ISSN: 2277-3754
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 1, Issue 3, March 2012

Call Admission Control Schemes and Handoff Prioritization in 3G Wireless Mobile Networks

V. S. Kolate, G. I. Patil, A. S. Bhide

Abstract- One of the major use of 3G wireless network systems is the ability to offer end user wireless QoS services. In this paper, Many CAC schemes have been proposed. Call admission control schemes play more important role in wireless cellular networks. They are used for achieving some desired quality of service parameters. The design of call admission control algorithms for mobile cellular networks is especially challenging given the limited and highly variable resources, and the mobility of users encountered in such networks. This paper provides a survey of admission control schemes & Handoff Prioritization for cellular networks and the research in this area. Our goal is to provide a broad classification and thorough discussion of existing call admission control schemes. We describe several admission control schemes. Handoff prioritization is the common characteristic of these schemes. Handoff is an essential element of cellular communications.

Key Words— **Call Admission Control Schemes, Handoff Prioritization, Handoff Schemes**.

I. INTRODUCTION

Third generation radio communication systems are designed to offer multimedia services, including voice and video telephony and high-speed Internet access. The interference-based schemes can be classified into:

Wideband Power-based CAC: This method computes the increase in the interference (power) caused by the establishment of a new user in the cell in uplink and accepts the call only if the total interference does not exceed a predefined threshold.[1]

Throughput-base CAC: A throughput-based CAC algorithm computes the increase in the load caused by the establishment of a new user in the cell in uplink and accepts the call only if the total load does not exceed a predefined threshold [1].

Signal to noise interference ratio-based CAC: This algorithm computes the minimum required power for the new user and accepts it if it is not below a predefined minimum link quality level [1]. One of the ways to reduce the handoff failure rate is to prioritize handoff. Handoff algorithms that try to minimize the number of handoffs give poor performance in heavy traffic situations. In such situations, a significant handoff performance improvement can be obtained by prioritizing handoff [2].

II. CALL ADMISSION CONTROL

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 tradeoff 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 [1]. 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.[1]

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 apriority 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. In general there are two categories of call admission control (CAC) schemes in cellular networks:

1. **Deterministic Call Admission Control (CAC):** Quality-of-service (QoS) parameters are guaranteed with 100% confidence. Typically, these schemes require extensive knowledge of the system parameters such as user mobility which is not practical, or sacrifice the scarce radio resources to satisfy the deterministic quality-of-service (QoS) bounds.

ISSN: 2277-3754
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 1, Issue 3, March 2012

2. **Stochastic Call Admission Control (CAC):** Quality-of-service (QoS) parameters are guaranteed with some probabilistic confidence. By relaxing quality-of-service (QoS) guarantees, these schemes can achieve a higher utilization than deterministic approaches [1].

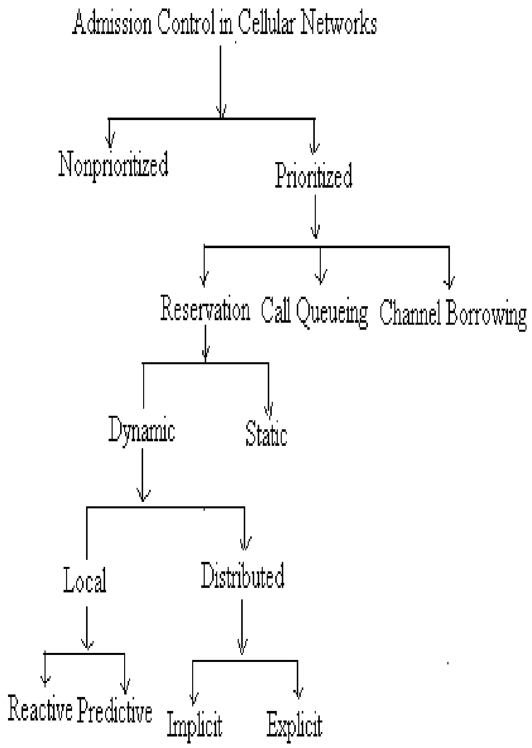

Fig. 1. Stochastic call admission control schemes in cellular networks [1].

Most of the call admission control (CAC) schemes which are investigated fall in the stochastic category. Figure depicts a classification of stochastic call admission control (CAC) schemes proposed for cellular networks.

Call admission control (CAC) schemes can be classified based upon the number of services/classes. Single-class call admission control (CAC) has been dominant in first and second generation (2G) wireless cellular networks when voice service was the main (and sometime the only) offered service. With the growing interest of data and multimedia services, single-class call admission control (CAC) schemes are no longer sufficient and as a result multiple-service/class call admission control (CAC) schemes are more relevant, especially in the enhanced second generation (2.5G) and third generations and beyond (3G/4G). The design of multiple-service/class call admission control (CAC) schemes is more challenging since some critical issues, such as service prioritization, fairness, and resource sharing policy, must be considered.

Optimal call admission control (CAC) schemes are always preferred, but they are not necessarily attainable, particularly in realistic scenarios with a large problem size and complicated system parameter interdependence. As such, heuristics and intelligent techniques are widely used to find suboptimal call admission control (CAC) scheme. Call admission control (CAC) schemes can be classified as proactive (parameter based) or reactive (measurement-based). In proactive call admission control (CAC) schemes, the incoming call is admitted/denied based on some predictive/analytical assessment of the quality-of-service (QoS) constraints. In reactive call admission control (CAC) schemes, the incoming call might start transmission (by transmitting some probing packets or using reduced power). Then the reactive call admission control (CAC) scheme decides to admit/reject the call based on the QoS measurements during the transmission attempt at the beginning.

Call admission control (CAC) can also be classified based on the information needed in the call admission control (CAC) process. Some CAC schemes use the cell occupancy information. This class of call admission control (CAC) schemes requires a model or some assumption for the cell occupancy. Alternatively, call admission control (CAC) schemes might use mobility information (or estimation) in making the admission decision.

The use of mobility information, however, is more complicated and requires more signaling. The information granularity used in call admission control (CAC) schemes can be considered at the cell level or at the user level. If a uniform traffic model is assumed, information of one cell is enough to represent the whole network condition. In a non-uniform traffic model, however, information from different cells is required to model the network status, which increases the information size. The third case, in which information of each individual user is considered, of course leads to a huge information size.

Call admission control (CAC) schemes have been designed either for the uplink or the downlink. In the uplink, transmit power constraint is more serious than in the downlink since the MS is battery operated. On the other hand, call admission control (CAC) in the downlink needs information feedback from MSs to the BSs for efficient resource utilization. Applying call admission control (CAC) for both links jointly is crucial since some calls might be admissible in one of the links and non-admissible in the other, particularly for asymmetrical traffic. Jeon and Jeong have proposed a joint call admission control (CAC) scheme for both the uplink and downlink. The call request is admitted only if it is admissible in both uplink and downlink. The asymmetry between uplink and downlink traffic, which is one of the characteristics of some multimedia services such as Web browsing, has been taken into account by adjusting the allocated bandwidth to each link in the call admission control (CAC) based on the traffic characteristics in each link.

It has been shown that this asymmetric allocation enhances resource utilization and other quality-of-service (QoS) parameters such as Pb and Phf. This work has been extended to investigate the same problem in CDMA networks. The impact of the bandwidth allocation between UL and DL on QoS parameters (Pb, Phf and outage probability (Pout)) has been analyzed using a SIR-based call admission control (CAC) scheme for voice and data (asymmetric) services. It has been shown that there is an optimum bandwidth allocation that minimizes the Pb, Phf and Pout. [1]

III. CALL ADMISSION ALGORITHM (CAC)

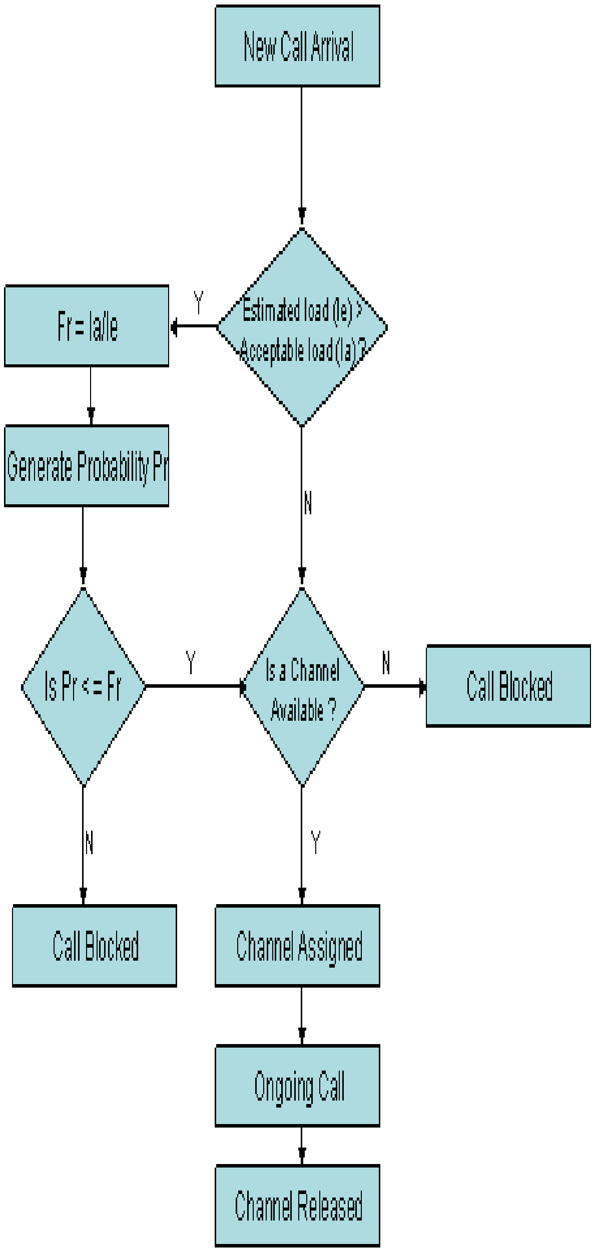

Fig. 2. Flow Chart for CAC Algorithm [3].

In the CAC algorithm the acceptable load is calculated based on simulation results and this value is used for comparison purpose. The estimated load is also calculated and it is checked with the acceptable load .If the estimated load is lesser than or equal to the acceptable load, then attempts are made to allocate channels for all the incoming calls. If the estimated load is greater than the acceptable load then only a fraction of the incoming calls will be allocated channels and the remaining fraction of the calls will be discarded even if there are available channels. This is called pre - blocking of channels and this scheme improves the FTP and SCCR of the profiled users [3].

IV. CALL ADMISSION CONTROL SCHEMES AND HANDOFF PRIORITIZATION ALGORITHM

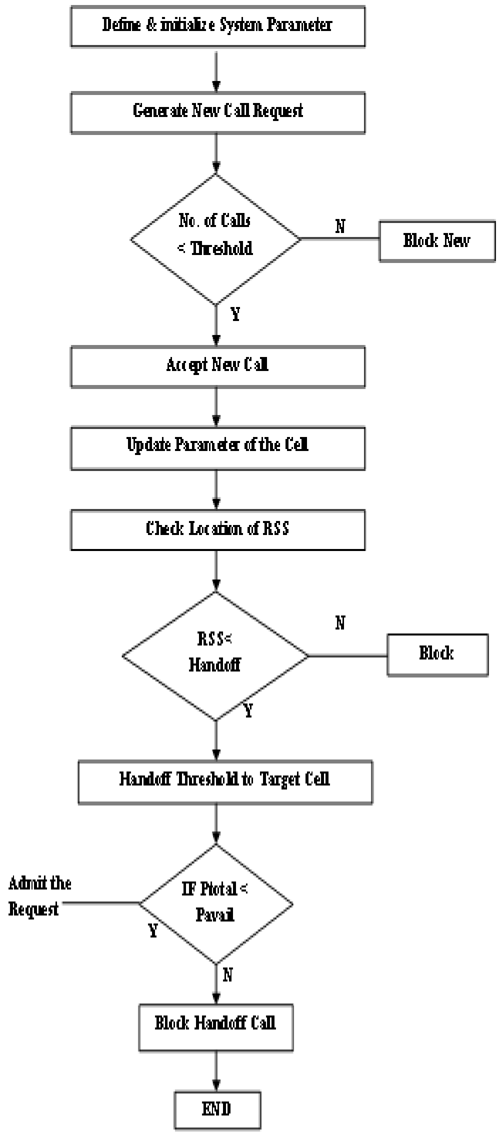

Fig. 3. Flow Chart for CAC Handoff Prioritization Algorithm

The Intelligent System to measure system parameters is developed in Matlab. The system will detect which type of multimedia request is demand. The multimedia request can be audio, data, images or text. The system will then apply its parameters on the multimedia request. The system parameters are firstly throughput which is nothing but the measurement of the rate of data transfer through a network. Secondly signal to noise ratio is the ratio which computes the minimum required power for the new user and accepts it if is not below a predefined minimum link quality level. Thirdly bit error rate which is the frequency of errors that occur when bits are transmitted in a digital system. Fourthly response time which is the time taken by a system or to react a given input. Then the new call request is generated and the request is send to the base station. The bandwidth of 3G is 3 GHz. The channels are available for traffic management is three. The bandwidth divided between these three channels is as for

ISSN: 2277-3754
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 1, Issue 3, March 2012

audio it is 2 GHz, for text it is 0.5 GHz and for image it is 0.5 GHz. The allocation of resources to users will depend on the cell size.

Now it will accept the new call, will check with the requirement of the call with recently available resources. It will check the location of Remote switching system. In the Remote switching system if the Request < Threshold, it will go to the first step the resources & update the parameter in the available section and it will follow the same steps and if the condition is not satisfied then request will be denied. For request received it will check if it is a handoff call/request is received and also will check with the required resources by the hand off call is Request power < available resources power. If yes it will grant them and update the status of available resources with it else it will discard the resource. The main goal of our project is maximum satisfaction of requests without fail of resources and we are interested in achieving throughput & minimizing bandwidth requirement.

V. Handoff Prioritization

One of the ways to reduce the handoff failure rate is to prioritize handoff. Handoff algorithms that try to minimize the number of handoffs give poor performance in heavy traffic situations. In such situations, a significant handoff performance improvement can be obtained by prioritizing handoff [2].

Channel assignment strategies with handoff prioritization have been proposed to reduce the probability of forced termination. Two basic methods of handoff prioritization, guard channels and queuing, are.

1. **Guard Channels** — Guard channels improve the probability of successful handoffs by reserving a fixed or dynamically adjustable number of channels exclusively for handoffs. For example, priority can be given to handoff by reserving N channels for handoffs among C channels in the cell. The remaining $(C – N)$ channels are shared by both new calls and handoff calls. A new call is blocked if the number of channels available is less than $(C – N)$. Handoff fails if no channel is available in the candidate cell. However, this concept has the risk of underutilizing spectrum. An adaptive number of guard channels can help reduce this problem. Efficient usage of guard channels requires the determination of an optimum number of guard channels, knowledge of the traffic pattern of the area, and estimation of the channel occupancy time distributions. [2]
2. **Queuing of Handoff** — Queuing is a way of delaying handoff; the MSC queues the handoff requests instead of denying access if the candidate BS is busy. Queuing new calls results in increased handoff blocking probability. The probability of a successful handoff can be improved by queuing handoff requests at the cost of increased new call blocking probability and a decrease in the ratio of carried-to-admitted traffic since new calls are not assigned a channel until all the handoff requests in the queue are served. Queuing is possible due to the overlap region between the adjacent cells in which MS can communicate with more than one BS. If handoff requests occur uniformly, queuing is not needed; queuing is effective only when handoff requests arrive in groups and traffic is low for two reasons. First, if there is a lot of traffic, it is highly unlikely that a queued handoff request will be entertained. Second, when there is moderate traffic and traffic arrives in bundles, a queued handoff request is likely to be entertained due to potential availability of resources in the near future and the lower probability of new handoff requests in the same period. Queuing is very beneficial in macro cells since the MS can wait for handoff before signal quality drops to an unacceptable level. However, the effectiveness of queuing decreases for micro cells due to stricter time requirements. The combination of queuing and channel reservation can be employed to obtain better performance. Joint optimization of queuing and handoff parameters may be better due to the following reasons.

- When handoff algorithms are designed to minimize the number of unnecessary handoffs, excessive call drops may occur during high traffic intensities. These strategies minimize the number of handoff attempts per boundary crossing, and sufficient time may not be available for entertaining handoff requests under heavy traffic conditions. For example, if a large amount of hysteresis is used to minimize handoffs, call quality may become unacceptable by the time a handoff request is entertained.
- Different handoff algorithms introduce different delays in handoff requests. Hence, the delay associated with handoff queuing may not be acceptable for some handoff algorithms. The performance improvement achievable with handoff queuing is variable and dependent on handoff algorithms.
- Some handoff requests may demand higher priority in a queue to save the call. This can be investigated properly by noting both the traffic and transmission characteristics [2].

Handoff Schemes-The handoff schemes can be classified according to the way the new channel is set up and the method with which the call is handed off from the old base station to the new one. At call-level, there are two classes of handoff schemes, namely hard handoff and soft handoff [1] .

1) **Hard handoff**- In hard handoff, the old radio link is broken before the new radio link is established and a mobile terminal communicates at most with one base station at a time. The mobile terminal changes the communication channel to the new base station with the possibility of a short interruption of the call in progress. If the old radio link is disconnected before the network completes the transfer, the call is forced to terminate. Thus, even if idle channels are available in the new cell, a handoff call may fail if the network response time for link transfer is too long. Second generation mobile communication systems based on GSM fall in this category [1].
2) **Soft handoff**- In soft handoff, a mobile terminal may communicate with the network using multiple radio

links through different base stations at the same time. The handoff process is initiated in the overlapping area between cells some short time before the actual handoff takes place. When the new channel is successfully assigned to the mobile terminal, the old channel is released. Thus, the handoff procedure is not sensitive to link transfer time. The second and third generation CDMA-based mobile communication systems fall in this category. [1]

Soft handoff decreases call dropping at the expense of additional overhead (two busy channels for a single call) and complexity (transmitting through two channels simultaneously). Two key issues in designing soft handoff schemes are the handoff initiation time and the size of the active set of base stations the mobile is communicating with simultaneously. This study focuses on cellular networks implementing hard handoff schemes. [1]

VI. Performance Criteria

In this subsection, we identify some commonly used performance criteria for comparing CAC schemes. Although others exist, we will focus on the following criteria in this survey:

1) Efficiency: Efficiency refers to the achieved utilization level of network capacity given a specific set of QoS requirements.
2) Complexity: Shows the computational complexity of a CAC scheme for a given network configuration, mobility patterns, and traffic parameters.
3) Overhead: Refers to the signaling overhead induced by a CAC scheme on the fixed interconnection network among base stations.
4) Adaptivity: Defined as the ability of a CAC scheme to react to changing network conditions. Those CAC schemes, which are not adaptive, lead to poor resource utilization. Typically, CAC schemes make admission decisions based on some internal control parameters, e.g. reservation threshold, which should be recomputed if the load changes.
5) Stability: Stability is the CAC insensitivity to short term traffic fluctuations. If an adaptive CAC reacts too fast to any load change then it may lead to unstable control. [1]
6) Throughput the rate at which the packets go through the network. Maximum rate is always preferred.
7) Delay this is the time which a packet takes to travel from one end to the other. Minimum delay is always preferred.
8) Packet Loss Rate the rate at which a packet is lost. This should also be as minimum as possible.
9) Packet Error Rate this is the errors which are present in a packet due to corrupted bits. This should be as minimum as possible
10) Reliability **The** availability of a connection. (Links going up/down).

VII. Conclusion

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.

In this paper, we provided a survey of the major call admission control approaches and related issues for designing efficient schemes. 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.

Acknowledgment

I express thanks to my project guide Prof. A.S. Bhide for his cooperation during the whole process of paper by providing his valuable time, support, encouragement, supervision and useful suggestions throughout this seminar work. His moral support and continuous guidance enabled me to complete my work successfully. Last but not least, I thank all my friends and classmates for giving me timely suggestions during preparation of the seminar and for providing encouragement.

REFERENCES

[1] 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

[2] Call Admission Control in Mobile Cellular Networks: A Comprehensive SurveyMajid Ghaderi and Raouf Boutaba School of Computer Science University of Waterloo.

[3] Handoff in Cellular Systems Nishith D. Tripathi, Nortel Jeffrey H. Reed and Hugh F. VanLandingham MPRG, Virginia Tech.

[4] QoS in Cellular Networks Dushyanth Balasubramanian, Washington University in Saint Louis.

[5] D. Wong and T. J. Lim, “Soft handoffs in CDMA mobile systems,” IEEE Personal Communications Magazine, vol. 4, no. 6, pp. 6–17, Dec. 1997.

[6] R. Prakash and V. V. Veeravalli, “Locally optimal soft handoff algorithms,” IEEE Transactions on Vehicular Technology, vol. 52, no. 2, pp. 231–260, Mar. 2003.

[7] Y.-B. Lin and A.-C. Pang, “Comparing soft and hard handoffs,” IEEE Transactions on Vehicular Technology, vol. 49, no. 3, pp. 792–798, May 2000.

[8] R. Ramjee, D. Towsley, and R. Nagarajan, “On optimal call admission control in cellular networks,” Wireless Networks, vol. 3, no. 1, pp. 29–41, Mar. 1997.

ISSN: 2277-3754
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 1, Issue 3, March 2012

[9] A. G. Valko and A. T. Campbell, "An efficiency limit of cellular mobile systems," Computer Communications Journal, vol. 23, no. 5-6, pp. 441–451, Mar. 2000.

[10] A. K. Talukdar, B. Badrinath, and A. Acharya, "Integrated services packet networks with mobile hosts: Architecture and performance," Wireless Networks, vol. 5, no. 2, pp. 111–124, 1999.

[11] S. Lu and V. Bharghavan, "Adaptive resource management algorithms for indoor mobile computing environments," in Proc. ACM SIGCOMM'96, Palo Alto, USA, Aug. 1996, pp. 231–242.

[12] G. Senarath and David Everitt, "Performance of handover priority and queuing systems under different handover request strategies for microcellular mobile communication systems," Proc. 45th IEEE VTC, 1995, pp. 897–901.

[13] S. Tekinay and B. Jabbari, "Handover and Channel Assignment in Mobile Cellular Networks," IEEE Commun. Mag., Nov. 1991, pp. 42–46.

[14] S. Tekinay and B. Jabbari, "A measurement-based prioritization scheme for handovers in mobile cellular networks," IEEE JSAC, vol. 10, no. 8, Oct. 1992.

[15] P. O. Gassvik, M. Cornefjord, and V. Svensson, "Different methods of giving priority to handoff traffic in a mobile telephone system with directed retry," Proc. 41st IEEE VTC, May 1991, pp. 549–53.

[16] Xue-Wu Zhang Gang Hu, "Strategies of improving QOS for Video Transmission over 3G Wireless Network".

[17] Si Wu, K. Y. Michael Wong, And Bo Li, "A Dynamic Call Admission Policy With Precision QoS Guarantee Using Stochastic Control For Mobile Wireless Networks", IEEE Transactions on Networking, Vol. 10, No. 2, April 2002.

[18] H. Y. Ng, K. T. Ko And K. F. Tsang, "3G Mobile Network Call Admission Control Scheme Using Markov Chain", 0-7803-8920-4/05/@ IEEE

[19] Salman Al-Qahtani, Ashraf Mahmoud, "A Prioritized Uplink Call Admission Control Algorithm for 3G WCDMA Cellular Systems with Multi-Services".

[20] Mohamed Hossam Ahmed, "Call Admission Control In wireless Networks A Comprehensive Survey", IEEE Communications Surveys & Tutorials, First Quarter 2005, Volume 7, No. 1.

[21] Majid Ghaderi and Raouf Boutaba, "Call Admission Control in Mobile Cellular Networks: A Comprehensive Survey", University of Waterloo, Ontario N2L 3G1, Canada.

[22] R. Jayram, N. K. Kakani, S. K. Das & Sanjoy K. Sen, "Call Admission & Control Scheme for QoS Provisioning in Next Generation Wireless Networks", Baltzer Journals Supported At Texas Advanced Research Program & Nortel Networks, Richardson, Texas.