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A Novel Resource Allocation Method For Multicasting Network Using Call Admission Control Approach

S.SANTHAKUMAR[1]
M.E, Dept of CSE
Arunai College of Engineering
Tiruvannamalai, India.
santhas92@gmail.com

S.PERIASAMY[2]
Associate Professor, Dept of CSE
Arunai College of Engineering
Tiruvannamalai, India.
sanperiace@gmail.com

Abstract— WiMAX relay networks make resource allocation decisions once per frame. An IEEE 802.16j frame consists of a downlink sub frame and an uplink sub frame. This study focuses on the downlink multicast problems. The downlink sub frame can be divided into an access zone and a relay zone. In the access zone, the BS transmits the video data to its served RSs and SSs. In the relay zone, the RSs further relay the video data to their served SSs. To determine the data transmissions within each frame, the BS should make a scheduling decision at the beginning of each frame using an appropriate resource allocation scheme. WiMAX is generally used to reduce the delays and packet loss. It a wireless standard designed to provide data transfer. In this paper mainly focuses on implementing BGWA based algorithm in order to avoid unwanted intrusion occurrences in handoff time. The Mobile Motion Prediction algorithm generally keeps track of the positions of the mobile stations and their relevant connections. The task of motion prediction is to track the motion of the mobile station in different gateways. Then different prediction methods are applied according to the sensitivity of the range to gain high precision. CAC Approach can be used to the worldwide interoperability for microwave access (WiMAX) is a promising technology for last-mile Internet access, particularly in the areas where wired infrastructures are not available. Mainly this approach is used to transmitting the video/Audio sending from base station to relay station with transmitting or secretes code.

Index Terms— IEEE 802.16e, WiMAX, Call Admission Control, BGWA.

I.INTRODUCTION

WiMAX is a standard based wireless technology that high throughput broadband connection over long distance WiMAX can be used for a number of applications including "last mile" broadband connection hotspots and high speed connecting for business customers it provides wireless metropolitan area network connecting up to 70 mbps and the WiMAX base station on the coverage can cover between 5 to 10 km. the IEEE 802.16 enhances the two technology namely IEEE 802.16j(single hop)network and IEEE 802.16j (multi hop).

The radio links between Base stations (BS) and relay stations (RS) are called relay links, while the links between BS and subscriber stations (SS) or between RSs and SSs are called access links. According to the channel qualities of these links, BSs and RSs can dynamically adapt the downlink modulation and coding schemes (MCSs) for data transmission. When RSs are deployed at appropriate locations between the BSs and SSs, the end-to-end channel qualities can be improved and the BSs and RSs can adapt high data rate MCSs. Based on this improvement in data rate, IEEE 802.16j systems can offer higher throughput and serve more users than IEEE 802.16e has the potential to provide realtime video multicast services such as mobile IPTV live video streaming (e.g. Athletic events) and online gaming. However, the BSs should allocate bandwidth efficiently to support such bandwidth-hungry services while guaranteeing the quality of user experience (QoE). The bandwidth allocation problems in IEEE 802.16j networks are more challenging than those in IEEE 802.16e networks because the BSs allocate bandwidth not only to the SSs, but also to the RSs. Multicasting also complicates the bandwidth allocation problems. In light of these factors, designing an efficient bandwidth allocation scheme for video multicast services in IEEE 802.16j networks is a critical issue. This study focused about 2 methodologies.

A. IPTV Use Case

The ability to perform cheap in-network adaptation of services. A video stream allows a more flexible provisioning of services in the context of IPTV. The main advantage of IPTV solutions in contrast to traditional terrestrial or satellite-based distribution channels is the existence of a dedicated link to each subscriber. Nowadays, Digital Subscriber Line (DSL) technologies are commonly deployed to serve both IPTV and broadband Internet services. Since the DSL link is not a shared medium but dedicated to a single subscriber, it is possible to offer Video-on-Demand (VoD) services with trick-play capabilities. As a consequence that both the VoD and the broadband Internet service are offered over a single DSL link, it is necessary to employ traffic control and QoS mechanisms to separate both services. As we have learned from an experimental analysis of a commercial IPTV solution offered in Austria (aonTV), this separation is often realized as fixed allocation of the bandwidth to both IPTV and Internet.

This allocation prevents the service from maximizing the utilization of the DSL link and from increasing the subscriber's benefit of the services. In order to overcome this shortcoming of existing solutions, we propose a proxy-based approach that makes use of H.264/SVC adaptation and traffic control (TC). The deployment of the proxy in the IPTV scenario at the IPTV provider's premises is depicted in Figure 1. The advantage of this approach is that the proxy can influence the traffic control and QoS mechanisms in a dynamic way. The key technology utilized for the traffic control is the Hierarchical Token Bucket (HTB). Additionally, the proxy performs admission control for the Video-on-Demand sessions issued by the IPTV subscriber and can optionally adapt the H.264/SVC-based video streams at the application layer.

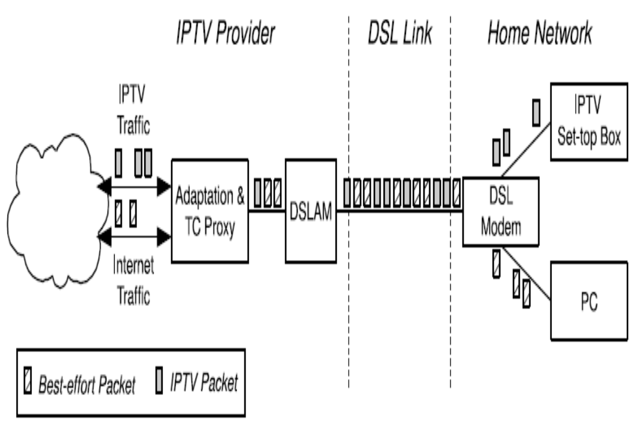

Fig. 1. IPTV deployment

B. CAC Approach

Worldwide interoperability for microwave access (WiMAX) is a promising technology for last-mile Internet access, particularly in the areas where wired infrastructures are not available. In a WiMAX network, call admission control (CAC) is deployed to effectively control different traffic loads and prevent the network from being overloaded. Simulation results are presented to demonstrate the effectiveness of the proposed WiMAX CAC approach. We also introduce an enhanced admission control function at the BS that takes into account video adaptability property. The simulation results show the effectiveness of our XLO mechanism for delivering better quality of service. For multicast traffic, we propose a new solution based on superposition coding and make use of scalable video coding in order to optimize the network resources.

II.WIMAX RELAY NETWORK

Scalable video transmissions over WiMAX network have attracted many researchers in recent years. Similar to our work, many studies aim to improve the performance of WiMAX networks [8-15]. In [10], Hong and Kim proposed wireless switched digital video (WSDV) scheme to increase the limited wireless capacity and simultaneously accommodating many users to watch the same channel.

The result of their model improves the spectral efficiency for mobile TV services in WiMAX networks also it can provide an accurate estimate of the amount of bandwidth required for WiMAX TV services. In [11], Haghani et al. explained the challenges in wireless networks while transmitting the video traffic, and discussed some of the WiMAX networks limitations and design considerations, which can significantly impact the video quality. To improve the video quality they have introduced a cross-layer approach which relies on the characteristics of the MPEG frames and the detailed QoS classification features at the WiMAX MAC layer. Huuskoa et al [12] proposed well-organized cross-layer communication method and protocol architecture in order to transmit the control information and to optimize the multimedia transmission over wireless and wired IP networks. Also they have illustrated how the scalable video transmission can be improved by use of the proposed cross-layer approach.

Various researchers have dedicated their efforts towards improving the resource utilization of IEEE 802.16e mobile WiMAX networks. The authors of [13], [14] proposed an uplink and downlink resource allocation schemes for IEEE

802.16e networks respectively. In [13] Huang et al., argued that the scheduling and resource allocation in uplink is complicated as compared to downlink and presented an optimization-based formulation technique. Whereas in [14] Rashid et al., proposed a queue and channel aware scheme as a resource allocation framework to provide quality of service support in the downlink of an IEEE 802.16e mobile WiMAX system. J. She et al. [15] concentrated on bandwidth allocation problem in mobile WiMAX (IEEE 802.16e) networks. They have presented a two-level modulation schemes, in first level they used QPSK and BPSK (lower data modulation code) in order to transmit the base-layer video data whereas higher data modulations, such as 16-QAM and 64-QAM is used in second level to transmit the enhancement layer video contents.

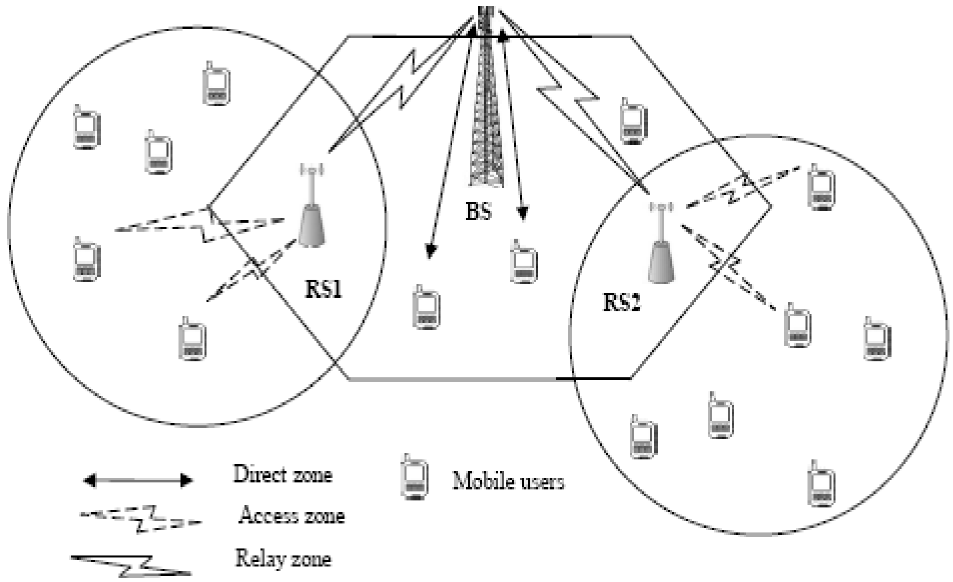

Fig: 2 Structure of WiMAX relay network

However, these methods cannot produce comparable performance for WiMAX relay networks, because 1) The resources should be allocated for both the BS and RSs in the network, and 2) Interference problems may occur due to RSs during the data multicast.

III. MULTICAST RESOURCE ALLOCATION SCHEME.

The proposed model is concentrated on the resource allocation problems in two-hop WiMAX relay networks as similar to the previous approaches [16-18], As shown in Fig. 2, the proposed model consists of one BS, one RS and four SSs. In Fig. 2, a solid line represents the channel quality (CQ) of the link between the BS and RS while dotted line represents the channel quality between RS and SS. DR represents the data rate required by SSs. This model consists of four modulation and coding schemes (BPSK, QPSK, 16-QAM and64-QAM). Assume that the lower channel quality links should use highly reliable modulation schemes. BPSK offers the high reliability among these four schemes (suitable for links with bad channel quality) and 64-QAM is suitable good channel quality links which provides the fastest transmission rate. Assume that every SSs has its own device capabilities and these SSs may request the same video with different quality. The H.264/SVC standard defines many video quality levels for their individual data-rate requirements. Here the proposed system considers six video quality levels 1, 1b, 1.1, 1.2, 1.3, and 2, and this model uses the maximum bit rate as a data rate, 64, 128, 192, 384, 768, and 2,048 kbit/s respectively. These data rates are specified for user convenience only but the proposed resource allocation scheme can also operate under any other data rates. Depending on the device capability the user can select a quality level. For example, when a user requests a video under video quality level 1, the BS should guarantee a 64 kbit/s data rate to that user, and its DR equals 64kbit/s. In order to provide different data rates, the H.264/SVC splits a video stream into one base layer and multiple enhancement layers. For instance, a user with the requirement of 64 kbit/s can be satisfied by receiving the base layer, whereas a user with Fig. 2. Example of proposed model the requirement of 128 kbit/s can be satisfied by receiving the base layer and one enhancement layer. Resource allocation decisions are made for each frame in IEEE 802.16j relay networks. This study concentrated on the downlink multicast problems. The downlink process can be divided into two zones, named as an access zone and a relay zone. The BS transmits the video data to its RSs and SSs in access zone while in relay zone, the RSs further relay the video data to their served SSs. The BS should make a scheduling decision at the beginning of every frame to determine the data transmissions by using an appropriate resource allocation scheme. Shannon-Hartley theorem is used to calculate the bandwidth consumption for every user. This theorem states that,

$$B = C/ (\log 2L) \qquad (1)$$

Here C signifies the channel capacity of the link (in bit/s), B represents bandwidth (in Hertz), and L represents the number of signal elements for a modulation scheme. For example, L's value for BPSK, QPSK, 16-QAM, and 64-QAM are 2, 4, 16, and 64, respectively. If SSx, y links to the BS with QPSK has the required data-rate DRx, y is 128 kbit/s, then the bandwidth required to serve the SSx, y would be 128/ (log24) = 64k Hertz. Here the selection of an appropriate modulation scheme is based on the Channel quality and we divide the channel quality into four subclasses as 1, 2, 4, and 6, the corresponding modulation schemes are BPSK, QPSK, 16-QAM, and 64- QAM.

The minimum bandwidth requirement B is calculated as,

$$B_{req} = DR_{x,y}/CQ_x + DR_{x,y}/CQ_{x,y} \qquad (2)$$

Where DRx,y,/CQx signifies the required bandwidth for first hop (from BS to RS) and DRx,y,/CQx,y signifies the required bandwidth for second hop transmission(from RS to SS). For instance, the minimum bandwidth requirement for SS4 in Fig. 2 is, Breq=DR4/CQ3+DR4/CQ3, 2, =128/6 + 128/2 = 85.33 KHZ. When a BS or RS multicasts a video data, group of SSs (within the BS/RS's coverage range) will receive the data concurrently.

If the BS/RS multicasts the video data using the modulation scheme corresponding to its CQ, then the video can only be received by the SSs who having the channel quality higher than or equal to the corresponding CQ. Consider the Fig. 2, If the base station multicasts the video by use of 64-QAM (with CQ=6) then the RS1 only can receive the video. On the other hand, the BS uses 16- QAM (with CQ=4) then the RS1 and MS2 can receive the same video data simultaneously.

A. Novel Resource Allocation Method

Resource allocation an IEEE 802.16 relay network with a limited amount of resource and proposes an algorithm to increase the network throughput and number of satisfied users. Due to bandwidth limitations all the SSs cannot be satisfied at the same time. It is important to determine that,

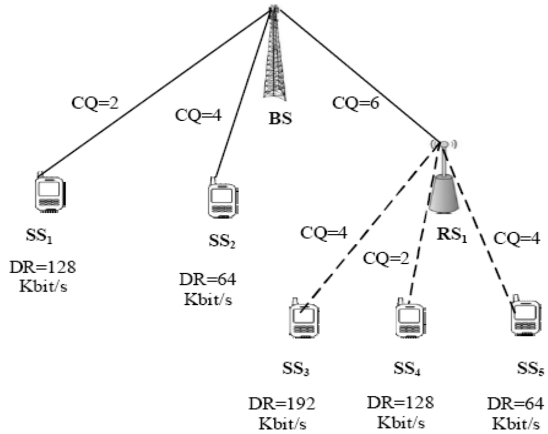

Fig.3 Proposed network model.

TABLE I.
SERVING PRIORITY FOR NETWORK THROUGHPUT

User	DR	Band width	Weighted value	Priority
SS1	128	128/2=64 khz	128/4=2	4
SS2	64	64/4=16 khz	64/16=4	1
SS3	192	192/6+192/4=80 khz	192/80=2.4128/85.33=1.5	2
SS4	128	128/6+128/2=85.33khz	128/85.33=1.5	3

which set of SSs should avail the bandwidth first and the serving priority for the same SS should be calculated in order to improve the network performance. We developed an algorithm called Greedy Weighted Algorithm (GWA) which decides the set of SSs and serving priority to efficiently use the limited bandwidth?

TABLE II.
MULTICAST TABLES

(A) FOR SS2

MCS	DR for BS(kbit/s)	DR for RS (kbit/s)
BPSK(1)	0	0
QPSK(2)	0	0

16-QAM(4)	0 to 64	0
64-QAM(6)	0	0

(B) FOR SS1

MCS	DR for BS(kbit/s)	DR for RS (kbit/s)
BPSK(1)	0	0
QPSK(2)	0 to 128	0
16-QAM(4)	64	0 to 192
64-QAM(6)	0	0

The weighted value W for each SS is defined as the performance gain by using the bandwidth. Proposed BGWA algorithm sequentially examines the SSs for bandwidth allocation based on the weighted value W in decreasing order. If one or more SSs have the same weighted value W, then the priority to MS will be in random order.

B. Throughput Maximization under Limited Resource

To increase the network throughput here we are considering GWA algorithm, by using the weighted value W as throughput gain per bandwidth DR/B, where DR is the data rate required by user and B is the amount of bandwidth to serve the particular SS for both the first hop and the second hop. Consider the model in Fig. 2, its equivalent weighted values for all the SSs and the serving priority has calculated and listed in Table I. Initially all the DR Fields in the multicast table is set to be zero. SS2 has the highest priority and it is analyzed first. In order to satisfy SS2 the DR Field of 16-QAM in multicast table (for BS alone) is modified from 0 to 64 Kbit/s (Table II. A). the next prioritized user is SS3 with required data rate of 192 Kbit/s. In previous step BS is allocated to 64 Kbit/s but it is not enough to satisfy SS3, because it required high data rate. So the DR field of 16-QAM is modified from 64 to 192 Kbit/s in BS table. In this case the DR Field for RS should be updated because SS3 has two-hop communication (BS to RS1 & RS1 to SS3) thus DR for RS is modified from 0 to 192 Kbit/s in 16-QAM modulation scheme. GWA further examines SS5 and it requires only 64 Kbit/s with CQ = 4 Last bandwidth assignment is well enough to satisfy the SS5 because the BS and RS both have already assigned more than 64 Kbit/s in 16-QAM field. Next SS1 is examined, it requires 128 Kbit/s with poor channel quality (CQ=2). Even though BS has equal bandwidth (128 Kbit/s = DR1) this data rate using 64-QAM cannot be received by SS1 due to its poor channel quality. In this scenario, the DR Field of QPSK in multicast table should be updated as 128 Kbit/s with respect to the requirement of SS1 (Table II. B). Similar procedure is repeated for the remaining SSs until all SSs requests have been processed. If the available bandwidth is insufficient to satisfy any SS means the proposed GWA simply skips that SS and proceeds to serve the next SS.

C. Increasing Number of Satisfied Users under Limited Resource

Satisfying a user is a major concern for service providers and this part concentrated on increasing the number of satisfied users under the limited resource.

TABLE III.
SERVING PRIORITY FOR SATISFIED USERS

User	User	Band width	Weighted value	Priority
SS_1	1	128/2= 64	1/64=0.015	3
SS_2	1	64/4=1	1/16=0.062	1
SS_3	1	192/6+ 192/4= 80	2/80=0.025	2
SS_4	1	128/6+ 128/2= 85.33	1/85.33=0.0 11	4

In this case we define that, a user is a satisfied user when the data-rate requirements are fully achieved. This section also using a weighted value but it is different from the previous section. Here we define the weighted value W as, wx=userx/Bx Where userx represents the users count that how many users getting satisfied simultaneously. For example in Fig. 2, user3=2 because while satisfying SS3, SS5 also got satisfied due to its equal channel condition. Whereas, user2= 1 because while serving SS2, its neighbors SS1 and RS1 are having different channel quality and thus cannot be satisfied concurrently. Table III lists the userx, B, W and the serving priority for all the SSs.

TABLE IV.
ALLOCATION STATUS FOR ALL MSS

Priority	user	Residual bandwidth	Allocation Status
1	SS_1	80-(64/4)=64	yes
2	SS_2	64-(64/4)=48	yes
3	SS_3	(48-128/6)-(128/4)=5.33<0	yes
4	SS_4	(48-128/6)-(128/4)=5.33	yes

TABLE V.
FINAL MULTICASTING TABLE FOR SATISFIED USERS

MCS	DR FOR BS (Kbits)	DR FOR RS (Kbits)
BPSK(1)	0	0
QPSK(2)	128	0
16-QAM(4)	64	192
64-QAM(6)	0	0

Assume that the limited bandwidth Blimit= 80KHZ the proposed algorithm prioritized all the SSs based on the W as shown in Table IV. As per the priority order SS2 is examined first, the initial bandwidth (80 k Hertz) is sufficient to support the DR 64 kbit/s from the BS to SS3 (80 – (64/4) = 64 kHz ≥ 0). Hence, the DR Fields of16-QAM for BS is first modified as 64 kbit/s. Next SS5 is taken and to satisfy this user we need 64 kbit/s for RS. We additionally need only 64/4 = 16KHZbandwidth to support SS5 (64 − (64/4) = 48 KHZ ≥ 0). While SS3 is examined it requires 192 kbit/s, but already the BS and RS has assigned 64 kbit/s. Thus we need extra 128kbit/s to support the SS3 with channel quality of 6 for first-hop transmission and 128 kbit/s with CQ of 4 (i.e., (48 − ((128/6) + (128/4)) = −5.33 < 0).

IV. RESULTS AND PERFORMANCE ANALYSIS

The BGWA and unicast algorithm allocate the same bandwidth to a certain SS e.g., SS1, 2in the case BGWA can multicast video stream in to satisfy SS1, 2 and SS1, 3 concurrently while the unicast algorithm can only satisfy SS1, 2therefore given the same amount of available

Bandwidth and the same serving priority, BGWA consistently satisfies more SSs and thereby yields more profit (e.g., network throughput and the users) than a unicast bandwidth allocation algorithm.

A. BGWANT Performance

This approach ensures that the maximum number of SSs can receive the video stream specifically the naïve algorithm first sorts the RSs and SSs into increasing order by channel qualities. Then, following the sorting order, the naïve algorithm greedily allocates the bandwidth to the RSs and SSs note that the naïve algorithm employs no table consulting mechanisms.

Figures 3 (a) (b) shows the intuitive results that when the amount of bandwidth increases, the throughput-to-bandwidth ratio decreases while the network throughput increases. In addition, when the amount of bandwidth is small, the curves of BGWANT are much higher than those of BGWASU and the naive algorithm.

(a)

(b)

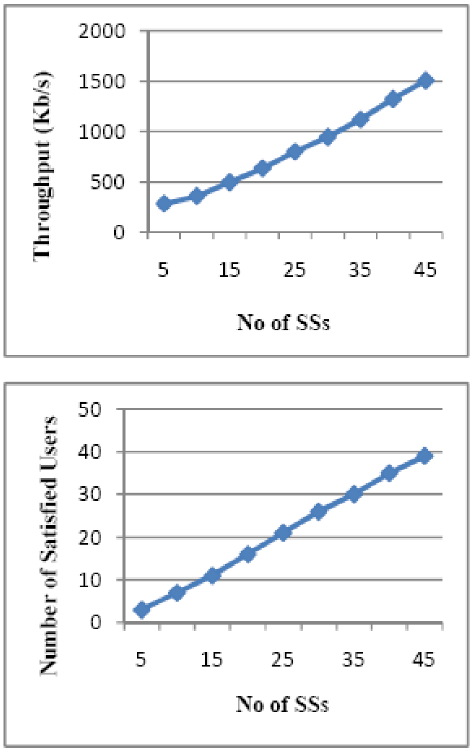

Fig. 3 (a) Network throughput for different number of MSs and (b) Number of satisfied users for different number of MSs.

B. BGWASU Performance

This approach ensures about BGWANT first allocates the bandwidth to the SS with higher ratios of throughput to bandwidth consumption when the bandwidth is insufficient to satisfy all the SSs. This results in higher efficiency of bandwidth utilization. On the other hand, when the bandwidth is large, the curves of BGWASU approach those of BGWANT. This phenomenon is explained as follows: When the bandwidth is large enough, it is sufficient to satisfy all the SSs. In this case, the throughput performance of BGWASU is the same as that of BGWANT. Besides, the curves in the two figures indicate that BGWANT provides higher throughput performance in various scenarios with the bandwidth ranging from 1,000 to 10,000 kilohertz.

(a)

(b)

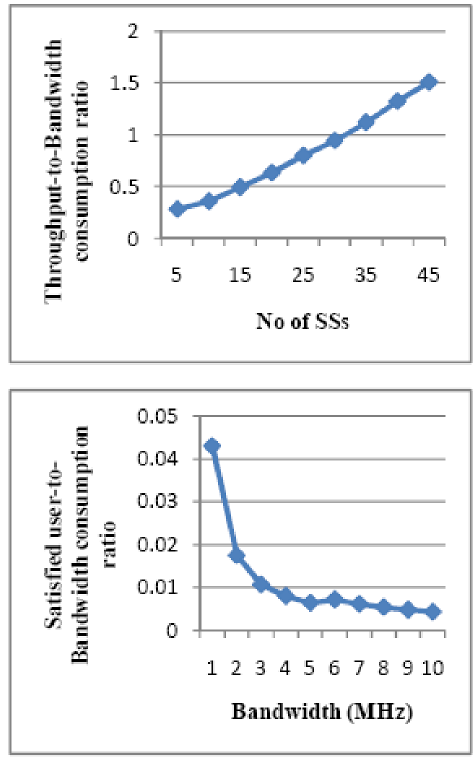

Fig 4 (a) Network throughput-to-bandwidth consumption (b) users-to-bandwidth consumption ratio.

V. CONCLUSION

In this paper we concentrated on the resource allocation problem in WiMAX relay networks. For this purpose, we have formulated a network with single hop and two hop communications by use of relay stations. We have constructed a table consulting mechanism for an efficient resource allocation in WiMAX relay networks. By using weighted value and priority the proposed BGWA algorithm constructs multicast tables for BS and RSs. Through simulation results we can conclude that the proposed BGWA algorithm achieves increased throughput and maximum number of satisfied users while increasing the amount of users.

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