OptimizationAdaptive Call Admission Control Schemes with Bandwidth Reservation for LTE Network

[1]ManojKumar Anuragi, [2]Prof. Amrita Khera

[1]Research Scholar, [2]Assistant Professor

Department of Electronics and Communication, Trinity Institute of Technology & Research, Bhopal

Abstract-In recent years, consumers of 4G cellular networks have increased exponentially as they discover that the service is user-friendly. Due to the large users and their frequent demands, it is necessary to use the limited network resources that guarantee the eminent standard quality of service (QoS). Call admission control (CAC) scheme has a major impact in assuring QoS for different users with various QoS requirements in 4G networks. Recently, the reservation-based scheme and bandwidth degradation schemes were proposed with the aim to provide effective use of network resources and assure QoS requirements to admitted calls.

In this paper, we propose a novel CAC scheme to provide effective use of network resources and avoid the starvation of best effect traffic. The scheme introduces an adaptive threshold value, which adjusts the network resources under heavy traffic intensity. Simulation results show that the proposed scheme significantly outperforms the reservation-based scheme and bandwidth degradation schemes in terms of admitting many calls and guaranteeing QoS to all the traffic types in the network.

Keywords- Call admission control, call blocking probability, calls dropping probability, Handoff, Quality of service.

I. INTRODUCTION

The rapid growth of cellular networks through various technologies necessitated the introduction of promising technology by the 3rd Generation Partnership Project (3GPP) Long Term Evolution (LTE). LTE employs Orthogonal Frequency Multiple Access (OFDMA) and Multi-user Multiple-Input Multiple-Output (MU-MIMO) technologies to increase users high data rate, provide wide area coverage, and improve spectral efficiency [1]. To achieve these mentioned objectives, there are great challenging issues in relation to meeting Quality of Service (QoS) requirements and to reduce network congestion. In order to solve the above-mentioned problems, there is the need to have an effective radio resource management (RRM). Call Admission Control (CAC) is one of the fundamental techniques for RRM. CAC scheme is the process of accepting a new call or handoff call in the network while regulating QoS of the existing calls without degrading any call drops. Handoff call refers to the method of transferring an ongoing call or data session from one channel to another in a cellular network without compromising QoS requirements [2]. To satisfy user QoS requirements the CAC scheme arranges handoff call to the network by considering the available bandwidth. Hence, some amounts of bandwidth are reserved for incoming handoff call and assign the outstanding to new calls. An effective CAC scheme must concurrently provide efficient network resources utilization and an excellent QoS to the admitted users.

The work in [3] proposed a channel-borrowing scheme in which the best effort (BE) traffic borrows the bandwidth reserved for high-priority calls. Henceforth for the purpose of this paper, we call [3] as the Reservation-Based scheme. The Reservation-Based scheme used modeling and approximation processes for its CAC scheme. However, modeling of individuals and approximation of key system parameters is inefficient for the wireless network, due to the starvation of user traffic. Additionally, the scheme dynamically reserved some amount network bandwidth for handoff call using time varying status. However when some bandwidth is borrowed and reserved for handoff call, it may happen that the network has only a few or no handoff calls, then those network resources may be underutilized or wasted; consequently, this results in ineffective use of network resources. In this paper, we propose a novel CAC scheme named, An Adaptive Call Admission Control with Bandwidth Reservation for Downlink LTE Networks to amend the inefficiency of Reservation-Based. Firstly, the mechanism determines new CAC criteria based on traffic types. In the new CAC criteria, to create opportunities for the new calls, bandwidth degradation approach is introduced when the networks have scarce resources under heavy load scenario. Subsequently, an adaptive threshold value is applied to reserves available bandwidth for handoff calls by considering its traf- fic strength intensity. The major contributions of this paper are threefold. First, is maximizing the throughput of the BE traffic which is blocked because of lack of efficient utilization of network resources. The second contribution is the reducing of call blocking probability (CBP) and call dropping probability (CDP) by using an adaptive threshold value which adjusts the network status. Lastly, an analytical model using two levels Markov chain was developed to measure the performance of the proposed scheme.

The organization of this paper is as follows. In the next section, we provide an overview of the related works. The proposed algorithm is presented in section III. In section IV an analytical study is illustrated. Results and discussion are described in section V, while conclusions and future directions are given in section VI.

II. REALTED WORKS

Reservation CAC has gathered a lot of momentum in LTE networks; hence researchers have proposed several works towards such direction. In [4], CAC scheme that relies on adaptive multilevel bandwidth allocation of non-realtime (NRT) calls is proposed. The algorithm utilizes the available radio resources to provide QoS. However, channel control allocation is ignored which resulted in high CBP and low resource utilization. The authors in [5], proposed an interference-aware spectrum handover scheme for a cognitive radio network. The scheme aims to maximize the network capacity and minimize the spectrum. The heuristic algorithm was designed using Branch and Bound approach to solve spectrum handover problem. A channel reservation and preemption (CRP) model using overlapping regions in a cellular network with multiple sectors is presented in [6]. Directional antennas are installed on enodeB which divide the coverage into equal sized sectors. The scheme aims to minimize the call dropping probability of the handoff call by using efficient usage of available channels in the sector. The work in [7], investigated the effect of group vertical handoff in heterogeneous networks. The congestion game approach was introduced to solve the issue of network congestion in group mobility scenarios. The approach uses two learning algorithms to attain the nash equilibrium point in a stochastic situation. CAC algorithm for cellular networks with direct and dynamic monitoring of QoS performance is proposed in [8]. The algorithm aims to meet the QoS requirements by estimating system delay detail and the residual throughput is calculated based on the total achieved throughput. It achieves efficient resource utilization. In [9], an opportunistic CAC for wireless broadband cognitive networks is presented. The scheme designed a framework and an optimization technique is formulated considering the demand for each service provider and cognitive subscribers. The work in [10] proposed a CAC reservation algorithm which looks resource variations into account, whereby resources are assigned to users based on QoS and channel quality. The algorithm considers two kinds of applications named wide-band and narrow-band. Extra resources needed are predicted and reserved to avoid QoS degradation for the incoming call. However, LTE environment has different cell sizes and reserving resources in such situation causes poor resources utilization. In [11], Quality of Experience scheme which statically or dynamically reserves network resources was proposed. To sustain undetectable quality fluctuation throughout the handover for LTE networks, the scheme dynamically reserves resources based on prior knowledge. However, this scheme resulted in increased system complexity and inefficient resource utilization due to mobility prediction. Several CAC schemes are proposed [12], [13] which considered bandwidth reservation from mobility prediction perspective. Mobility prediction scheme for the cellular network was developed in [12]. The scheme uses Hidden Markov Model (HMM) to analyze users mobility in temporal scale and large spatial. The proposed scheme was combined with threshold-based statistical bandwidth multiplexing strategy to enhance system performance. Initially, mobile reservation protocol starts the session with mobile host sending a service request to the active cell. The active cell verifies whether the available channels are free then request is granted; otherwise, the request is forbidden. A framework and scheme for bandwidth reservation were proposed in [14]. The scheme integrates user mobility and available bandwidth model to predict paths to destinations, times when users enter/exit cells along predicted paths, and available bandwidth in cells on predicted paths. The scheme achieves low complexity, making the proposed framework real for practical implementation in mobile networks.

III. SYSTEM MODEL

In this work, a novel CAC scheme is proposed as an improvement of Reservation-Based scheme. Moreover, the shortcomings of Reservation-Based scheme are described. The scheme defined its CAC benchmark based on modelling, approximation method, and the BE traffic which reserved bandwidth for the high-level priority call. However, the BE traffic are not admitted into the network throughout the borrowing period which resulted in the starvation of this traffic. Therefore, the starvation of this traffic leads to increases of handoff CBP and CDP. Furthermore, the scheme dynamically distributes channels for an individual cell or reserved certain quantity of channels from the overall channels in the cell for handoff call using time-varying condition. However, when new calls and handoff calls occur repeatedly then some network resources may be left unutilized and this results in ineffective usage of network resources. Therefore, to solve the aforesaid obstacles a new CAC approach is proposed. The proposed scheme uses different traffic loads to admit new users and employs a threshold QoS provisioning approach to increase the efficient bandwidth utilization. The basic concept of our proposed scheme is taken into consideration that user traffic has different adaptive threshold QoS requirements. Thus a CAC criterion is adjusted by using the available bandwidth to increase the number of admitted calls with adaptive QoS. Moreover, RT traffic has high priority hence their handoff or new call bandwidth requirements can be described as:

$$a_i = BW_i^{\max} \quad (1)$$

Whereai denote the call admission criteria for call i while $BW_i^{\max}$ represent the maximum bandwidth for call i. If handoff or new call belongs to NRT or BE traffic, their bandwidth requirement is calculated as follows:

$$a_i = BW_i^{\min} \quad (2)$$

While $BW_i^{\min}$ denote the minimum bandwidth requirement for call i.

Furthermore, when the available bandwidth cannot be enough to admit new call, bandwidth degradation approach is applied to RT traffic since they were assigned enough; this will save the BE traffic from starvation. Therefore, to compute bandwidth degradation for each class j considers the given equation below:

$$BW_j^{degraded} = BW_j^{\max} - D_j^{level} \quad (3)$$

Where $BW_j^{degraded}$ denote degraded bandwidth for class j, $BW_j^{\max}$ represents available bandwidth and D_j^{level} is the present degradation level. However, Equation (3) must satisfy Equation (4) as given below:

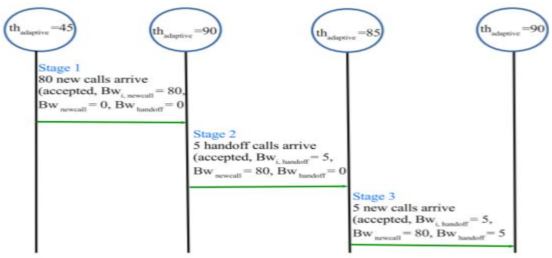

Figure 1: Proposed scheme case study scenario with Adaptive threshold

A simplified case study scenario is illustrated in Fig. 1 where we assume the total bandwidth of the network is 100 (BW_{total} = 100) and at the initial stage, the network is empty. Suppose that 80 new calls, 5 handoff calls, and 5 new calls arrive consecutively. Both schemes are assumed to have between 0 and 90 threshold values respectively with an initial threshold value of 45 units.

For the Reservation-Based scheme 5 new call ($BW_{i,new}$) and 5 handoff calls ($BW_{handoffcall}$) are rejected, resulting in 10 units of networks resources left unused and cannot be used again for new call admission. Therefore, ineffective bandwidth resource utilization occurred. But, our scheme significantly improves such situation by admitting new calls to the network resulting in efficient bandwidth resource utilization. Algorithm 1 represents the pseudocode for the proposed An Adaptive Call Admission Control with Bandwidth Reservation for Downlink LTE Networks.

IV. PERFORMANCE EVALUATION

In this section, the performance results of the adaptive call admission control with bandwidth reservation technique scheme are obtained and compared against the traditional scheme using MATLAB simulation tool. The new call blocking probability, handoff call dropping probability and RB utilization, as a function of new call arrival rate, are presented in Fig. 2.

In Fig. 2, it can be observed that the new call blocking probability for adaptive call admission control with bandwidth reservation technique scheme increases, as the new call arrival rate increases. This is due to the fact that as the load (new call) in the MP increases, more resource are consumed; while the probability of the arriving new callfinding a larger percentage of the RBs in the MH network occupied, increases.

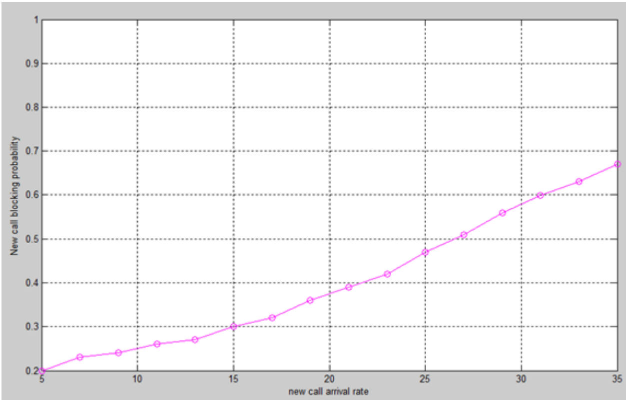

Figure 2: New call blocking probability as a function of new call arrival rate.

The handoff call dropping probabilities for adaptive call admission control with bandwidth reservation technique isshown in Fig. 4. Generally, the handoff calls dropping probability increases as the new call arrival rate increases. This is due to the fact that, as the arrival rates of new call increases relatively to the constant handoff call arrival rate.

V. CONCLUSION

In this paper, we have proposed an Adaptive Call Admission Control with Bandwidth Reservation for wireless cellular networkof user traffic and improve the effective usage of network resources in wireless networks. The new scheme introduced CAC criteria to avoid starvation of user traffic. The criteria use bandwidth degradation to admit many users when there are insufficient network resources to accommodate new users. The proposed scheme in addition to its bandwidth degradation included an adaptive threshold value which adjusted the network conditions to enable efficient used of network resources. Extensive simulation experiments were conducted to evaluate the effectiveness of the proposed scheme. A mathematical model was introduced using CBP and CDP to validate the experimental results of the proposed scheme. Simulation results and numerical results are in total agreement with negligible differences. Results also show the outstanding performance of the proposed scheme as it was able to achieve an improvement of data throughput, reduces CBP, CDP and degradation ratio as compared to the Reservation-Based scheme and other bandwidth degradation schemes.

REFRENCES

[1]. EnoruwaObayiuwan, OlabisiFalowo, "Adaptive Mobility Aware Call Admission Control For Mobile Hotspot Networks", 2016 IEEE 27th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications - (PIMRC): Mobile and Wireless Networks.

[2]. M. Ghaderi and R. Boutaba, ''Call admission control in mobile cellular networks: A comprehensive survey,'' Wireless Commun. Mobile Comput., vol. 6, no. 1, pp. 69–93, 2006.

[3]. H. Halabian, P. Rengaraju, C.-H. Lung, and I. Lambadaris, ''A reservationbased call admission control scheme and system modeling in 4G vehicular networks,'' EURASIP J. Wireless Communication Network, vol. 2015, no. 1, p. 125, 2015.

[4]. M. Z. Chowdhury, Y. M. Jang, and Z. J. Haas, ''Call admission control based on adaptive bandwidth allocation for wireless networks,'' J. Commun. Netw., vol. 15, no. 1, pp. 15–24, Feb. 2013.

[5]. D. Lu, X. Huang, W. Zhang, and J. Fan, ''Interference-aware spectrum handover for cognitive radio networks,'' Wireless Commun. Mobile Comput., vol. 14, no. 11, pp. 1099–1112, 2014.

[6]. T.-L. Sheu, C.-N. Lin, and J.-N. Hwang, ''A channel reservation and preemption model using overlapping regions in sector-based cellular networks,'' Wireless Commun. Mobile Comput., vol. 15, no. 12, pp. 1589–1605, 2015.

[7]. A. Walid, A. Kobbane, A. Mabrouk, E. Sabir, T. Taleb, and M. El Koutbi, ''Group vertical handoff management in heterogeneous networks,'' Wireless Commun. Mobile Comput., vol. 16, no. 10, pp. 1256–1270, 2015.

[8]. D.-H. Kim, D. Zhang, N. Bhushan, R. Pankaj, and S.-J. Oh, ''Admission control for cellular networks with direct QoS monitoring,'' Wireless Netw., vol. 19, no. 2, pp. 131–144, 2013.

[9]. M. E. Khedr and R. N. M. Hassan, ''Opportunistic call admission control for wireless broadband cognitive networks,'' Wireless Netw., vol. 20, no. 1, pp. 105–114, 2014.

[10]. M. Khabazian, O. Kubbar, and H. Hassanein, ''Call admission control with resource reservation for multi-service OFDM networks,'' in Proc. Int. Conf. Comput., Netw. Commun. (ICNC), 2012, pp. 781–785.

[11]. M. Shehada, B. Fu, S. Thakolsri, and W. Kellerer, ''QoE-based resource reservation for unperceivable video quality fluctuation during handover in LTE,'' in Proc. IEEE Consum. Commun. Netw. Conf. (CCNC), Jan. 2013, pp. 171–177.

[12]. P. Fazio, M. Tropea, C. Sottile, S. Marano, M. Voznak, and F. Strangis, ''Mobility prediction in wireless cellular networks for the optimization of call admission control schemes,'' in Proc. IEEE 27th Can. Conf. Elect. Comput. Eng. (CCECE), May 2014, pp. 1–5.

[13]. A. Nadembega, A. Hafid, and T. Taleb, ''Mobility-prediction-aware bandwidth reservation scheme for mobile networks,'' IEEE Trans. Veh. Technol., vol. 64, no. 6, pp. 2561–2576, Jun. 2015.