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An Efficient Resource Allocation with Adaptive Rate Scheduling For WCDMA Networks

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Abstract: *WCDMA is a spread spectrum technique that uses a unique spreading code to spread the data before transmission based on its orthogonal property. WCDMA is mainly used for 3rd generation cellular and mobile networks. In Centralized Call Admission Control (CCAC) technique, when a new call arrives into the system, it checks whether the call should be admitted or not on the basis of signal to interference ratio (SIR) and transmission power in the network. If the call is accepted, it will create some interference to the new arrivals during data transmission and reception. This new interference would degrade the performance of new arrival users. Hence, proper Resource Allocation in the network is very essential to regulate the Real Time traffic with guaranteed quality of service (QoS). At the same time, Scheduling also plays an important role to monitor the Real Time traffic. This paper proposes a novel approach to Resource Allocation with Connection Admission Control (RA-CAC) and Adaptive Rate Scheduling (ARS) scheme to minimize delay by maximum resource utilization for Real time traffic with better QoS. The simulation results show that the proposed scheme can significantly increase packet delivery ratio, throughput & reduce delay.*
Keywords: *ARS, CCAC, QoS, RA-CAC, SIR, WCDMA*

I. Introduction

Wide band Code Division Multiple Access technique uses channels with bandwidth much greater than that of the data to be transferred. Wideband CDMA can support services with higher rate when it is compared with the narrow-band CDMA and it is much more adaptable to distribute multimedia traffic. On the other hand, a new Medium Access Control protocol (MAC) is required to manage packet access efficiently in Wideband CDMA wireless networks [2]. Efficient Call Admission Control (CAC) and Medium Access Control (MAC) protocols are necessary for the QoS provisioning in WCDMA environment. But due to the bursty nature of packet traffic, CAC alone is not enough to provide most optimal resource utilizations [6]. In an integrated multiclass packetized network, efficient utility based CAC is required for providing better quality of service in WCDMA Network for Third Generation (3G) cellular and mobile communication. Radio resources for CDMA networks are mainly related to transmission power, channel rates and the spreading of bandwidth.

In this paper, a Resource Allocation with Connection Admission Control Scheme (RACAC) and an Adaptive Rate Scheduling (ARS) scheme are designed for Real time traffic like voice, video and data. RACAC determines the optimum number of admitted users with marginal utility; so as to minimize the call rejection rate. At the same time, ARS adjusts the rate of the incoming session based on feedback obtained from already 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 result evaluation for the proposed approach. Finally, conclusions are provided in Section V.

II. 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 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 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.

III. Proposed 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, record the arrival and calculate the throughput achievement ratio 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.

3.1 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, $\widetilde{Ach\_Ratio_i}$ 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.

3.2 Adaptive Rate Scheduling (ARS)

A heuristic based feedback control unit (FCU) is present in the network, which records all the information related to the session rate of every session. On the basis of the rate of the operating sessions, the rate of the incoming sessions is adjusted.

3.2.1 ARS algorithm

1. The average scheduling delay of the session *i* is estimated from the first session admitted into the network.
2. The FCU determines the sessions whose average delay is greater than or lesser than the threshold delay.
3. If $D_{avg}(i) > D_{threshold}(i)$, then it indicates that an error has occurred during session operation with greater probability and session i has degraded as a result of the improper assignment
4. If $D_{avg}(j) < D_{threshold}(j)$, then FCU preempts all the sessions with $i \neq j$.
5. Preemption is conducted by sending the rate information as a feedback to the CAC so that the rate allocation can be performed according to the new incoming session.

IV. Simulation Results

In this section, proposed Resource Allocation with Connection Admission Control (RACAC) scheme and Adaptive Rate Scheduling scheme (ARS) are simulated for Real-time Traffic in WCDMA networks using an NS-2 simulator.

4.1 Based on Number of Users

In our first experiment, we vary the ratio of the number of users 1, 2, 3…6 to the packet delivery ratio from 0 to 1.2. From Figure 1, it can be observed that the proposed RACAC scheme has 34% more delivery ratio, when compared to the CCAC scheme.

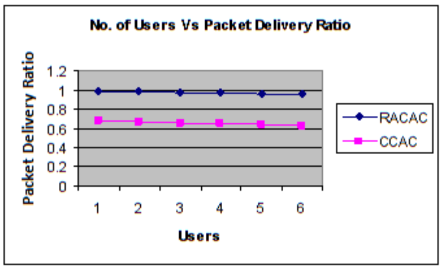

Fig.1. No. of users vs. Packet delivery ratio

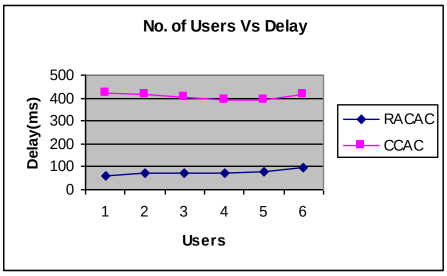

Fig.2. No of users vs. Delay

With the help of Figure 2, it is clear that the proposed RACAC Scheme attains 80% less delay, when compared to the CCAC scheme.

4.2 Results of RACAC-ARS scheme

The RACAC-ARS technique is compared to the Centralized Call Admission Control and Fixed rate Scheduling (CCAC-FS) scheme. By having a look at Figure 3, it is clear that RACAC-ARS scheme attains a higher delivery ratio, when compared to the CCAC-FS scheme.

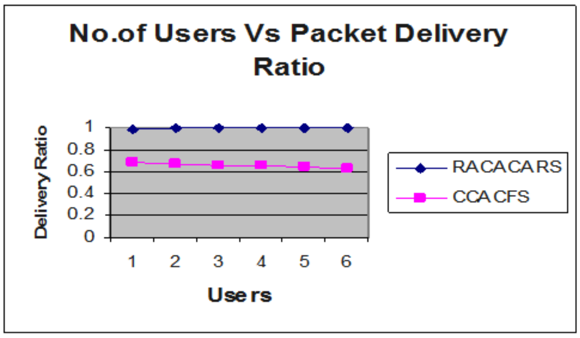

Fig.3. Users vs. Packet delivery ratio

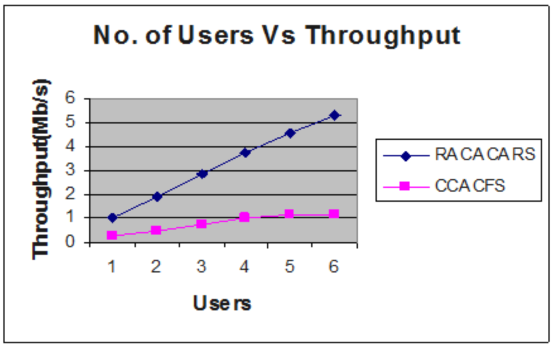

Fig.4. No of users vs. Throughput

Similarly, the average throughput shown in Figure 4 can help us observe that the RACAC-ARS scheme attains a higher throughput than CCAC-FS, when the number of users is increased.

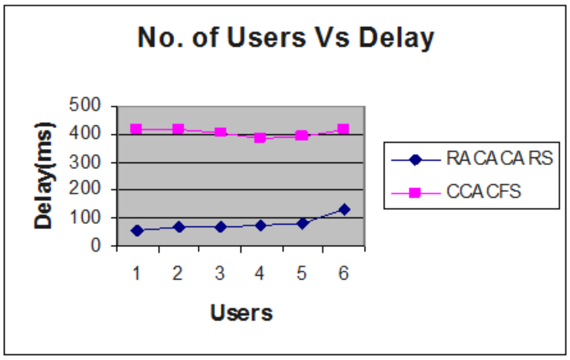

Fig.5. Users vs. Delay

Similarly, the average delay shown in Figure 5 tells us that the RACAC-ARS scheme attains a lesser delay than the CCAC-FS scheme.

V. Conclusion

In this work, the Resource Allocation with Connection Admission Control Scheme maximizes the throughput by proper resource allocation in the WCDMA networks and the Adaptive Rate Scheduling scheme dynamically adapts rates based on the feedback obtained from existing sessions. The proposed scheme keeps the call dropping probability below the threshold level while maintaining higher system reliability. We observed that during simulation, Resource Allocation with CAC and Adaptive Rate Scheduling provide an efficient throughput & a lesser delay in the network. A power control part that manages interference is still remaining out of this research work, and a hand off in WCDMA network will definitely be worked out in future.

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