International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 8 (2017) pp. 1779-1783

Adaptive Power Control for Quality of Service Improvement in WCDMA Wireless Networks

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Abstract

In third generation (3G) cellular networks, WCDMA is a widely used technique for Quality of Service (QoS) improvement because of its high data transmission rate. Power control scheme is also very essential to reduce interference and improve network performance. Existing techniques are rarely considered for the power controlling scheme along with Resource Allocation for different traffic classes. This paper proposes a Resource Allocation with Connection Admission Control (RA-CAC) scheme, along with a power control scheme for improving Signal strength as well as providing a handoff in WCDMA Wireless networks. According to the proposed scheme, the transmitted power during the session entry is controlled using a constrained Power Control (PC). The simulation results show that the proposed scheme can significantly increase throughput, residual energy & reduce call blocking probability as well as delay.

Keywords: 3G, RA-CAC, QoS, WCDMA & PC

INTRODUCTION

In 3G devices, the WCDMA technique is heavily used for creating a wireless connection. WCDMA technologies support a data rate ranging from 144Kbps to 2Mbps. WCDMA technologies provide multimedia services such as the wired and wireless broadband networks. When compared with the narrow band CDMA technique, WCDMA is capable of handling services with greater data rate and is also capable of allocating multimedia traffic.

Issues in WCDMA networks:

- ✓ Pilot pollution
- ✓ HO problem
- ✓ SHO parameter
- ✓ Hierarchical cells

QoS for WCDMA networks :

In a network, QoS is a method of ensuring the service level that will be delivered in an application. Based on the application needs, the QoS factors are taken into account. In communication networks, most of the multimedia traffic needs guaranteed Quality of Service (QoS). Delay jitter, bandwidth, delay, etc., are some of the QoS factors [2] [3].The nature of the WCDMA network is a soft type of capacity nature. As a result, the cell coverage range relies on QoS factors like reliable interference points, spatial mobile user distribution as well as the subsequent time-dependent user traffic intensity [4].

In this paper, we propose a Resource Allocation with Connection Admission Control (RACAC) Scheme along with Power Control scheme for Real time traffic. RACAC allocates resources for existing and new arrival users based on utility function and maximizes throughput with the help of throughput achievement ratio and the Power Control scheme controls transmitted power with the help of a PC constraint for admitted sessions. The rest of the paper is organized as follows: **Section II** gives the details about the related work. The complete detail about proposed methodology is illustrated in **Section III**. Next, **Section IV** gives the results evaluation for the proposed approach and finally, conclusions are provided in **Section V**.

RELATED WORK

Juan Liu, Wen Chen [1] has presented the major problem for maximizing utility for fair and efficient multicasting in cellular networks. The optimal multicast scheme is developed for two scenarios: Users experiencing nearly equal path losses and different path losses. Especially, it has been found that the pure multicast scheme is optimal in the equal path loss. On the other hand, when the users that attempt to receive the same messages are uniformly distributed in a cell, the group multicast scheme should be applied. This result is of group multicast scheme that adapts data transmission rate to the worst case users among a group and it cannot satisfy throughput maximization for all the users distributed in a cell for improving the quality of services. However, the number users should be controlled for better QoS performance.

Bijan Golkar [2] has proposed Resource Allocation in Autonomous Cellular Networks and developed a Network Clustering scheme in which the scheduling cell is defined by a set of coordinating Base Stations (BS). Proposed approach is that each terminal communicates with only one BS and alternatively each terminal can communicate with more than one BS in the scheduling cell. Resource Allocation across the scheduling cell is distributed. This means that each scheduling cell is performed without knowledge from previous work. However, Power Control is still an area to work thoroughly, in case of Autonomous Cellular Networks.

Mohamed Khadim Karry and Yasir khan [3] have proposed Evaluation and Comparison of Resource Allocation strategies for new streaming services in wireless cellular networks. There are two categories of services in wireless cellular networks. In first category, there are variable bit rate (VBR) and constant bit rate (CBR) and in the other category, streaming call (video, voice, broadcast) is given that is used in current generation based on QoS and demand of the user. However, there is delay in the scheme.

N. Mohan and T. Ravichandran [4] have proposed to design a new CAC algorithm with Power Control for multiple services like voice, video and data for multiclass users. It determines the optimum set of admissible users with optimum transmitting power level, so as to minimize the interference level and call rejection rate. In addition to this, an Adaptive Scheduling scheme to allocate optimum rate for each traffic queue is proposed to minimize the scheduling delay. The proposed algorithms achieve reduced call blocking probability, and optimum rate with reduced delay. However, there is a delay in the scheme.

Rekha Patil and Dr.A.Damodaram [5] have developed a cross-layer based joint algorithm for Power Control and Scheduling. The multiple access problems are solved via two alternating phases, namely, Scheduling and Power Control. They introduced the notion of power control as part of a contention-based multiple access protocol that characterizes successful transmissions depending on a set of Signal-to-Interference-and-Noise Ratio (SINR) constraints (which directly translates to quality of service (QoS) constraints on the bit-error rate (BER) at individual receivers). The Scheduling algorithm is essential to admit the transmission of static as well as mobile users of multi service classes, in order to eliminate strong levels of interference that cannot be overcome by power control. By simulation experiments, they evaluate the performance of their algorithm in a set of admissible and non-admissible users and show that Power Control algorithm converges for a set of admissible users. However, there is a decrease in the power.

Young-Long Chen et al [6] have proposed a novel approach which combines the CAC and Power Control mechanisms and operates in a centralized control manner. The essence of the proposed Centralized Call Admission Control scheme is to combine the two mechanisms and to treat the call admission decision as an eigen-decomposition problem. In order to reduce the computational complexity of the eigen-decomposition problem, the paper proposes an additional scheme, which uses a norm operation rather than direct computation. The proposed scheme, even with the norm approximation, outperforms conventional call admission methods in terms of both its blocking rate and its outage rate. Consequently, the actual SIR of each link in a neighboring base station may not be guaranteed, with the result that outage may occur.

Tajje-eddine Rachidi et al [7] have presented QaPC and QaHO mechanisms as enabling QoS parameters, which are based on the class of service, the bit rate, and the Service Degradation Descriptor (SDD). They have used bit rate, service class and Service Degradation Descriptor for enabling QoS parameters. The proposed QoS aware mechanism significantly improves QoS contract upholding for premium mobile users, as well as increases resource utilization, while improving SHO acceptance. However, there is overload in the system. **Leonardo Badia et al** [8] have proposed a novel optimization technique based on the Logarithmic Barrier Method, which is shown to exhibit a good trade-off between computational complexity and accuracy of the solution. This simple strategy has proven to be fast and efficient. However, for very low SIR, the optimization is very low.

PROPSED RESOURCE ALLOCATION WITH CONNECTION ADMISSION CONTROL ALGORITHM

Consider a WCDMA network with a single downlink and a Base Station (BS). The BS transmits radio signals to a number of member nodes of the network. For the network operation, the time t is indexed by frames of equal length. New incoming sessions representing connections are indexed in the incoming sequence. As the session arrives, the arrival is recorded and the throughput achievement ratio is calculated with the help of target throughput and achieved throughput. The CAC considers the session that arrived at time t and represents its utility function but since the utility function is dependent on achievement ratio which is a future function, we have to calculate predicted achievement ratio and allot the resource based on conditions.

RACAC Algorithm-

Step 1: When a new session i arrives, record the $Arrival_i$.

Step 2: Initialize power P_i to get a target throughput $(\_TP_i\ \_)$ and achieved throughput of session i $(achieved\_TP_i\ )$ is computed.

Step 3: Calculate Achievement ratio Ach_Ratio_i of session i.

Step 4: Based on utility function, calculate predicted Achievement Ratio, $\widehat{Ach\_Ratio_i}$ by Future Target throughput FTP_i.

Step 5: calculate predicted Achievement Ratio $\widehat{Ach\_Ratio_i}$ of both the session and consider cumulative.

Step 6: check the following conditions.

If $\widehat{Ach\_Ratio}_i \geq 1$, Go to step 1 and assign a rate increment including new session.

Else if

$\widehat{Ach\_Ratio}_i < 1$, then

Assign a power increment for both the sessions.

Step 7: If $TP_i = FTP_i$ or ≥ 0, Go to step 1 and admit the new sessions .

Else if

new arrival is blocked and Go to step 3.

POWER CONTROL SCHEME

The transmitted power during the session entry is controlled using the Power Control (PC) constraint. The PC constraint is developed on the basis of the Signal-to-Interference Ratio (SIR) obtained from the inner closed loop.

Power Control algorithm-

1. The network maintains a SIR_{target} value which is pre defined.
2. After the session i is admitted into the network, SIR_{est} is calculated.
3. The SIR_{est} is compared with the SIR_{target}.
4. If $SIR_{est} > SIR_{target}$ then

   PC sends REQ_POW_RED to transmitter

5. Else If $SIR_{est} < SIR_{target}$ then the

   PC sends REQ_POW_INC to transmitter

   End

SIMULATION RESULTS

In this section, proposed Quality of service based Resource Allocation with Connection Admission Control (RACAC) along with Power Control scheme are simulated for Real-time Traffic in WCDMA networks using an NS-2 simulator.

Based on Number of Users-

In our first experiment, we vary the number of users as 18, 36, 54…..108 and throughput from 0 to 200. It is observed that the proposed QRAAS scheme has a higher throughput when compared to the CCACFS scheme.

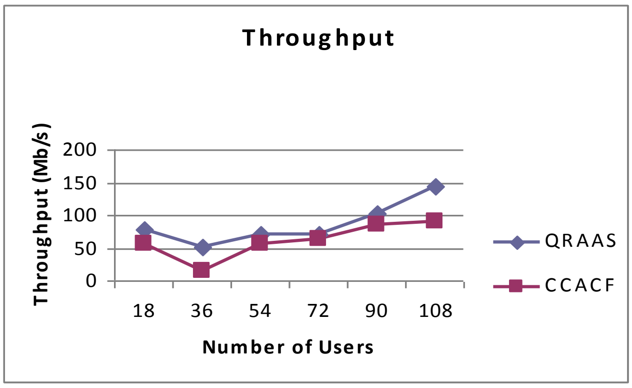

Figure 1: Users vs. Throughput

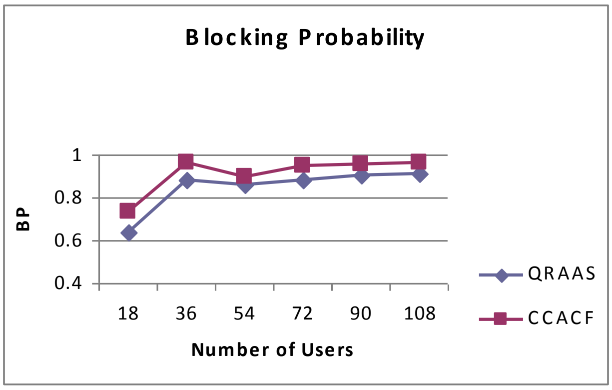

Figure 2: Users vs. Blocking Probability

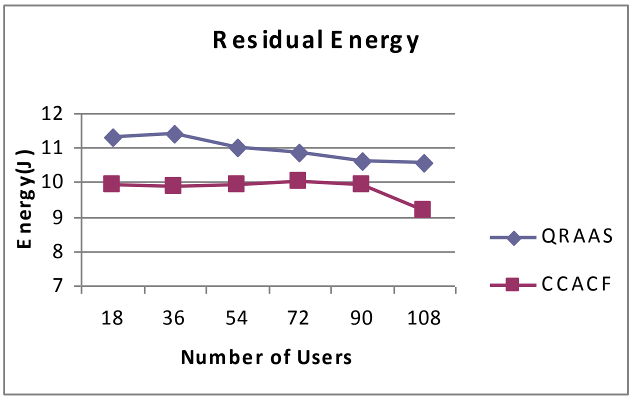

Figure 3: Users vs. Residual Energy

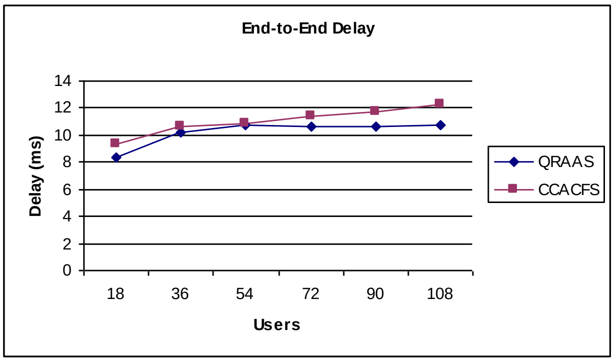

Figure 4: Users vs. Delay

Figures 1 to 4 show the results of throughput, blocking probability, residual energy and delay, respectively, by varying the number of users from 18 to 108 for the VBR traffic in QRAAS and CCACFS scheme. When comparing the performance of the two schemes, we find that QRAAS outperforms CCAC by 41% in terms of throughput, 7% in terms of blocking probability, 9% in terms of residual energy and 7% in terms of delay.

CONCLUSION

In this paper, we have proposed a Resource Allocation with Connection Admission Control (RACAC) along with adaptive Power Control (PC) constraint for minimizing interference and providing handoff in 3G-WCDMA Wireless networks. The algorithm is proposed for RACAC scheme based on the predicted throughput achievement ratio and depending upon the target throughput and future target throughput of every session. In case of Power Control scheme, when the estimated Signal to Interference Ratio is greater than the target Signal to Interference ratio, then, PC command requests to reduce the transmitted power. If it is less than the target Signal to Interference ratio, then, PC command requests to increase the transmitted power. Estimated Signal to Interference ratio is calculated with the help of spreading factor, received power, thermal noise and inter as well as intra cellular noise. Whenever an existing or new arrival hits the Power Control (PC) Constraint, the transmitted power is incremented or decremented with the help of PC command. From our simulation results, we have proven that the Resource Allocation with Adaptive Power Control scheme provides efficient handoff in WCDMA Wireless network by improving the throughput and reducing the delay for existing and new arrival users.

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International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 8 (2017) pp. 1779-1783

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