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A NOVEL MULTICAST BENEFICIARY IN IEEE 802.16J WIMAX RELAY NETWORKS

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Abstract

In IEEE 802.16j based wimax multihop-relay network, in addition to a base station, multiple relay stations are used for enhancing the throughput, and improving the coverage distance of the base station. Multicasting is a more efficient method of supporting group communication than unicasting, as it allows transmission and routing of packets to multiple destinations using fewer network resources. An important issue in the multicasting of wimax multihop-relay networks is the improving multicast recipients and most existing algorithms try to minimize the total energy of a multicast tree. In contrast to this problem we propose Optimum Subscribe Station Serving(OSSS) scheme to improve multicast resource utilization by improving number of recipients in multicast tree for given resource budget. OSSS scheme is a resource allocation scheme which adjusts the distribution of resource in multihop-relay network to increase number of recipients in multicast tree. The performance of the OSSS scheme will be evaluated through simulations.

***Keywords*-- IEEE 802.16j network, multihop relay networks, multicasting, resource allocation.**

I. INTRODUCTION

IEEE 802.16 standard is more popularity known as worldwide Interoperability for Micro Wave Access (WIMAX). WiMAX network is a wireless Metropolitan Area Network provides network access to subscribe through exterior antennas communicating with central radio base stations (BSs). The wireless Metropolitan area Network offers an alternative to cabled access networks, such as fiber optic links, coaxial systems using cable modems, and digital subscriber line(DSL) links[1].WiMAX enables delivery of last mile broad band access to subscribes. WiMAX can operate both in Line-Off-Site(LOS) and Non-Line-Of-Site(NLOS).Line-Of-Site uses frequency range of 10-66 GHz and Non-Line-Of-Site uses 2-11GHz frequency range. IEEE 802.16 standard encourages worldwide spectrum allocation and increases commercialization of broadband wireless access to support worldwide deployment of WiMAX BWA system [2]. IEEE802.16j is standard for WiMax relay network, which includes relay stations (RSs) to increase the coverage distance of the base station. This WiMAX relay network is also called as Multihop relay (MR) network. In Multihop relay network, the Base Stations will be replaced by multihop relay BS (MR-BS) and one more relay stations. All traffic between the Subscriber Station (SS) and MR-BS are relayed by the RS to increase the coverage distance of MR-BS in areas where RS is deployed [3].

1. In multicasting same data or content is delivered to multiple subscribers from base station at the same time.

An important problem in wireless multicasting is improving utilization of the resources. Many works have been discussed various issues in multicasting. For example, in [4] dynamic multicast routing problem is discussed and they proposed Virtual Trunk Dynamic Multicast (VTDM) routing algorithm to solve this problem. In [5], several algorithms are evaluated for defining multicast tree when transceiver resources are limited in ad hoc networks. Here algorithms select the relay nodes and their transmission power levels, and provides different degrees of scalability and performance. In [6], multicast tree energy is reduced in ad hoc network but they considered nodes have fixed transmission power. In [7], minimum energy multicast tree problem is discussed, in which summation of the transmission power of all multicast nodes are minimized. In [8], to solve minimum energy multicast (MEM), ant colony optimization metaheuristics for networks with Omni directional and directional antennas is proposed. In [9], multicast recipient maximization (MRM) problem is discussed and they proposed DSS algorithm to solve the problem, but they considered only single hop network. In [10], a utility based resource allocation for WiMAX multicasting is proposed, in layered encoding is used to maximize the total utility of the network.

2. In this paper, we introduce a resource allocation scheme for improving resource utilization resource in WiMAX. We propose Optimum Subscriber Station Serving (OSSS) scheme to improve resource utilization if WiMAX multihop-relay network.

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OSSS scheme allocate resource to optimum subscriber stations, so that resource utilization will be maximized and OSSS scheme will adjust the distribution of resource allocation between MR-BS and RSs, so that number of served subscriber station will be increased for given resource budget and resource utilization will be improved. Here we improve resource utilization by increasing number served subscriber stations for given resource budget. Resource budget refers to total allocated bandwidth to MR-BS for a multicasting of data.

3. Reminder of the paper is organized as follow: Section-2 modeling of problem is discussed. In section-3, modified utility function if defined and Optimum Subscriber Station Serving (OSSS) scheme is proposed. In section-4, we discussed about the simulation of OSSS scheme and numerical outputs and section-5 contains conclusion.

II. Problem Modeling

In this section first we discuss about multicasting in wireless network then problem in improving resource utilization of WiMAX multihop-relay networks multicasting, then we modeled WiMAX multihop-relay system to improve resource utilization finally we present an auxiliary graph model to simplify the improving resource utilization problem.

2.1 Multicasting

As the capacity of wireless communication improves, several multicast applications like video conferencing and iptv have been developed. An important issue in these multicast applications is improving bandwidth utilization. In multicasting same data is transmitted to multiple subscriber stations. We can achieve this data transmission using unicasting also, but it requires difference channel to be established BS and SS. But in the case of multicasting a single channel can be used to transmit the data to different users as long as channel strength is good. Since SS has different bit error rates due to heterogeneous channel connection, all SSs in multicast tree requires different resource to receive same data. Adjustment the resource distribution will increase number of served SSs and improve resource utilization of multicasting. In WiMAX relay network in addition to MR-BS multiple RS are included to improve coverage distance. Since the inclusion of relay stations will increase the complexity of improving multicast resource utilization.

2.2 System Model

In a WiMAX relay network, the resource that can be distributed to different transmissions is the time slots in a time division duplexing super frame.

We use the term “resource” to refer to the time slots hereafter in order not to lose generality. The budget of a multicast program means its maximal usable resource, which may be set by the system or left by other high priority traffic. This budget (i.e., the number of time slots) is to be distributed among the MR-BS and RSs since they are in the same interference range (ie., only one of them can transmit at the same time). We denote this resource budget by RB.

Let M and N represent the number of RSs and SSs in an IEEE 802.16j WiMAX multihop-relay network, respectively. Each SS accesses the BS either directly or through an RS or through more than one RS(Based on the number of hop), and its path to the MR-BS can be predestinated by any existing route-selection scheme. Since SSs may be served by different transmitters (i.e., the MR-BS or the RSs), they are classified into different groups and subgroups according to their senders. Let the SSs directly served by the MR-BS be classified as group 0, the SSs that receive data via the mth RS be placed in group m, where m>o and the SSs that receive data from mmth RS inside group m be placed in m,mmth group. To denote the sender of each group, let RS0, 0 be the sender of group 0 (i.e., the BS), whereas RSm,mm denotes the mmth RS in group m and the sender for subgroup mm. Since the RSs have to receive the multicast stream from the BS before relaying it, we also include all RSs in group 0. The SSs in a group are considered together, because they cannot served before their sender receives from the MR-BS. Fig.1 shows relations between MR-BS, RS ANA SS.

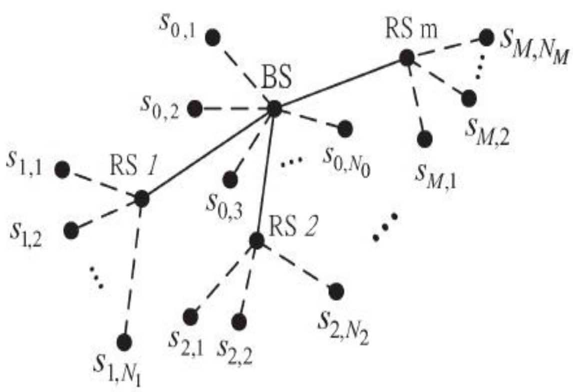

Figure 1. Nodes in WiMAX multihop-relay network.

To differentiate between nodes, we use $S(m,m_m,n)$ to denote the nth node in group m and subgroup m_m. We use Nm to denote the number of nodes in group m and Nm_m to denote number of nodes in subgroups m_m of group m.

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In each group m, the sender is the zeroth node of the group. Since each node has different channel qualities, the, i.e., acceptable modulation schemes and transmission rates may vary; therefore, it takes different amounts of resource for a sender to transmit a stream to different recipients. We define the resource requirement of a receiver as the total amount of resource required to receive the stream. If an SS needs an RS to relay the stream, the resource requirement includes the resource for transmitting from the MR-BS to the RS and from the RS to the SS. However, if the SS is in group 0,its resource requirement is the resource required for the MR-BS to directly transmit. We assume that the nodes in each group are placed in increasing order of r(m,mm,n), which is the resource requirement of S(m,mm,n)i.e.,r (m,mm,1) ≤ r(m,mm,2)≤……≤r(m,mm,Nm).Because of the broad cast nature of the wireless medium, if RSm,mm can receive the stream and serves S(m,mm,n), nodes in the same group that require fewer resources [i.e., the nodes from S(m,mm,1) to S(m,mm,n-1)] can also be served. Another function Δrm,mm(n)=r(m,mm,n)-r(m,mm,n-1) is used to represent the additional resource for serving S(m,mm,n). Therefore, r(mm,mm,n) represents the total required resource of S(m,mm,n), whereas Δrm,mm(n) represents the additionally required resource of S(m,mm,n) when the last node S(m,mm,n-1) is served. Moreover, we use the matrices Rm=[R0,R1,R2,…RM] to aggregate r(m,mm,n) and represent the channel quality of the overall network. To distinguish RSs from SSs in group 0, we mark each RS m with imm to represent its order in group 0, i.e., RSm,mm=S(m,mm,0)=S(0,m,im), followed by r(m,mm,0)=r(0,m,im). Since the MR-BS does not require any additional resource to receive the stream, r(0,0,0)=0. For ease of presentation, the RSs are also placed in increasing order of their resource requirements, i.e., r(0,m,i0)<r(0,m,i1)<r(0,m,i2) aggregate the positions of the RSs. Based on the preceding notations, the channel conditions and node connections of a relay network are denoted by channel quality matrix R and RS position matrix I. It has M RSs in multihop network (i.e., M=m0+m1+m2+….mm). Here m0 RSs will be from group 0 all others RSs will be from subgroups.

A. Auxiliary Graph

To simplify subsequent analysis of the problem, we introduce an auxiliary graph, which is tree with weighted edges. As shown in fig.2,a wireless mulitihop-relay network can be represented as an auxiliary tree. All elements of group 0(i.e., the RSs and SSs directly served by the BS) are placed in the main branch, and the elements of group m>0 are placed in a "side branch" connected to the main branch at (0, 0, im). All elements of subgroup are placed inside branch of that group branch.

With this placement, for each node, the total distance (i.e., the sum of weights of edges) to the root is equal to the number of resource that it requires, i.i., r(m,mm,n). On the m,mmth branch, the distance between the(n-1)th node and the nth node is Δrm,mm(n). Given such a graph, we ccan easily determine the additional resource required to serve a node by finding the distance to the nearest served nodde. For example, in Fig.2 if the last node served by th BS is S(0,0,2), it takes r(0,1,2)-r(0,0,2) resources [i.e.,Δr0,0(3)+Δr0,1(1)+Δr0,1(2)] to include S(0,1,2) into the service, because the BS has to allocate r(0,0,3)-r(0,0,2) to serve RS0,1 before RS 0,1 can serve (0,1,2) with r(0,1,2)-r(0,0,3). Based on the tree, we now define the concepts of "subtree" and "children" used in the succeeding sections. On the auxillary graph, the subtree of S(m,mm,n) refers to all nodes that cannot be served before S(m,mm,n) is served. We use node set ST(m,mm,n) to denote the subtree of S(m,mm,n). On the otherhand, the children are the next nodes to be served. Therefore, all RSs have two children, which are the adjacent nodes to be served next in groups 0 and m, respectively. In contrast, SS nodes only have one child (i.e., the next RS or SS in the same group). We use node set CH(m,mm,n) to represent the children of S(m,mm,n).

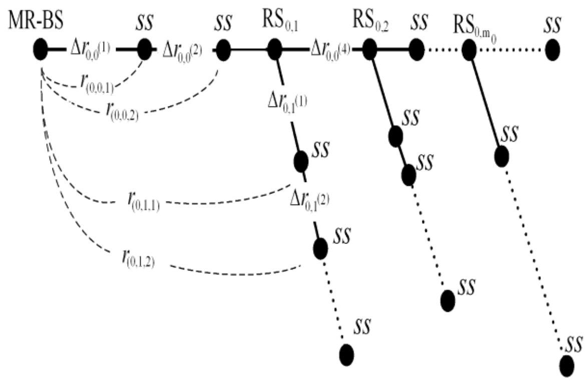

Figure 2.Auxillary graph.

III. PROPOSED SCHEME

In this section first we address Utility function then introduce Modified Utility function, finally propose OSSS scheme to improve resource utilization.

3.1Modified Utility Function

We introduce two function to find utility of the multicasting, they are USm,mm(n) utility value of serving the first n nodes in subgroup mm group m and AUm,mm(n) average utility of serving. USm,mm(n) is the number of served SSs when serving S(m,mm,n), starting from the MR-BS.

EXPLORING RESEARCH AND INNOVATIONS
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$$US_{m,m_m}(n) \leftarrow \begin{cases} n - \max\limits_{i'_{m_m} \le n} m'_0, & m = 0, m_m = 0 \\ n - \max\limits_{i'_{m_m} \le n} m'_m + US_{0,0}, & m = 0, m_m \ne 0 \\ n + US_{0,m_m}(n), & m \ne 0, m_m \ne 0 \end{cases}$$

$$AU_{m,m_m}(n) \leftarrow \frac{US_{m,m_m}(n) - US_{m,m_m}(n-1)}{\Delta r_{m,m_m}(n)}$$

Figure 3.1 .Modified Utility Functions.

Consider auxiliary graph shown in figure. First figure uses utility functions and second figure uses modified utility functions. For figure 4 a, Average utility of serving and utility of serving values are shown above nodes. AU value is represented in side the bracket and US value in represented outside of bracket. Based on AU value only, nodes will be served. In the case of figure b, Modified average utility of serving and modified utility of serving values are shown above nodes. MAU value is represented inside the bracket. Based on MAU value only, nodes will be served. For given values in diagram, if we take resource budget of 3 time slots, utility functions can serve only three SSs(SS1,SS2,SS3) but modified utility functions can serve here. Using Modified utility function in resource allocation we can serve more SSs for given resource budget.

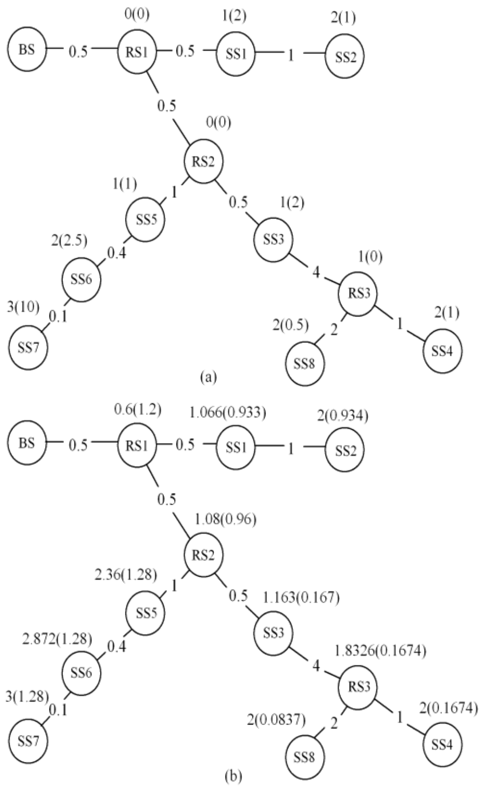

Figure 4. Auxiliary graph using (a) Utility function (b) Modified Utility function.

3.2 OSSS Scheme

To improve resource utilization of WiMAX network, we propose a resource allocation scheme called OSSS,which is shown in Fig 6.OSSS scheme uses modified utility functions. OSSS scheme takes resource matrix, position matrix of RSs and resource budget as input and produces number of served SSs in a group as output.

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Input: $\mathbf{R} = [\mathbf{R_0}, \mathbf{R_1}, \ldots, \mathbf{R_M}]$, $\mathbf{I} = [i_0, i_1, \ldots, i_{m_m}]$ and RB
Output: $\mathbf{RA} = \{n_{0,0}, n_{0,1}, .. n_{m,m_m}\}$

OSSS()
For m=0 to M and **m_m =0 to M_m**
$MUS_{0,0}(0) \leftarrow 0$;
For n=1 to N_m,
$MAU_{m,m_m}(n) \leftarrow \max_{S_{(m',m'_m,n')} \in ST_{(m,m_m,n)}} \frac{US_{m',m'_m(n')} - MUS_{m,m_m(n-1)}}{r_{(m',m'_m,n')} - r_{(m,m_m,n-1)}}$;
$MUS_{m,m_m}(n) \leftarrow MUS_{m,m_m(n-1)} + MAU_{m,m_m(n)} \Delta r_{m,m_m(n)}$;
End for;
End For;
For m=0 to m, $n_{m,m_m} \leftarrow 0$; **End for;**
$\mathbf{R}_{res} \leftarrow$ **RB;**
Do Loop:
$u_{max} \leftarrow 0$;
For m=0 to M and **m_m =0 to M_m,**
If ($i_{m_m} \leq n_{0,0}$),
If ($MAU_{m,m_m}(n_{m,m_m} + 1) > u_{max}$),
$u_{max} \leftarrow MAU_{m,m_m}(n_{m,m_m} + 1)$; $m,m_{m_{max}} \leftarrow m,m_m$;
End if;
End if;
End for;
If ($u_{max} = 0$ **or** $\mathbf{R}_{res} < \Delta r_{m,m_{m_{max}}}(n_{m,m_{m_{max}}} + 1)$;), **exit loop;**
Else
$\mathbf{R}_{res} \leftarrow \mathbf{R}_{res} - \Delta r_{m,m_{m_{max}}}(n_{m,m_{m_{max}}} + 1)$;
$n_{m,m_{m_{max}}} \leftarrow n_{m,m_{m_{max}}} + 1$;
End if;
End loop
Return ($[n_{0,0}, n_{0,1}, .. n_{m,m_m}]$)

Figure 5. Pseudo code for OSSS scheme.

OSSS scheme serves SSs based on modified utility os serving value, after serving to SS then it increases the served SSs count and reduces resource budget by nodes resource. This process is repeated until all nodes have been served or until the residual resource is insufficient to serve any more nodes. Finally it produces total number of served SSs in all groups. This OSSS scheme improves number of served SSs as compared with resource allocation scheme using modified utility functions. Modified utility function considers sub tree, while making decision but utility function only considers child node. So considering sub tree in decision will improve resource utilization in OSSS scheme by improving served SSs for given resource budget.

IV. NUMERICAL RESULTS

OSSS scheme is simulated in NS2 network simulator under Red hat Linux OS. Here NS2.34 version network simulator used for simulation. First OSSS scheme with Utility functions is simulated then OSSS scheme with Modified utility functions is simulated. Then output of two schemes is compared. To simulate OSSS scheme, initially WiMAX Multihop-Relay network is modeled with one Base Station, 6 Relay Station and 64 Subscriber Stations. Here simulation is carried out for different attenuation values.

In first simulation attenuation value is fixed as 2 and resource budget of 500 Time slots is fixed and simulation is carried out. OSSS scheme with utility functions covers only 49 Subscriber Stations for given resource budget where as OSSS scheme with modified utility functions covers 59 Subscriber Stations.

Clearly OSSS scheme with modified utility functions increases 10 Served Subscriber Stations for same resource budget, shown is figure 7. So Modified Utility function increases multicast recipients for WiMAX Multihop-Relay networks for given resource budget.

Figure 7. Comparison of Utility and Modified Utility Functions with attenuation value of 2.

In second simulation attenuation value is fixed as 3 and resource budget of 860 Time Slots is fixed and simulation is carried out. OSSS scheme with utility functions covers only 50 Subscriber Stations for given resource budget whereas OSSS scheme with modified utility functions covers 60 Subscriber Station. Clearly OSSS scheme with modified utility functions increases 10 Served Subscriber Stations for same resource budget, shown is figure 8.

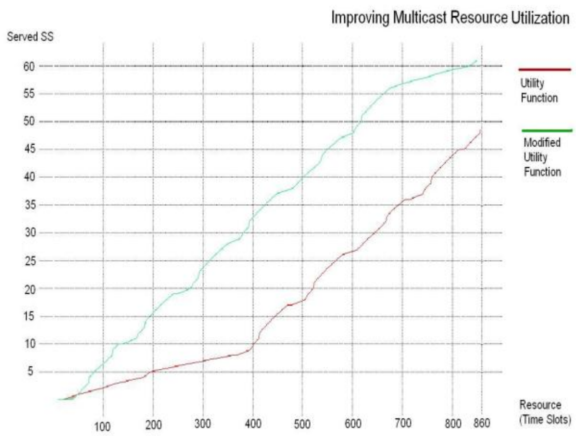

Figure 8. Comparison of Utility and Modified Utility Functions

So Modified Utility function increases multicast recipients for WiMAX Multihop-Relay networks for given resource budget.

V. CONCLUSION

In this paper we proposed resource allocation scheme called Optimum Subscriber Station Serving (OSSS) scheme to improve resource utilization of WiMAX multihop-relay network by increasing multicast recipients. Our Optimum Subscriber Station Serving scheme increases number of served subscriber station in multicast tree by adjusting allocated resource between Multihop Relay Base Station and Relay Stations to improve resource utilization. Our proposed scheme uses modified utility function to modify resource allocation among SSs and increases served SSs in WiMAX Multihop-Relay networks.

REFERENCES

[1] C.Eklund,R,B.Marks,K.L.Stanwood,and.Wang, "IEEE standard 802.16:A technical overview of the wireless MAN air interface for broadband wireless access, "IEEE Commun.Mag.,vol.40,no.6,pp.98-107,jun,2002.

[2] IEEE Standard for Local and Metropolitan Area Networks-part16:Air Interface for Fixed Broadband Wireless Access Systems, IEEE Std.802.16-2004,2004.

[3] IEEE Standard for Local and Metropolitan Area Networks-part16:Air Interface for Fixed Broadband Wireless Access Systems, IEEE Std.802.16J,2009.

[4] Hwa-Chun Lin and Shou-Chuan Lai,"VTDM-a dynamic multicast routing algorithm" INFOCOM'98 proceedings, vol.3,pp 1426-1432.Apr 1998.

[5] Wieselthier.J.E Nguyen.G.D and Ephremides.A,"Algorithms for energy-efficient multicasting in ad hoc wireless networks", in MILCOM 1999,vol 2,pp 1414-1418.

[6] D.Li,X.Jia,and H.Liu, "Energy efficient broadcast routing in static ad hoc wireless networks," IEEE Trans. Mobile Compput.,vol.3,no.2,pp144-151,Apr-Jun.2004.

[7] W.Liang, "Constructing minimum-energy broadcast trees in wireless ad hoc networks," in Proc.3rd ACMlnt.Symp.MobileAdhocNetw.Comput..,2002,pp.112-122.

[8] Hernandez.H and Blum.C,"Energy-efficient multicasting in wireless ad hoc networks: An ant colony optimization approach" in Wireless Communication Systems.2008.ISWCS'08.pp 667-671.

[9] Wen-Hisng Kuo and Jeng-Farn Lee,"Multicast Recipient Maximization in IEEE 802.16J WiMax Relay Networks", Vehicular Technology,vol 59,issue 1,Jan 2010

[10] W-H.Kuo,T.Liu,and W.Liao, "Utility-based resource allocation for layer-encoded IPTV multicast in IEEE multicast in IEEE 802.16(WIMAX) wireless networks." in proc. IEEE Int.Conf.Commun.,2007,pp.1754-1759