# SURVEY ON CALL ADMISSION CONTROL (CAC) SCHEMES IN WIMAX NETWORK

Shruti Maniar[1], Nitul Dutta[2]
[1,2]Department of Computer Engineering, Faculty of PG studies-MEF Group of Institutions, Rajkot
Email:maniar.shruti251@gmail.com[1], nitul.dutta@marwadieducation.edu.in[2]

**Abstract**

**Call admission control (CAC) mechanism plays a critical role in providing quality-of-service (QoS) guarantees for various traffic classes with different QoS requirements in IEEE 802.16e networks. Network resources can be efficiently utilized when a proper CAC scheme is chosen as a call admission criterion. In this paper we have studied and surveyed many mechanisms that have already been adopted to enhance QoS of the system. This paper contains the work done in the field of Call Admission specifically to enhance QoS and the paper guides newcomers who are willing to work in this field.**

**Index Terms: Mobile WiMAX, Handoff Connection, New Connection, Admission Criteria.**

## I. INTRODUCTION

### *A) An Overview of IEEE 802.16e*

IEEE 802.16e standard does not specify the criteria to admit a call in the network. It is remained as an open issue to developer. The mail objective behind designing CAC mechanism is to accept or reject a new or handoff call depending on its required QoS parameters. If all the required parameters are satisfied, the developed CAC module will admit a call the network. Fig 1 gives the architecture of WiMAX network. The IEEE 802.16 standard divides all service flows in five scheduling classes, each of which is associated with a set of QoS parameters for measuring its bandwidth requirement. With the handling of users in the WiMAX network, there are two terms associated mostly together: The Call Admission Control (CAC) and Scheduling.

The CAC procedure is implemented at the Base Station (BS) that ensures the load supplied by the Subscriber Station (SS) can be handled by the network. While the Scheduling mechanism guarantees that the mandatory amount of resources is allocated to the connections, so that QoS requirements are met, the admission control mechanism bounds the number of connections entered in the network so that network will never be overloaded. This scheme only focuses on admission criteria. The call admission is about accepting or rejecting incoming connections. Call admission control is done at each subscriber station to limit the number of ongoing connections through that subscriber station. Traffic from all uplink connection is gathered into a queue at each subscriber station. This queue has limited size and if this queue is full the next arriving packets will be dropped.

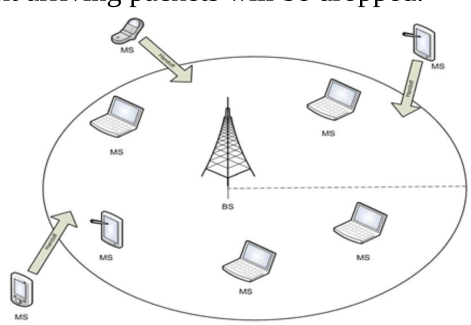


Figure 1 WiMAX Architecture [1]

*B) Challenges in CAC*

In WiMAX (Worldwide Interoperability for Microwave Access) network *resource allocation* to all the entered connections, fairness between all of them is the major challenge in designing particular algorithm. On the acceptance of the new or handoff connection, already admitted call should not be compromised its requirement from the network.

IEEE 802.16e network supports mobility of the WiMAX network users, so handover process should also be taken into consideration while developing any call admission scheme. Thus *handoff calls* should be maintained through CAC mechanism.

Accepting new connections should not affect the QoS requirements of the already admitted calls in the network. Thus *QoS provisioning* is another main challenge in creating CAC scheme.

Communication in WiMAX network happens between WiMAX Customer Premises Equipment (CPE) and base station at Non Line Of Sight (NLOS). This is a major challenge for WiMAX networks as the *link security* requirements are more than that of in wireless technology. Setting up radio links with high performance that are capable of providing data rates as high as wired networks and cable modem that can increase data rate in NLOS environment.

*C) Traffic classes* [1]

The *unsolicited grant service* (UGS) periodically generates constant-size data packets for real-time traffic such as VoIP without silence suppression. UGS is sensitive to transmission delays, and the BS allocates grants to the MS in an unsolicited fashion using the maximum sustained traffic rate (MSTR), traffic priority, and maximum latency tolerance as its QoS requirements.

The *real-time polling service* (rtPS) generates variable-size data packets for real-time traffic such as MPEG video. It has less stringent delay requirements and is periodically polled by the BS for each MS to individually determine its bandwidth requirement. Its mandatory QoS specifications are the minimum reserved traffic rate (MRTR), MSTR, traffic priority, and maximum latency tolerance.

The *extended real-time polling service* (ertPS) generates variable-size data packets for real time traffic such as VoIP with silence suppression. It combines features of both UGS and rtPS and has strict, guaranteed delay requirements and provides unicast grants in an unsolicited manner by the BS, as with UGS. Because UGS grants are of constant size whereas ertPS grants vary in size, an MS can request a change of its bandwidth grant to suit its requirements. The ertPS QoS requirements are MRTR, MSTR, traffic priority, maximum latency tolerance, and delay jitter tolerance.

The *non–real-time polling service* (nrtPS) generates variable-size data packets for non–real-time traffic such as FTP. It has minimum bandwidth requirements that are delay tolerant. It is polled by the BS in order for each MS to state its desired bandwidth. The QoS requirements are MRTR, MSTR, and traffic priority.

The *best-effort service* (BE) is designed to support traffic for which delay and throughput are not guaranteed, such as HTTP. It requests bandwidth through contention request

Opportunities and unicast request opportunities.

## II. PARAMETERS FOR DEVELOPING CAC SCHEME IN WIMAX

In this paper we have consider many parameters that effecting the call admission control scheme like delay means we have to minimize the delay from source to destination, throughput means from source to destination maximum throughput we have to consider. Call blocking probability that gives the probability of blocking the new incoming connection request. Handoff call dropping probability should also be considered. Arrival rate of the connection requests should need to be covered over here.

## III. CAC MECHANISMS

IEEE 802.16 is connection oriented standard and the Subscriber Station must establish an end to end connection before actually transmitting data. Call Admission Control is done by base station. It blocks or avoids an unwanted call in order to guarantee the QoS of existing call in the network. Thus main objective behind designing any CAC mechanism is to limit the number of active connections and provide guaranteed QoS to all that admitted calls. When BS receives the connection request it takes the decision whether to accept or reject that request, based on the current network load, bandwidth requirement of requested connection and bandwidth available in the network.

In [1], proposed CAC scheme, prevents starvation of service classes and enhance utilization of network resources. Bandwidth degradation policy is used in this scheme to admit more users when there is no available bandwidth to admit a user. Adaptive threshold is used to decide the quantity of reserved bandwidth for handoff connections based on traffic intensity of handoff connections. Among the five types of service classes this scheme only degrades the bandwidth requirements of ertPS and rtPS service classes. This scheme uses adaptive QoS strategy in which the scheduled service class is assigned MSTR or MRTR requirements. The admission criteria are dynamically determined by three classification of the network load: low, moderate and heavy. If the network load is low, the QoS requirement is adjusted to MSTR. If the network load becomes moderate to heavy then linear adaptation policy is used to reduce the bandwidth requirements from MSTR to MRTR. The scheme also uses adaptive threshold that is dynamically changed based on arrival rate of new or handoff connections.

In [2], An efficient Call Admission Control (CAC) scheme for IEEE 802.16e Mobile WiMAX that satisfies both bandwidth and delay guarantee to the admitted connections has been proposed. The scheme provides higher priority to Handoff connections, because it is more annoying to drop an on-going connection than blocking a newly originated connection. Also UGS connections are given higher priority because UGS is the most common service used by the people for communication in everyday life. ertPS connections requests are considered to be same as rtPS connections, because both connections have same QoS parameters and differ only by the way of Request/Transmission policy. Also BE connections are not measured in this scheme, because they are designed to support best effort flows which does not require QoS guarantees. Therefore BE service flows are always admitted into the network and are controlled by available bandwidth basis.

In [3], density based CAC scheme is proposed. It refers to different areas in a single OFDMA-based WiMAX cell. Users are permitted to move internally in those areas as well as externally in other cells. It decreases the dropping probability of user moving away from base station lacking increasing blocking probability of new calls. This scheme gives a resource allocation strategy which is also referred to as a Max-Min problem. As dropping a call in progress, is considered to have more negative impression from user's point of view than blocking a new call. So in order to limit call drops, this scheme assigns higher priority to calls migrating from one region to an adjacent one over new calls arriving to network. Conditions for accepting new or migrated calls are different. This scheme has one equation that gives the region, and no. of accommodated users in that particular region is adjusted dynamically. As it is based on the level of dense region, this scheme is known as density based CAC mechanism.

In [4], a dynamic connection admission control (CAC) and bandwidth reservation (BR) scheme for IEEE 802.16e Broadband Wireless Access networks to simultaneously improve the utilization efficiency of network resources and guarantee QoS for admitted connections is proposed. The proposed algorithm dynamically controls the admission criteria according to network loads and adopts an adaptive QoS strategy to improve the utilization efficiency of network resources. After new or handoff connections are accepted in the networks based on current admission criteria, the proposed adaptive BR scheme adjusts the amount of reserved bandwidth for handoffs according to the arrival distributions of new and handoff connections in order to increase the admission opportunities of new connections and provide handoff QoS as well.

In [5], they proposed an adaptive CAC method and two different scheduling schemes for multihop WiMAX networks. The proposed CAC, Base Station reserves some bandwidth for the mobile users and changes the BW reservation adaptively based on recent connection requests from the handover connections. When there are few or no handover users are in a network, the residual reserved BW is allocated to low priority Best Effort (BE) users for effective BW utilization. While admitting the New Calls or Handoff Calls, the BS verifies both BW and multihop delay requirements to satisfy the QoS of the call. When there are few or no handover users exist in a network, the remaining reserved BW is allocated to low priority Best Effort (BE) users to effectively utilize bandwidth. While accepting the new Calls or handoff Calls, the BS verifies both BW and multihop delay requirements to satisfy the QoS of the call. This scheme also proposes two downlink scheduling algorithms (P+E) and (P+TB) for the BS in multihop networks. The (P+E) scheduler combines the Priority and Earliest Due Date (EDD) scheduling methods, while the (P+TB) scheduler combines the Priority and Token Bucket (TB) scheduling methods. When the network is lightly or moderately loaded, the (P+E) scheduler performs well for both single and multihop users but the performance of real time services are highly affected under high load conditions. On the other hand, the (P+TB) scheduler has very good QoS performance for real time services under high load conditions and also has closer QoS performance to (P+E) scheduler for multihop users under low and moderate load conditions.

In [6], they have proposed a novel admission control scheme which employs the ant colony algorithm and lays stress on the fairness between services. Their revenue-weighted scheme mainly focuses on fairness of service response. However, it is also based on the revenue value which results in the most efficient performance. In WiMAX, with regard to limitations of bandwidth, this algorithm tries best to leverage revenue and fairness. But optimization of this revenue strategy is still can be expanded.

In [7], they proposed a new algorithm Forward Selection Call Admission Control with Intrusion Detection System [FSCACIDS], It provides proper and reliable communication for all WiMAX nodes. It access the gateway based on higher energy and low mobility nodes and provide high security using Intrusion detection system. FSCACIDS is used to find the best Gateway based on High Energy and Low Mobility to choose and access the long and High Data communication. This reduces the routing overhead and results in fewer broadcast storm problems in the MAC layer. This increases the probability of successful route discovery and improves the Quality of service. This gives greater bandwidth and Frequency Utilization and reduces the routing overhead.

In [8], proposed mechanism is using dynamic admission criteria which based on predefined standard for all service classes. For QoS provisioning bandwidth reservation and bandwidth degradation policy is taken into account. Degradation is only applied on nrtPS service class. Maximum priority is given to UGS class and minimizes blocking probability of service classes. Handoff calls are not taken into consideration in this scheme. Bandwidth reservation scheme will reserve predefined amount of bandwidth for all the service classes. On the other hand degradation policy is applied only on the nrtPS classes. Amount of degraded bandwidth requirement is also adjusted dynamically based on available network resources and amount of reserved bandwidth for handoff connections.

In [9, 10], CAC and packet scheduling both schemes were proposed for WiMax networks that provisions QoS. A token bucket based CAC scheme is used that allows a new connection by ensuring that QoS of the already admitted connections will never be degraded or affected and they will be provided the same required QoS. Bandwidth reservation is used only for UGS and rtPS service classes and other available bandwidth is used for other service classes. When bandwidth requirements are satisfied it also ensures delay guarantees to rtPS class.

Drawback of this scheme is that it starves low priority class and ignores handover calls and efficient network resource utilization.

In [11], proposed CAC scheme supports both new and handoff calls based on characteristics of an adaptive multimedia service. When there is no available bandwidth to admit a new connection in network it will degrade bandwidth of active connections. And when network traffic reduces, the degraded bandwidth will be upgraded in the reverse order. This method utilizes network resources efficiently and reduces blocking and dropping probability. But this method is somewhat unfair because it degrades bandwidth of lowest priority class to its minimum bandwidth in a step wise fashion.

In [12], bandwidth borrowing policy to assign high priority to handoff connections comparatively new connection and also guard channel is used in the proposed CAC mechanism. Policies used in this scheme provide reasonable priority order to new and handoff calls to different service classes. This scheme maximizes bandwidth utilization and reduces connection blocking and dropping probability. Only one shortcoming of this scheme is that if handoff connections don't consume reserved bandwidth then certain portion of bandwidth may be wasted because it then never be utilized to accept a new connection request.

In [13], a CAC scheme is developed in order to guarantee QoS to different traffic service classes in IEEE 802.16e. Service classes are divided into two groups: real time and non-real time. Scheme is using dynamic guard channel that dynamically changes between minimum and maximum reserved threshold, based on entry and exit of handoff connections. This scheme reduces blocking and dropping probabilities.

In [14], dynamic CAC and BR mechanisms are proposed for IEEE 802.16e.It not only improves network resource utilization but also guarantees QoS for all admitted new and handoff connections. Admission criteria is adjusted dynamically based on network loads. The admission criteria used starved the high and the low service classes when the traffic load is moderate or heavy. It also uses fixed maximum reserved amount of bandwidth based on arrival rate of new and handoff connections.

## IV. CONCLUSION

From this paper, we have presented analytical comparisons of the existing call admission schemes in mobile WiMAX network and listed according its challenges and issues. We have also discussed advantages and limitations of the mentioned CAC schemes. For the future research work this paper might be useful in current field of Mobile WiMAX networks and also motivate them toward further design of it.

## V. REFERENCES

[1] I. Saidu, S. Subramaniam, A. Jaafar, and Z. A. Zukarnain, "A QoS-Aware CAC with Bandwidth Reservation and Degradation Scheme in IEEE 802.16e Networks," *Wirel. Pers. Commun.*, vol. 82, no. 4, pp. 2673–2693, 2015.

[2] K. Suresh and I. S. Misra, "Bandwidth and Delay Guaranteed Call Admission Control Scheme for QOS Provisioning in IEEE," pp. 1–6, 2008.

[3] C. Tarhini and T. Chahed, "Mobile WiMAX," pp. 1–5, 2008.

[4] C. Wang, W.-J. Yan, and H.-K. Lo, "Dynamic admission control and bandwidth reservation for IEEE 802.16e mobile WiMAX networks," *EURASIP J. Wirel. Commun. Netw.*, vol. 2012, no. 1, p. 143, 2012.

[5] P. Rengaraju and C. Lung, "Adaptive Admission Control and Packet Scheduling Schemes for QoS Provisioning in Multihop WiMAX Networks," pp. 866–871, 2012.

[6] Y. Hongbing and L. Chen, "A Fair Revenue-Weighted CAC Scheme," pp. 362–365, 2009.

[7] D. M. Gharge, S. V Halse, and S. B. Jagtap, "Forward Selection Call Admission Control withIntrusion Detection System in IEEE 802 . 16E WiMAX Network," vol. 2, no. 4, pp. 1–9, 2013.

[8] Wang, H., Li,W.&Agrawal, D.P. "Dynamic admission control and QoS for 802.16 wirelessMAN". In *Wireless Telecommunications Symposium*,pp. 60–66,2005.

[9] Wongthavarawat, K., & Ganz, A. (2003)." Packet scheduling for QoS support in IEEE 802.16 broadband wireless access systems". *International Journal of Communication Systems*, vol no.16,pp. 81–96.

[10] Jiang, C-H. & Tsai, T-C. (2006). Token bucket based CAC and packet scheduling for IEEE 802.16 broadband wireless access networks. In *Consumer Communications and Networking conference*,CCNC. 3rd IEEE,Vol. 1, pp. 183–187,2006.

[11] Ge, Y. & Kuo, G-S. (2006)."An efficient admission control scheme for adaptive multimedia services in IEEE 802.16 e networks",In *Vehicular Technology Conference*,IEEE 64th,pp. 1–5,2006.

[12] Wang, L.,Liu, F., Ji,Y.,&Ruangchaijatupon, N."Admission control for non-preprovisioned service flow in wireless metropolitan area networks",In *Fourth European Conference on Universal Multiservice Networks*,pp. 243–249,2007.

[13] Chaudhry, S.B. & Guha, R.K. (2007)."Adaptive connection admission control and packet scheduling for QoS provisioning in mobile WiMAX", In *International Conference on Signal Processing and Communications*, ICSPC. IEEE,pp. 1355–1358, 2007.

[14] Wang, C.,Yan,W.-J.,&Lo, H.-K. (2012).Dynamic admission control and bandwidth reservation for IEEE 802.16 e mobileWiMAX networks. EURASIP Journal on Wireless Communications and Networking, 1,1–20.