A Novel Call Admission Control Scheme for Multimedia Traffic in IEEE 802.16e OFDMA Systems

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Abstract—*IEEE 802.16e Broadband Wireless Access (BWA)technology is one of the most promising technologies for broadband access and has many applications. In order to meet the requirements of diverse multimedia services, it is necessary toprovide quality of service (QoS) guarantee. Call Admission control plays an important role in QoS provisioning for wirelesscommunication systems [1–2]. However, IEEE 802.16e standarddoes not specify the CAC scheme at all. In this paper, a novel call admission control scheme is proposed for 802.16e networks based on maximum use of subchannels using AMC to minimize the overall transmit power in OFDMA systems for low, medium and heavy multimedia traffic .the results clearly indicates the performance the novel call admission control algorithm to show the effectiveness of bandwidth estimation andresource allocation using this novel CAC algorithm over that of dynamic bandwidth allocation call admission control (CAC).*

Keywords—*Admission Control; Broadband Wireless Access (BWA);IEEE 802.16e; Quality of Service (QoS)*

I. *Introduction*

The broadband access via digital subscriber line (DSL) or Cable modem is still not available or not satisfactory for many home and business customers so far. While, IEEE 802.16 Broadband Wireless Access (BWA) standard provides a wireless alternative to DSL and cable modem, it also overcomes barriers to the “last mile” connection. IEEE 802.16 BWA system has many advantages in terms of high capacity, high-speed transmission, advanced multimedia services, easy deployment and implementation, etc. The 802.16e standard aids mobile subscriber station (MSS) roaming among service areas, which is the further requirement in wireless communications [3–6]. Therefore, 802.16e BWA technology is very promising for mobile vehicular.

At moving vehicular speeds, MS’s may change theirserving cells several times during the lifetime of their conversations,and handoff droppings will happen when the availableresource in the target cells cannot meet the requirementsof the handoff calls. In order to keep the handoff droppingrate at an acceptable level, call admission control (CAC) iswidely adopted in mobile communication systems, the mainidea of which is to reduce handoff droppings by limiting the amount of radio resource allocated to active calls and newcalls in each cell. A significant number of CAC schemes have been proposed during the last two decades. Because of the scarcity of bandwidth resource in wireless networks ,CAC has always to manage with in available resources.

Call admission control (CAC) is such a provisioning strategy to limit the number of call connections into the networks in order to reduce the network congestion, call blocking and call dropping. A good CAC scheme has to balance the call blocking and call dropping in order to provide the desired QoS requirements. Call admission control for high-speed wireless networks has been intensively studied in the last few years [7]. Due to users’ mobility, call admission control becomes much more complicated in wireless networks. An accepted call that has not completedin the current cell may have to be handed off to another cell. During the process, the call may not be able to gain a channel in the new cell to continue its service due to the limited resource in wireless networks, which will lead to the call dropping. Thus, the new calls and handoff calls have to be treated differently in terms of resource allocation [8].The AC schemeproposed in [9] does not consider the handover situation,which is the radical feature in 802.16e networks. The traditional guard channel schemes reserve a fixed number of channels exclusively for handoff calls , which do not adapt to changes in the traffic pattern. Unfortunately, these channel reservation schemes are not competent in IEEE 802.16e system for two reasons. First, in WiMAX systems is high spectrum utilization is achieved by efficient and flexible channel allocation [10],[11],. Therefore, reserving a number of channels for handoff calls will potentially result in poor spectrum utilization.Second, there exists a fundamental tradeoff between bandwidth resource and power resource.

In this paper, we propose a novel Call Admission Control algorithm for new calls and hand off calls considering real time and non real time services for low, medium and heavy multimedia trafficbased on maximum use of subchannels to minimize the overall transmit power in OFDMA systems.

Section II describes the system model for IEEE 802.16e in. We present frame work for novel call admission control scheme to deal with real time and non realtime multimedia traffic in section III. Section IV highlight the result analysis in terms of performance evolution.

II. *System Model*

A. *Network Model*

Consider an IEEE 802.16e cellular system consisting of 19 cells, with six cells in the first tier and twelve cells in the second tier (figure 1), surrounding the central cell. A single BS is located at each cell center, and the cell radius is set to 1Km. The wraparound technique is used to eliminate boundary effect and MSs are uniformly distributed throughout the whole system topology.

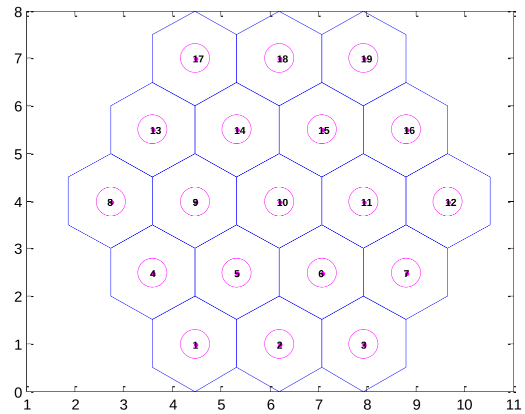

Figure 1: IEEE 802.16e cellular 19Hexgonal Cells systems

The center frequency (fc) is 3.5GHz, and the total bandwidth in each cell (Bt) is 10MHz. The subcarriers of each logical subchannel are spread though the whole frequency band of that cell. The technique of adaptive modulation and coding (AMC) is used, thus the AMC scheme of each active call could be dynamically adjusted according the factors such as channel conditions and available radio resource. Information about the IEEE 802.16e OFDMA Parameters and specified AMC schemes are listed in Table I & Table II respectively.

Table I. IEEE 802.16e OFDMA Parameters

Parameters	Values			
Bandwidth (MHz)	1.25	5	10	20
FFT Size(Sub-carrier)	128	512	1024	2048
Sub-carier Spacing (K Hz)	9.8	9.8	9.8	9.8

Table II. AMC levels in IEEE 802.16e

AMC level	bit/s/Hz	AMC mode	SINR thrsh. (dB)
1 (*Lmin*)	1.0	QPSK-1/2	7.6
2	1.5	QPSK-3/4	10.3
3	2.0	16QAM-1/2	14.3
4	3.0	16QAM-3/4	17.4
5	4.0	16QAM-2/3	21.0
6 (*Lmax*)	4.5	16QAM-3/4	22.0

B. *Traffic Model*

Real-time services and non real time services are considered in this paper, multiple classes and direction of calls are listed in Table III & Table IV respectively.

Table III. Traffic model of multimedia services

Services	Data Rate In K bps Random	Call duration In Sec Random
Class 1	3.5 to 4.5	01 to 60
Class II	64 to 144	90 to 180
Class III	256 to 1Mb	210 to 300

Table III Traffic model of direction

Direction No	Direction
1	West
2	North-West
3	North-East
4	East
5	South-East
6	South-West

C. *Propagation Model*

Path loss and shadow fading are taken into account in then propagation model, which is given by

$$PL(d) = PL(d_0) + 10\,\alpha\,\log(d/d_0) + \chi_\sigma \quad \text{---------------}(1)$$

where d is the transmitter-receiver separation distance; $d0$ is the reference distance, which is set to 30m; α is the path-loss exponent with the value of 3.5; χ_σ denotes the log-normal shadow fading, with a zero mean and a standard deviation of8dB.

III. *Admission Control Scheme*

Considering the fact that admission control strategies are highly dependent on the resource allocation algorithms adopted in the system, an optimal admission control algorithm for multimedia system is proposed in this section. The optimization objective of this resource allocation problem is to minimize the overall transmit power of the BS while guarantee the data rate requirements of all users.

Let S denote the total number of available subchannels in a cell and P denote the maximum transmit power in the BS. Suppose there are N active calls in the cell at present, and the data rate requirement of the ith user is $DR_i(1 \leq i \leq N)$,the number of subchannels and the transmit power assigned to user i can be denoted by Si and Pi, respectively. If user i's AMC level is set to MCi, the resulting data rate per unit of bandwidth from AMC level MCican be denoted by $DR(MCi)$, and the corresponding SINR are $f(MCi)$ requirement, can be looked up in Table II.

Accordingly, the number of subchannels required by user i is given by

$$si = \frac{DRi}{DR(MCi) * B0}$$

where$B0$ denotes the bandwidth of each subchannel. The required transmit power on each subchannel of user i is

$$P\_SC = \frac{f(MCi) * (\eta + Ii)}{Gi}$$

whereη is the thermal noise assumed to be the same at each receiver, Ii denotes the co-channel interference perceived by user i, and Gidenotes the channel gain of the link from the BS to the ith user (i.e path loss).

The required power from the BS to user i is given by:

$Pi = Si * P\_SC$

At first, each user is assigned the highest AMC level $Lmax$(according to Table II, $Lmax$= 6). Then, in each iteration, we try to reduce each user's AMC level to the next lower level. Consequently, for user i, there will be an increment in subchannel requirement denoted by $\Delta Si$and a decrement in transmit power requirement denoted by ΔPi, thus a metric of unified power reduction can be defined as $\Delta Pi/\Delta Si$.

The user with the largest unified power reduction is selected to lower its AMC level, and gets the right to obtain additional subchannels. This iteration process continues until every user reaches the lowest AMC level *Lmin* or no subchannels are left unoccupied. The details of this algorithm can be described as follows:

1) Initialization: For each user *i*, initializes *MCi= Lmax*, the Corresponding subchannel and power requirements are given by

$$Si = [DRi/(DR(Lmax) * B0$$
$$Pi = Si * P\_SCi$$

2) For each user *i* that satisfies *MCi>Lmin*, Calculate the required resource for the next lower AMC level:

$$MCi *= MCi - 1$$
$$Si *= [\frac{DRi}{DR(MCi *)} * Bo]$$
$$Pi *= Si * P\_SC$$

The subchannel requirement increment and the power requirement decrement are given by

$\Delta Si = Si* - Si$, and $\Delta Pi = Pi - Pi*$

3) Find user i^* with the largest unified power reduction:

$$i *= \max(\Delta Pi/\Delta Ni)$$

then, update the allocation information of the selected user *i**

MCi*= MCi*−1,

Si*= (DRi/(DR(MCi*) ・B0)

Pi*= Si*・P_SC

4) Repeat step 2) and 3) until all users reach the lowest AMC level or all the subchannels are assigned.

5)) Check the assignment results.

If $$\sum_{i=1}^{N} Pi < P$$

Thenallocation is finished successfully,
else resource allocation is failed.

IV. SimulationResults

In our simulation, the total number of subchannels in each cell is set to 1024, the overall transmit power of each BS is restricted to 100W and the thermal noise is -90dBm. In our simulation we have used three different traffic scenario (i.e. Low traffic , Medium Traffic, heavy Traffic) . The random walk mobility model is adopted to each MS, with maximum velocity is 120km/h with for low traffic call arrival rates are 0.1 to1, for medium traffic call arrival rates are 0.5 to 5 and for heavy traffic call arrival rates are 1 to 10. Call blocking and dropping probability for multimedia traffic as well as each class traffic for different call arrival are shown in the graph.

For low traffic model arrival are increased from 1 to 10 call arrivals /munity. Figure.2,Figure.3, Figure.4 & Figure.5 show the blocking probabilities and dropping probability for multimedia traffic as well as for each class traffic versus call arrival ratefor low traffic.

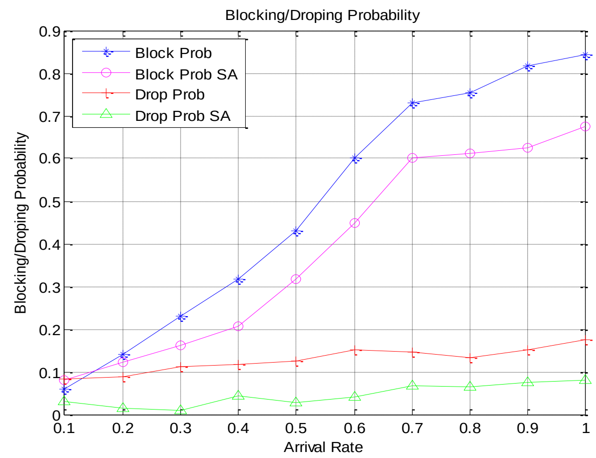

Figure 2. Blocking and Dropping probability for multimedia traffic versus call arrival rate

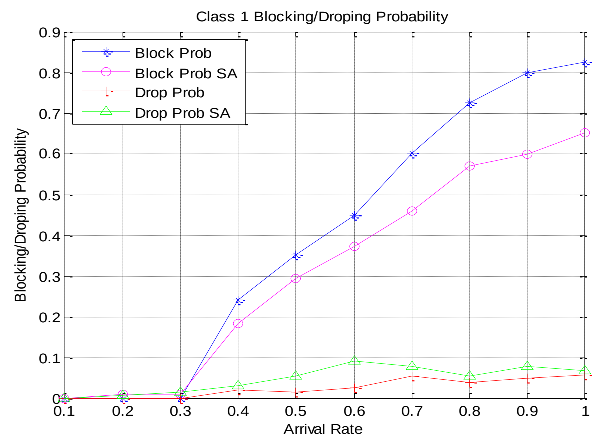

Figure 3. Blocking and Dropping probability for Class1 traffic versus call arrival rate

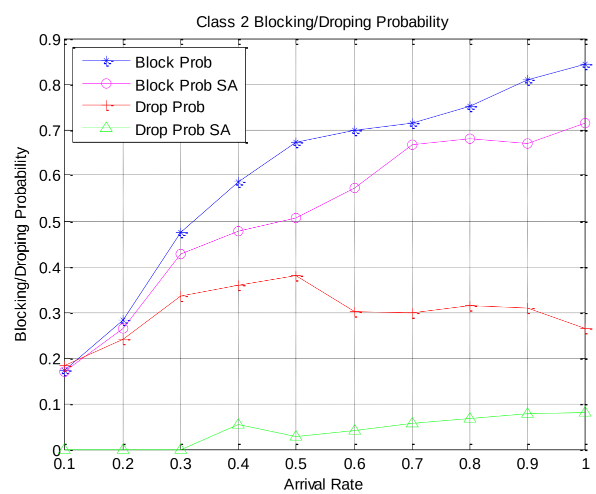

Figure 3. Blocking and Dropping probability for Class 2 traffic versus call arrival rate

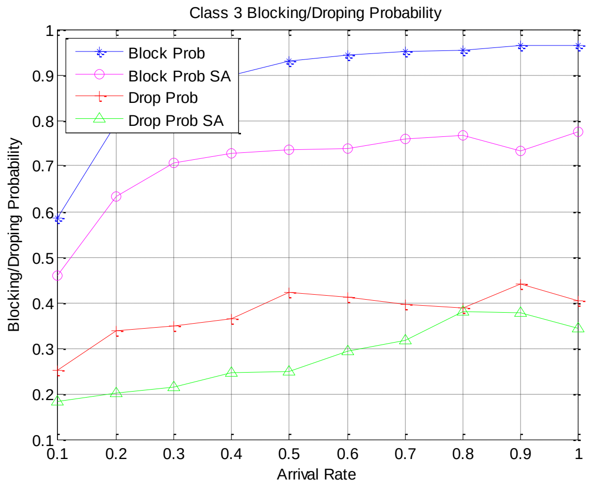

Figure 5. Blocking and Dropping probability for Class 3 traffic versus call arrival rate

B.*Medium traffic*

For medium traffic model arrival are increased from 5 to 50 call arrivals/ munity .Figure 6,Figure 7, Figure 8 & Figure 9 show the blocking probabilities and dropping probability for multimedia traffic as well as for each class traffic versus call arrival rate for medium traffic.

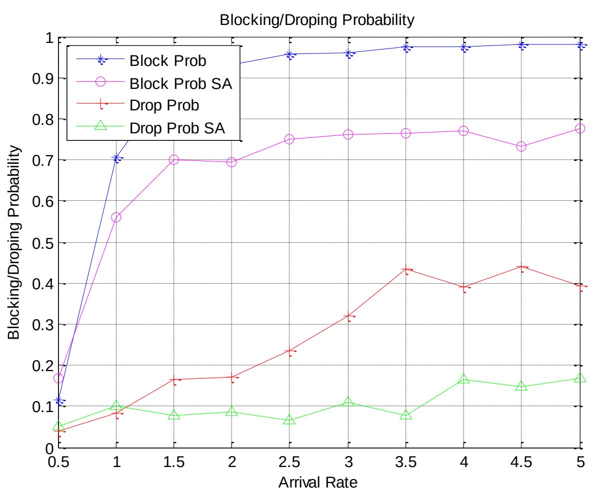

Figure 6. Blocking and Dropping probability for multimedia traffic versus call arrival rate

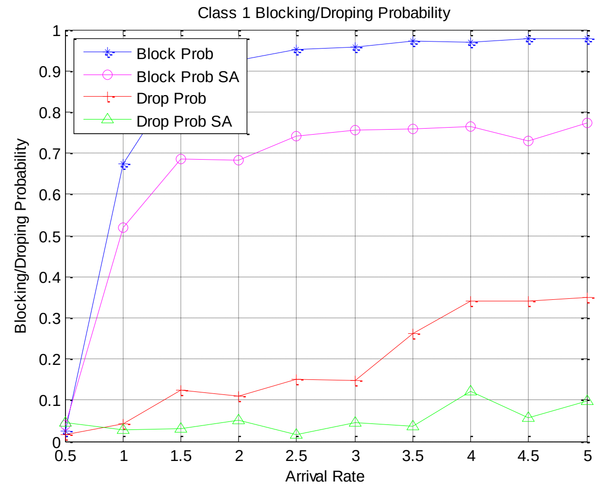

Figure 7. Blocking and Dropping probability for Class 3 traffic versus call arrival rate

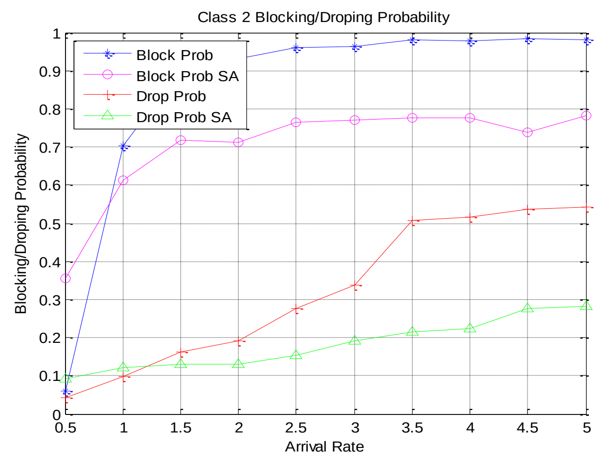

Figure 8. Blocking and Dropping probability for Class 2 traffic versus call arrival rate

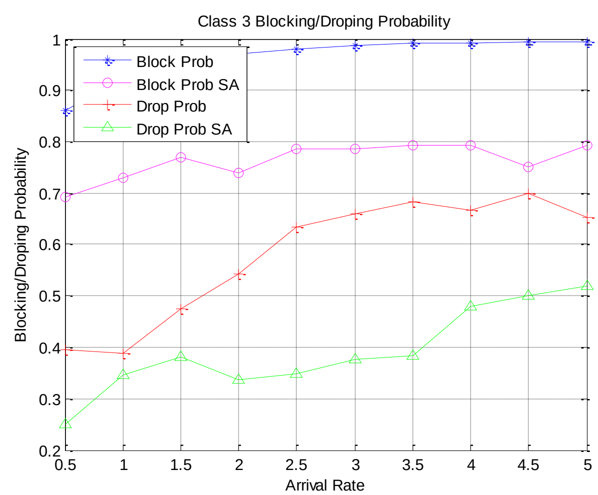

Figure 9. Blocking and Dropping probability for Class 3 traffic versus call arrival rate

C.*Heavy Traffic*

For heavy traffic model arrival are increased from 10 to 100 call arrivals/ munity .Figure 10,Figure 11, Figure 12 & Figure 13 show the callblocking probabilities and call dropping probability for multimedia traffic as well as for each class traffic versus call arrival rate for heavy traffic.

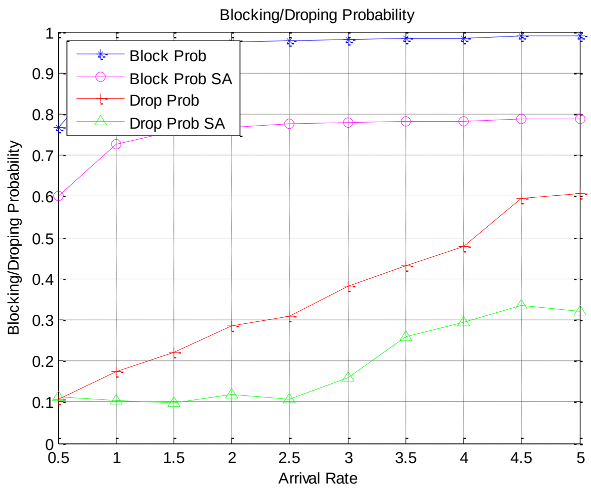

Figure 10. Blocking and Dropping probability for multimedia traffic versus call arrival rate

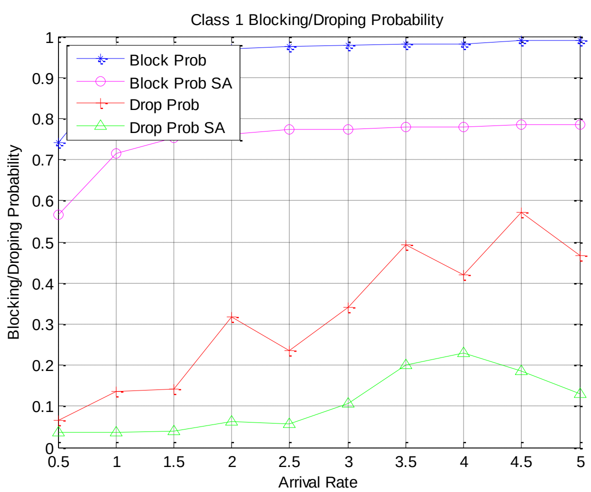

Figure 11. Blocking and Dropping probability for Class 1 traffic versus call arrival rate

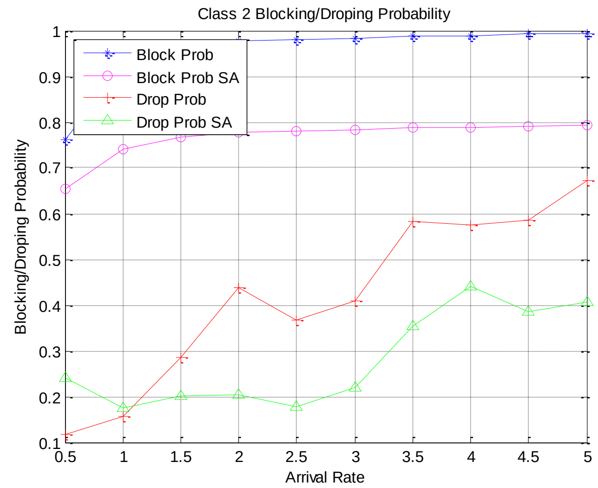

Figure 12. Blocking and Dropping probability for Class 2 traffic versus call arrival rate

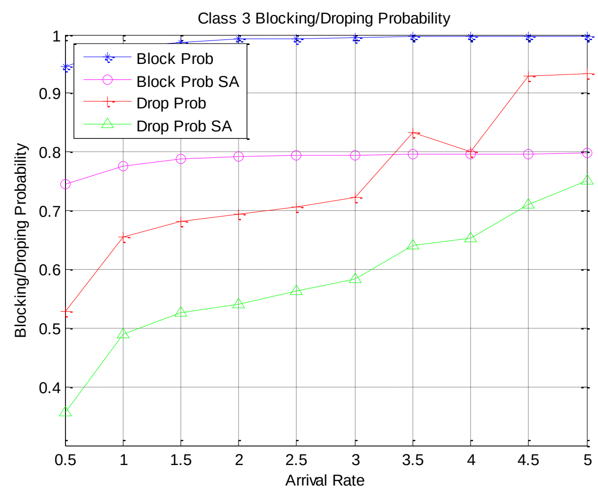

Figure 13. Blocking and Dropping probability for Class 3 traffic versus call arrival rate

Simulation results indicates that call blocking probability and call dropping probability of proposed novel call admission control scheme for multimedia traffic as well as for each class traffic are better performance over the tradition call admission control for low, medium and heavy traffic scenario. This is mainly because of maximum use of subchannels using AMC to minimize the overall transmit power.

It also show that for low traffic, our algorithm worksefficient, call blocking probability and call dropping probability are in accepting level for multimedia calls and for each class calls where as for medium and heavy traffic, our call admission control algorithm performance is better over dynamic bandwidth based call admission control (CAC) but call blocking probability for multimedia calls as well as each class calls are approximately more than 70% and call dropping probability for multimedia calls as well as each class calls are approximately more than are more than 30%that is not in accepting level.

V. Conclusion

It is anticipated that demands for multimedia services will grow in future wireless networks. Call Admission Control is essential for the efficient utilization of scarce radio bandwidth. In this paper, considering the support to multimedia service in IEEE802.16e standards, a novel call admission control scheme is proposed for IEEE 802.16e network. Based on maximum use of subchannels using AMC to minimize the overall transmit power in OFDMA systems for low, medium and heavy multimedia traffic

Both analyses and simulation results show that the proposed call admission controlresult shows the effectiveness of bandwidth estimation and better performance over dynamic bandwidth based Call Admission Control

VI. References

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