Improvement of QoS in Wireless N/W Using Call Admission Control Scheme

[1*]Shirishkumar N. Mahajan and [2]N. C. Patil

1. M.E. Scholar, Dept. of E & TC, (M.E.), D.N. Patel COE, Shahada, Dist. Nandurbar, MH, India
2. Assistant Professor, Dept. of E & TC, D.N. Patel COE, Shahada, Dist. Nandurbar, MH, India

ABSTRACT

A call admission control (CAC) algorithm used for WCDMA prioritized uplink for UMTS, which combines QoS tolerance and service differentiation by priority for voice, data, multimedia. This CAC algorithm gives preferential treatment to high priority calls, such as soft handoff calls, by reserving some bandwidth margin (soft guard channel), Power consumption, no. of users (load) to reduce handoff failures. In addition, queuing is also used to enhance the service quality. The algorithm uses the effective load as an admission criterion and applies different thresholds for new calls, handoff calls, bandwidth requirement, and power consumption. Finally, the study considers three types of services: voice, data and multimedia calls. Use of CAC algorithm indicates that this algorithm reduces the drop of handoff calls and increases the total system capacity and performance; hence the Grade of Service (GoS) of the system can significantly be improved especially in case of high mobility environments.

KEYWORDS: No. of users (load), Bandwidth, Power Consumption, CAC, UMTS, W-CDMA, QOS.

1. INTRODUCTION

In 1G networks and 2G networks such as GSM and CDMA there was only one aspect of QoS and it is voice. Providing quality speech was the major concern. Now in 3G networks QoS has to be provided for voice as well as data. Still priority is given for voice services as they are considered as the primary service. They are very delay sensitive and require real - time service. Data services are comprised of text and multimedia. These services are less delay sensitive but expect better throughput and less or no loss rate. The Universal Mobile Telecommunications System (UMTS) is a third generation mobile cellular system for networks based on the GSM standard. Developed and maintained by the 3GPP (3rd Generation Partnership Project), UMTS is a component of the International Telecommunications Union IMT-2000 standard set and compares with the CDMA2000 standard set for networks based on the competing CDMA One technology. UMTS uses wideband code division multiple access (W-CDMA) radio access technology to offer greater spectral efficiency and bandwidth to mobile network operators. The 3G wireless cellular mobile systems which are based on WCDMA technology are expected to be interference limited. Soft capacity is one of the main characteristics of 3G (i.e.UMTS) and it requires new radio resource management strategies to serve diverse QoS requirements. [1]

In conventional TDMA and FDMA systems such as IS-54 (TDMA) and GSM (hybrid TDMA/FDMA), the number of traffic channels is fixed. It is determined by the number of time slots in the TDMA system or by the number of non-overlapping frequencies in the FDMA system. The spread spectrum system, such as WCDMA, does not have a fixed number of channels. Instead, the capacity of the CDMA system is limited by the total interference the system can tolerate. Such a system is referred to as an interference-limited system. Each additional active mobile user will increase the overall level of interference. Normally, the interference level increases rapidly when the system load reaches a certain level. Users with different traffic profiles and attributes such as the service rate, the signal to-Interference ratio (SIR) requirement, media activity, etc. introduce different amounts of interference to the system. These factors are especially important in 3G wireless networks that support multimedia services. [2-7]

2. SYSTEM DESIGN

The main function of call admission control algorithm is to limit the interference by controlling the number of new call accepted in the network. CAC need to perform separately for uplink and downlink transmissions as the traffic load offered by the uplink and downlink transmissions is different from each other. The uplink and downlink admission control requirements must be fulfilled by each new user while entering into the system. For high-speed networks such as asynchronous transfer mode networks and wireless networks Call Admission Control has been intensively studied in the last few years. CAC becomes much more complicated in wireless networks Due to users, mobility.

This CAC scheme gives preferential treatment to high priority calls, such as handoff calls, by reserving some bandwidth (guard channel) to reduce handoff failures. In addition, queuing is also used to enhance the handoff success probability. The algorithm uses the effective load as an admission criterion and applies different thresholds for new and handoff calls. Finally, the study considers three types of services: data, voice and video calls. Results indicate that this algorithm reduces the drop handoff calls and increases the total system capacity; hence the GoS and the system performance can significantly be improved especially in case of high mobility environments.

Call admission control (CAC) is a technique to provide quality-of-service (QoS) in a network by restricting the access to network resources. Simply stated, an admission control mechanism accepts a new call request provided there are adequate free resources to meet the quality-of-service (QoS) requirements of the new call request without violating the committed quality-of-service (QoS) of already accepted calls. There is a trade off between the quality-of-service (QoS) level perceived by the user (in terms of the call dropping probability) and the utilization of scarce wireless resources. In fact, call admission control (CAC) can be described as an optimization problem [8]. We assume that available bandwidth in each cell is channelized and focus on call-level quality-of-service (QoS) measures. Therefore, the call blocking probability (Pb) and the call dropping probability (Pd) are the relevant quality-of-service (QoS) parameters. Three call admission control (CAC) related problems can be identified based on these two quality-of-service (QoS) parameters:

MINO: Minimizing a linear objective function of the two probabilities

MINB: For a given number of channels, minimizing the new call blocking probability subject to a hard constraint on the handoff dropping probability.

MINC: Minimizing the number of channels subject to hard constraints on the new and handoff calls blocking/dropping probabilities.[8]Channels could be frequencies, time slots or codes depending on the radio technology used. Each base station is assigned a set of channels and this assignment can be static or dynamic. MINO tries to minimize penalties associated with blocking new and handoff calls. Thus, MINO appeals to the network provider since minimizing penalties results in maximizing the net revenue. MINB places a hard constraint on handoff call blocking thereby guaranteeing a particular level of service to already admitted users while trying to maximize the net revenue. MINC is more of a network design problem where resources need to be allocated a priority based on, for example, traffic and mobility characteristics. Since dropping a call in progress is more annoying than blocking a new call request, handoff calls are typically given higher priority than new calls in access to the wireless resources. This preferential treatment of handoffs increases the blocking of new calls and hence degrades the bandwidth utilization. The most popular approach to prioritize handoff calls over new calls is by reserving a portion of available bandwidth in each cell to be used exclusively for handoffs.

2.1 Requirements for CAC System

1. Limit the interference

2. QoS Requirements
3. To support multimedia services
4. Fast internet access
5. Voice and Video telephony
6. Signal Quality
7. Call Dropping Probability
8. Packet-Level Parameters
9. Transmission Rate
10. To reduce network congestion.
11. To increase signal to noise ratio.
12. To improve transmission rate.
13. To resolve the problems of hand off.

2.2 Quality of Service

QoS (Quality of Service) refers to a broad collection of networking technologies and techniques. The goal of QoS is to provide guarantees on the ability of a network to deliver predictable results. Elements of network performance within the scope of QoS often include availability (uptime), bandwidth (throughput), latency (delay), and error rate. QoS involves prioritization of network traffic. QoS can be targeted at a network interface, toward a given server or router's performance, or in terms of specific applications. A network monitoring system must typically be deployed as part of QoS, to insure that networks are performing at the desired level. QoS is sometimes used as a quality measure, with many alternative definitions, rather than referring to the ability to reserve resources. Quality of service sometimes refers to the level of quality of service, i.e. the guaranteed service quality. High QoS is often confused with a high level of performance or achieved service quality, for example high bit rate, low latency and low bit error probability.

2.3 Need of QoS

Imagine a situation where you are hardly able to hear what your friend is talking over the phone or the phone gets cut when you are talking something important. These things are highly undesirable and you do not want to get low quality service for paying high monthly bills. Communication plays a major role in today's world and to support it QoS has to be given maximum priority. It is important to differentiate the traffic based on priority level. Some traffic classes should be given higher priority over other classes, Example: voice should be given a higher priority compared to data traffic as voice is still considered as the most important service. It should be noted that more preference has to be given to customers who pay more to get better service, without affecting the remaining customers who pay normal amount. To realize all these things effective QoS schemes are needed. Issues and schemes related to providing better QoS is the main subject of this paper. [9]Quality of service comprises requirements on all the aspects of a connection, such as service response time, loss, signal-to-noise ratio, crosstalk, echo, interrupts, frequency response, loudness levels, and so on. A subset of telephony QoS is grade of service (GoS) requirements, which comprises aspects of a connection relating to capacity and coverage of a network, for example guaranteed maximum blocking probability and outage probability. [10]In the field of computer networking and other packet switched telecommunication networks, the traffic engineering term refers to resource reservation control mechanisms rather than the achieved service quality. Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow. For example, a required bit rate, delay, jitter, packet dropping probability and/or bit error rate may be guaranteed. Quality of service guarantees are important if the network capacity is insufficient, especially for real-time streaming multimedia applications such as voice over IP, online games and IP-TV, since these often require fixed bit rate and are delay sensitive, and in networks where the capacity is a limited resource, for example in cellular data communication. A network or protocol that supports QoS may agree on a traffic contract with the application software and reserve capacity in the network nodes, for example during a session establishment phase. During the session it may monitor the achieved level of performance, for example the data rate and delay, and dynamically control scheduling priorities in the network nodes. It may release the reserved capacity during a tear down phase.

2.4 Classification of CAC

Several CAC schemes have been developed in wireless cellular networks. Some of them are based on a predetermined maximum number of users in the system. Many schemes are more CDMA-oriented and consider the SIR as the determinant parameter in accepting or not accepting a new call. Those schemes are commonly called Interference-CAC (I-CAC) and can be further classified into 3 types.

1. Wideband Power Based CAC

This method accepts the call only if the total interference does not exceed a predefined threshold and computes the increase in the interference (power) caused by the admission of a new user in the cell in uplink [9].

2. Throughput-Based CAC

A throughput-based CAC scheme computes the increase in the load caused by the establishment of a new user in the cell and accepts the call only if the total load does not exceed a predefined threshold.

3. Signal to Noise Interference Ratio-Based CAC

This scheme computes the minimum required power for new user and accept it if is not below a predefined minimum link quality level.

2.5 Queuing priority (QP) schemes

In this type of scheme, calls are accepted whenever there are free channels. Depending on the approach, new calls are blocked and handoff calls are queued, vice versa, or all calls are queued and the queue is rearranged based on certain priorities.[11]

In our paper variant of the throughput-based CAC is considered. This scheme differentiates between two types of services and gives the higher priority to soft handoff calls by using a soft load factor margin and by implementing queuing techniques. Rejection of soft handoff requests causes forced termination of an ongoing real-time call, which is a server problem than blocking of new call attempts. This admission control scheme can guarantee a higher QoS for the soft handoff requests of real-time services in 3G DS-CDMA systems by introducing the idea of soft guard channel to prioritize soft handoff calls. Unlike FDMA or TDMA systems, which use frequency bands or time slot as resources for 'hard' guard channels, the resources in CDMA cellular systems are interference limited. To prioritize the soft handoff calls, a certain amount of cell load is reserved exclusively soft handoff calls. In addition, queuing is also used to enhance the handoff success probability.

3. CAC ALGORITHM

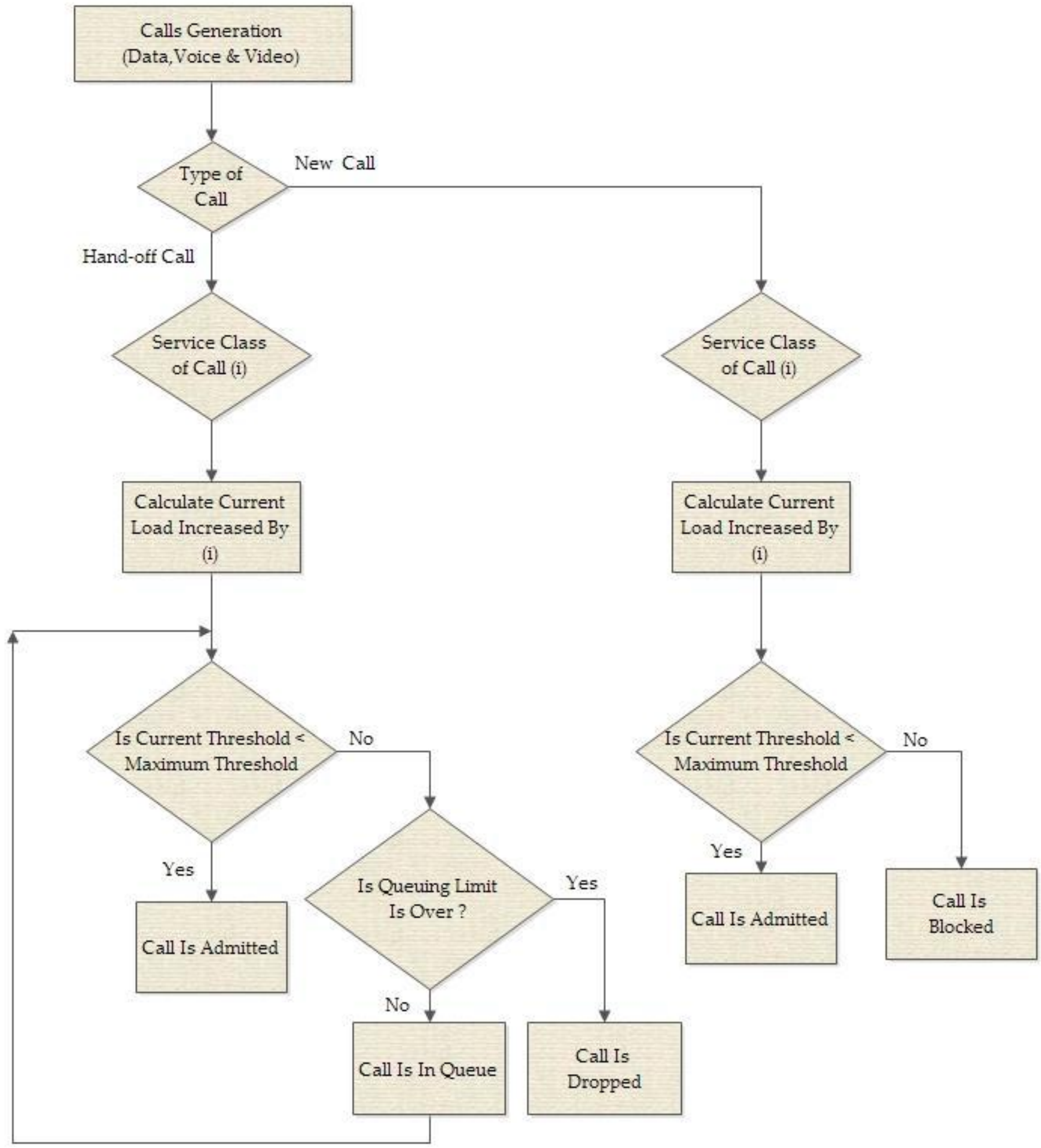

Figure 1. Flow chart for CAC algorithm

This algorithm has the following steps:

When a call arrives, load factor threshold for new and handoff calls n_{Thri} and QoS requirements (in term of BER) are determined. Then the load increase of the arrived call and the current cell load factor before accepting the arrived call are calculated, η_{new}. After calculating the current load of the target cell ηi, it is compared with the load factor threshold of the arrived call of type i, n_{Thri}. If the current cell load factor plus the load increase is less than or equal the required load factor threshold for the arrived call, then the arrived call can be admitted to enter the target cell. Otherwise, the arrived call is queued or rejected based on queue availability. Queued soft handoff calls can be accepted if sufficient bandwidth gets available, or can be terminated due to timeout.

4. SIMULATION RESULT AND DISCUSSION

Our algorithm is evaluated based on three QoS key points:

The blocking probability for newly originating calls, the forced termination probability and the total system carried traffic. The blocking probability is the probability that a new call is denied access to the system, while the forced termination probability is the probability that a call has been admitted will be terminated prior to the call's completion.

New calls and hand-off calls are treated differently. Hand-off calls are given higher priority to new calls, and load factor threshold for hand-off calls and new calls are also different. In simulation we go through the following different scenarios:

In simulation we consider the following three scenarios:

Scenario1: All call services classes (new calls and soft handoff calls) are treated equally where they have the same load threshold and no queuing is used.

Scenario2: Same as 1, and in addition to that, the handoff calls are allowed to be queued till the resource is available or the time out is reached.

Scenario3 (proposed algorithm): Same as 2, and in addition to that, the handoff calls have higher load threshold than new calls. This scenario is repeated using different channel holding times.

Average service time for all services is 180 seconds. Arriving rates of all services are changed. Scenario3 is repeated using different service times (120s and 90sec). Fig. 3 depicts voice (GoS) vs. arrival rates while Fig. 2&4 depicts data (GoS) vs. arrival rates. From these figures, it is clear that the performance improves as we use the queue and the soft guard channel. Also, as the channel holding time decreases (for example mobility increases) the system performance increases. So as the service time decreases the waiting calls will have better chance to get the channel before they timed out.). Fig. 5 depicts the carrier interference ratio. It is clear that our proposed algorithm has better system capacity and this improvements increase as channel holding time decreases. In general as shown in these figures, the system has a better performance under this proposed algorithm.

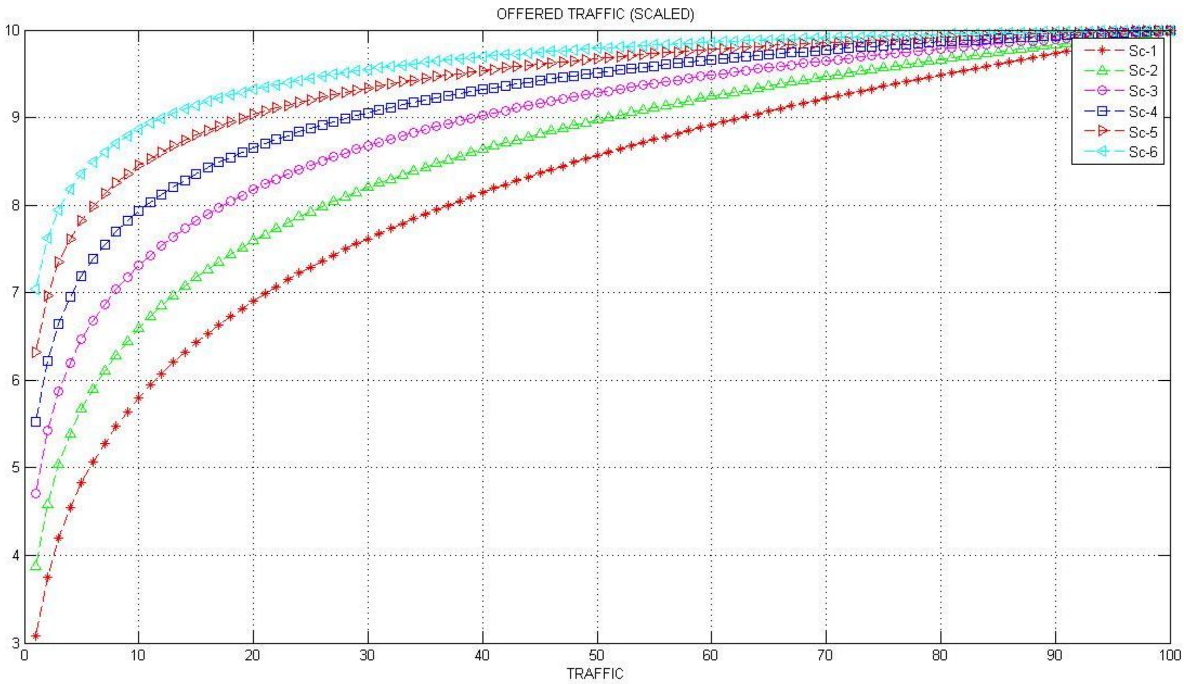

Figure 2. Gos for data calls

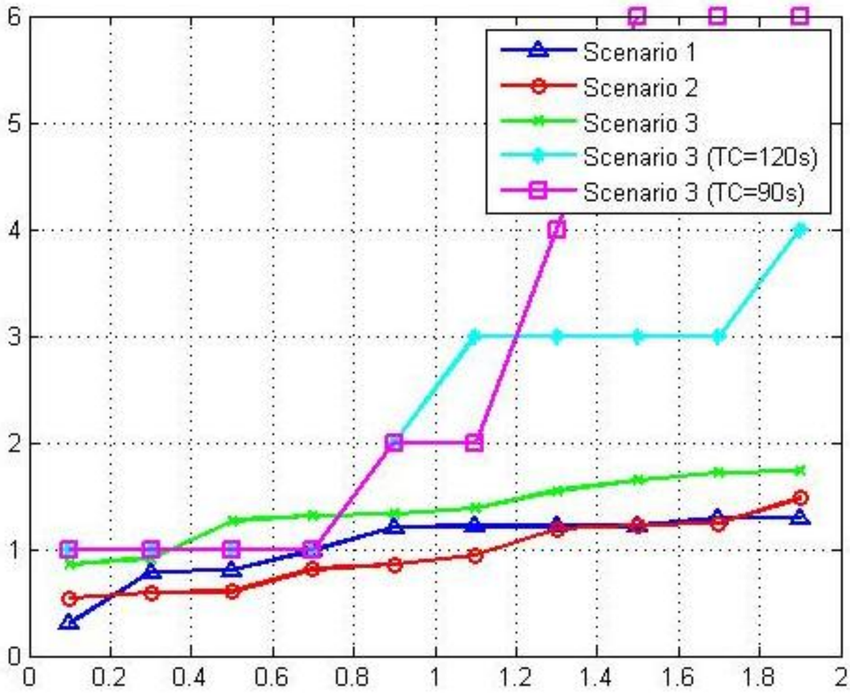

Figure 3. Gos for voice calls

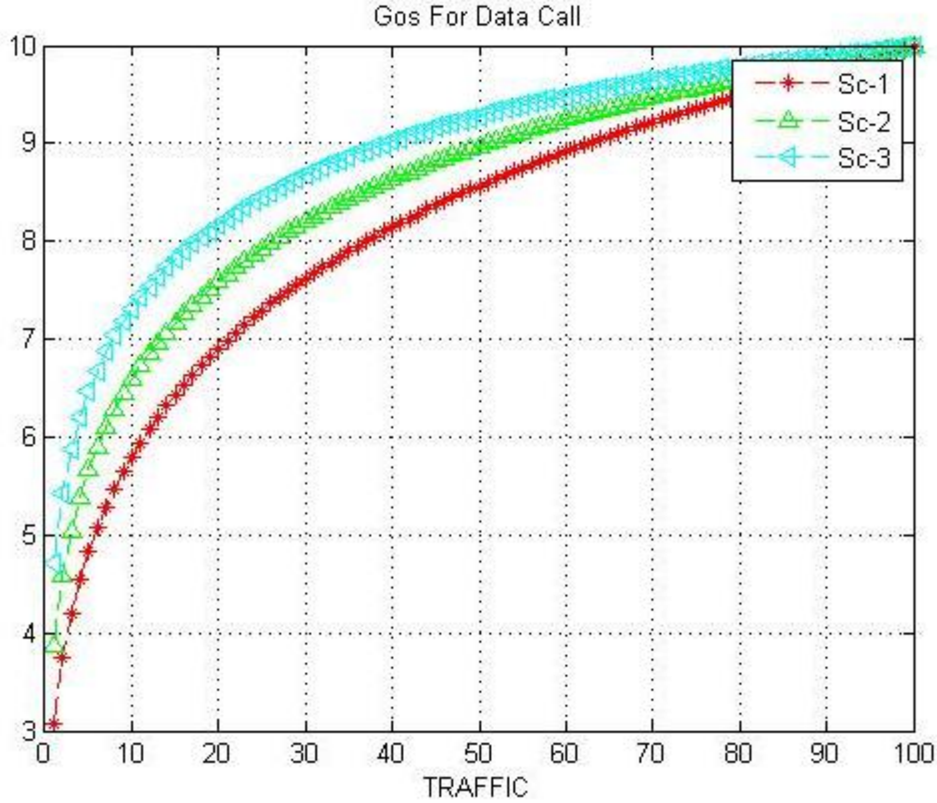

Figure 4. Gos for data calls

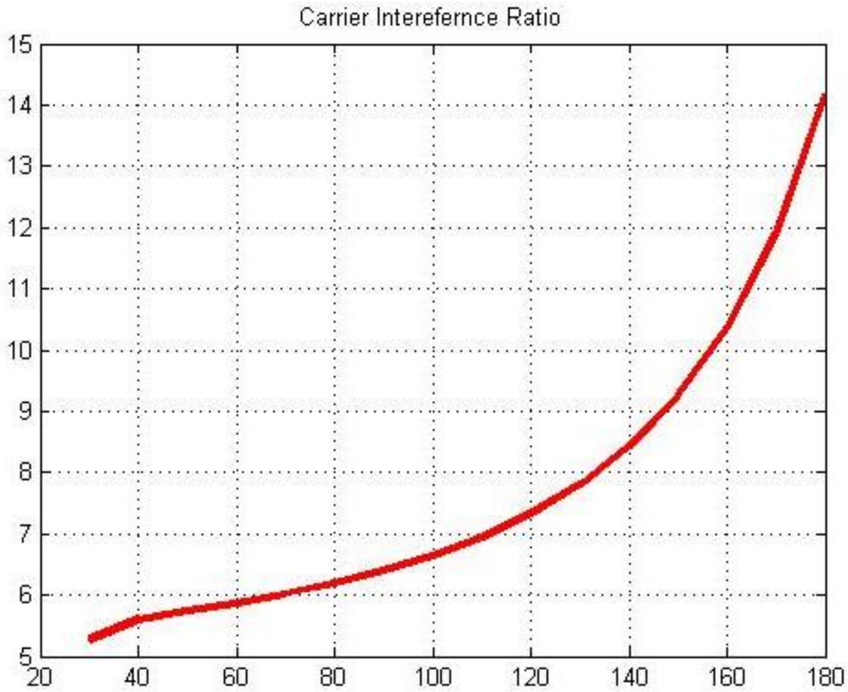

Figure 5. Carrier interference ratio

5. CONCLUSION

Usually based on the measured information's like signal-to-interference ratio (SIR) or the total received power in the individual cells, conventional call admission control (CAC) methods accept or reject new incoming calls. In this paper, we have designed a new CAC algorithm with power control for multiple services like voice 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.

Call admission control is a very important measure in CDMA system to guarantee the quality of the communicating links. The design of call admission control schemes/algorithms for mobile cellular wireless networks is especially challenging given the limited and highly variable resources, and the mobility of users encountered in such networks. In future wireless networks multimedia traffic will have different QoS requirements. Call admission control (CAC) is a key element in the provision of guaranteed quality of service (QoS) in cellular wireless networks. One of the key quality-of-service (QoS) measures in wireless cellular networks is the handoff voice call dropping probability as dropping a call-in-progress is generally not considered as acceptable or user-friendly. In this paper Handoff prioritization can improve handoff related system performance. Two basic handoff prioritization schemes, guard channels and queuing, are discussed.

To give priority to soft handoff calls, we introduce queuing techniques and the idea of 'soft guard channels', which is represented by reserving a small fraction of the cell load for the higher priority calls. Based on simulation results, we have shown that the proposed algorithms achieve reduced call blocking probability, optimum rate with reduced delay. This algorithm reduces the dropped soft handoff calls and improves the overall system capacity.

REFERENCES

[1] "Quality of Service (QoS) Concept and Architecture," June 2006, 3GPP23.107 V7.4.0

[2] H. Holma and A. Toskala (Editors), "WCDMA for UMTS: Radio Access for Third Generation Mobile Communications," John Wiley & Sons, Ltd, England, 2000.

[3] M. Viterbi and A. J. Viterbi, "Erlang capacity of a power controlled cdma system," IEEE Journal on Selected Areas in Communication, vol. 11, no. 6, pp. 892–900, 1993.

[4] Dongwoo K. and Jeong D.G., "Capacity unbalance between uplink and downlink in spectrally overlaid narrowband and wideband CDMA mobile systems," IEEE Transactions on Vehicular Technology, Vol. 49, No. 4, , pp. 1086-1093,July 2000.

[5] K S Gilhousen, I M Jacobs, R Padovani, A J Viterbi, L. A. Weaver, Jr., and C. E. Wheatly III, "On the capacity of a cellular CDMA system," IEEE Transactions on Vehicular Technology, vol. 40, no. 2, pp. 303–312, May 1991.

[6] Sampath et al., “Erlang Capacity of a Power Controlled Integrated Voice and Data CDMA System,” IEEE VTS Proceedings of Vehicular Technology Conference, pp. 1557-1561, May 1997.

[7] Jamie S. Evans and David Everint, “On the Teletraffic Capacity of CDMA Cellular Networks,” IEEE Transactions on Vehicular Technology, vol. 48, no. 1,

[8]A QoS-Aware Call Admission Control Algorithm for 3G Cellular Wireless Networks Salman AlQahtani and Ashraf S. Mhmoud King Fahd University of Petroleum & Minerals, Dhahran 31261, Saudi Arabia

[9] Mr. Gajanan U. Patil1, Prof. Chandrashekhar N. Deshmukh2,” QoS Based CAC Scheme for 3G Wireless Cellular Networks-A Review”, NCAICN-2013

[10] Salman Al-Qahtani, Ashraf Mahmoud, “A Prioritized Uplink Call Admission Control Algorithm for 3G WCDMA Cellular Systems with Multi-Services”, pp-173-177

[11] Yuan-yuan Su, Ren-yong Wu†, Ren-fa Li, Wei Duan, Jianhui Luo “A Novel Measurement based Call admission Control Algorithm for Wireless Mobility Networks under Practical Mobility Model”,ICCMC 2010.