accommodate the incoming call. Figure 2 shows call admission control procedure in heterogeneous cellular networks. A multi-mode mobile terminal wanting to make a call will send a service request to the JCAC algorithm. The JCAC scheme, which executes the JCAC algorithm, will then select the most suitable RAT for the incoming call.

The main responsibility of CAC is not only to minimize The blocking of new call requests and the dropping of handover connections, but also to reduce the unnecessary handovers as far as possible. As we have know that , Admission control is a research field that has been receiving a considerable amount of interest since the introduction of IP network architectures designed to support QoS for traffic flows.

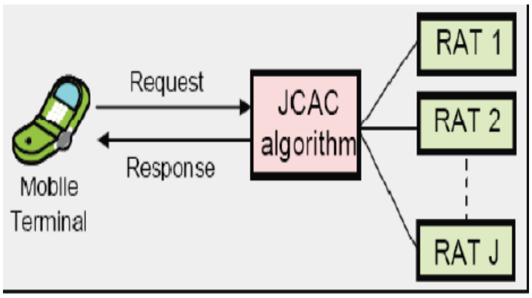

Figure 2: Call Admission Control Procedure

C. System model for the reservation based schemes:

Different classes of traffic have been defined in 4G wireless mobile networks. For example, WiMAX standard supports five different traffic classes and LTE defines nine traffic classes. A new call belongs to one of the traffic classes defined in the network. Other than the new call arrivals, there exist hand-off calls which are generated in a cell due to the mobility of users into the cell.

In this model, we assume that the high-priority class contains only the hand-off calls that is coming from other cells in the cellular network. We may also categorize the real-time new calls in the current cell into this class. The low-priority class contains the new calls generated in the current cell. We assume that the new calls are subcategorized to non-real-time (nRT) new calls and best effort (BE) new calls. Examples of nRT and BE calls are non-real-time multimedia traffic (e.g., Youtube video) and web traffic, respectively. Example of real-time traffic is live broadcasting. It is assumed that the arrival processes of hand-off, nRT, and BE calls are Poisson distributed with parameters λH, λnRT, and λBE, respectively.

We further assume that the service processes of the hand-off, nRT, and BE calls are exponentially distributed with parameters μH, μnRT, and μBE, respectively. The system bandwidth is channelized, and the number of channels (bandwidth units) in the system is *C*. *C* is not the network capacity in terms of amount of served traffic (which is dependent on the users' wireless channel model and interference). In this model, *C* denotes the number of physical network resources in a cell which should be allocated to the arriving calls, e.g., number of physical resource blocks in an LTE network.

D. Call Borrowing scheme in Reservation based schemes:

In this section, we introduce our channel borrowing Approach in the new call bounding scheme. The idea of channel borrowing can be implemented in any reservation-based CAC algorithm. Before we proceed to introduce our CAC scheme, we will clarify our motivations by mentioning the following points(Halabian et al., 2015):

- Among the new call arrivals, BE calls are the ones that are flexible in terms of QoS requirements. BE traffic is usually dedicated to non-critical services such as web traffic or file transfers. Therefore, the service of a BE call can be delayed or can be disrupted.
- In reservation-based CAC approaches, in cases where the hand-off arrival rate is relatively low and the arrival rate for BE calls is relatively high, the channels statically reserved for hand-off calls may be wasted since we idle the reserved channels and keep them for hand-off calls arriving in future. Hence, the channel utilization in such schemes is not efficient.

By considering the inefficiency of bandwidth utilization in reservation-based schemes and the flexibility of the service of BE calls, we propose the following channel borrowing scheme: We consider a reserved bandwidth of *T* channels for hand-off calls. We admit an nRT call only if there exists a free channel in the system, and the total number of new calls (nRT and BE) does not exceed $C - T$ (similar to what we do in the new call bounding scheme). However, we allow the BE calls to use all the channels in the system (upon the availability). When admitting a new BE call even if we violate the reservation of handoff calls, we still admit it if there exists any free channel in the system. Hence, a new BE call can borrow a channel from the reserved channels of hand-off calls. In this case, if in the near future a hand-off call arrives and there is no available channel in the system to serve it while the total number of hand-off calls in the system is less than *T* calls, the hand-off arrival can pre-empt the service of the borrower BE call. In this case, the BE call returns the borrowed channel. Nevertheless, we do not drop the service of the pre-empted BE call; instead, we will keep the preempted BE call in a queue and will resume its service as soon as a channel becomes available. We denote the size of this queue at time *t* by *X(t)*. At the arrival time of a BE call if $X(t) > 0$, we will block the new BE arrival. If we denote the number of hand-off calls, nRT calls, and BE calls in the system by $n1$, $n2$, and $n3$, respectively, we have the following properties for the dropping of hand-off calls and blocking of nRT calls and BE calls(Halabian et al., 2015)

- A hand-off arrival will be dropped if $n1 + n2 + n3 = C$ and $n1 \geq T$.
- If $n1+n2+n3 = C$ and $n1 < T$, a hand-off arrival will be admitted by pre-empting a BE call.
- An nRT arrival will be blocked if $n1 + n2 + n3 = C$ or $n2 + n3 \geq C - T$.
- A BE arrival will be blocked if $X(t) > 0$ or if $X(t) = 0$ and $n1 + n2 + n3 = C$.

4. Conclusion

In this paper, the general architecture of CAC scheme and its simple procedure of requesting and responsing the calls is described , which in turn gives the general idea of wired and wireless communication. The main focus of this paper is to have efficient utilization of bandwidth resources and increase the QoS by decreasing the call dropping probability. So, as to achieve this a call borrowing scheme is proposed in which BE calls are able to borrow channels from reserved channels based on priority for hand-off calls. The future scope for this area can be optimizing the frequency of high priority calls.

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