REVIEW ON EFFICIENT REUSE OF BANDWIDTH FOR THROUGHPUT ENHANCEMENT IN IEEE 802.16 NETWORKS

P.Rajeshwar Rao.
M-Tech(SE).
Karimnagar,AP,India.

Abstract:
IEEE 802.16 is a standard supporting applications demanding bandwidth. Bandwidth reservation and usage depends on the type of the application. Transmission rate varies with respect to transmission medium and traffic. If the amount of bandwidth reserved is less and actual load is more then the data may be distorted or lost. For this efficient Reservation scheme is required [1][2]. If the amount of bandwidth reserved is more and actual load is less then the reserved bandwidth may be wasted [6]. In this paper we discussed several mechanisms for better bandwidth reservation schemes and reuse mechanisms. We also discussed the concurrent transmission sachems for throughput enhancement. Efficient bandwidth reservation schems like Dynamic reservation schems are used. Here the bandwidth reuse mechanism is achieved without affecting the Quality of service applications in the system. So the mechanisms discussed are QoS guaranteed services.

Key words: Reuse of bandwidth, Throughput, QoS, enhancement.

Introduction:

IEEE 802.16 networks are standard networks which support bandwidth demanding applications. These networks gained huge recognization nowadays. For efficient bandwidth reservation and reuse we have bandwidth reuse method [6] and also it require scheduling algorithms such that bandwidth requesting applications may be multiple applications. So we require scheduling mechanisms for this [6]. We also discuss the dynamic reservation schemes so that we can reserve the bandwidth dynamically by which we can reduce the amount bandwidth being wasted. We also discuss the concurrent transmission mechanism which can improve the throughput of the system [3]. Two types of reservation schems include static and dynamic. Static: in this mechanism bandwidth is reserved by estimating the incoming data based on previous results(forecasting). Here the bandwidth reserved cannot be changed at the time of data transmission, so it is little bit unusual.

Dynamic: dynamic reservation scheme involves reservation of bandwidth dynamically i.e., bandwidth is reserved at the time of transmission, here the amount of bandwidth required is accurate and the wastage of reserved bandwidth is less so it is very efficient mechanism.

Scheduling Algorithm

Let Q represents the set of SSs serving non-real time connections and *T* is the set of TSs. Due to the feature of TDD(Time Division Duplex) we can not perform that the Up Link and Down Link operations simultaneously, we can not schedule the SS which UL transmission intervals overlapped with the target TS. For any TS, *St*, let *Ot* be the set of SSs which UL transmission interval overlaps with that of *St* in *Q*. Thus, the possible corresponding CSof *St* must be in $Q-Ot$. All SSs in $Q-Ot$ are considered as candidates of the CS for *St*. A scheduling algorithm, called *Priority-based Scheduling Algorithm* (PSA), shown in Algorithm 1 is used to schedule a SS with the highest priority as the CS. The priority of each candidate is decided based on the scheduling factor (SF) defined as the ratio of the current requested bandwidth (CR)to the current granted bandwidth (CG). The SS with with higher SF has more demand on the bandwidth. Thus, we give the higher priority to those SSs. The highest priority is given to the SSs with zero CG. Non-real time connections include nrt PS and BE connections. Then rtPS connections should have higher priority than the BE connections because of the QoS requirements. The priority of candidates of CSs is concluded from high to low as: nrt PS with zero CG, BE with zero CG, nrt PS with non-zero CG and BE with non-zero CG. If there are more than one SS with the highest priority, we select one with the largest CR as the CS in order to decrease the probability of overflow.

Reuse mechanism

According to the IEEE 802.16 standard, the allocated space with in a data burst that is un used should be initialized to a known state [6]. Each un used byte should be set as modulation for transmissions between TS and BS, the SBV can be transmitted via this agreed modulation. However, there are no agreed modulations between TS and CS. Moreover, the transmission coverage of the RM should be as large as possible in order to maximize the probability that the RM is able to be received successfully by the CS. To maximize the transmission coverage of the RM, one possible solution is to increase the transmission power of the TS while transmitting the RM. However, the power may be a critical resource for the TS and should not be increased dramatically. Therefore, under the circumstance of without increasing the transmission power of the TS, the RM should be transmitted via BPSK which has the largest coverage among all modulations supported in the IEEE 802.16 standards.

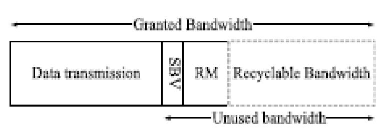

Fig.1.Relese of unused bandwidth in UL Message

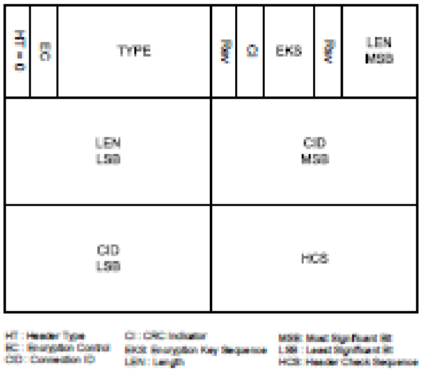

Fig.2. RM format.

Algorithm 1 Priority-based Scheduling Algorithm

Input: T is the set of TSs scheduled on the UL map.

Q is the set of SSs running non-real time Applications.

Output: Schedule CSs for all TSs in T.

For *i* =1 to ||T|| do

a. *St* ← *TSi*.

b. *Qt* ← *Q*−*Ot:*

c. Calculate the SF for each SS in *Qt*.

d. **If** Any SS ∈ *Qt* has zero granted bandwidth,
If Any SSs have nrtPS traffics and zero granted bandwidth,

Choose one running nrtPS traffics with the largest CR.

else

Choose one with the largest CR.

else

Choose one with largest SF and CR.

e. Schedule the SS as the corresponding CS of *St*.

End For.

Concurrent Transmission mechanism

As various wireless networks evolve into the next generation to provide better services, a key technology, wireless mesh networks (WMNs), has emerged recently. There are many advantages about wireless mesh network such as rapid building, robustness and easy deployment, which makes it one of the indispensable technologies in next generation networks. IEEE 802.16 MAC protocol is mainly designed for point-to-multipoint (PMP) access in wireless broadband application. To accommodate the more

demanding physical environment and different service requirements of the frequencies between 2 and 11 GHz, the 802.16a project upgrades the MAC to provide automatic repeat request (ARQ) and support for mesh. The Mesh mode is the extension to the PMP mode, with the advantage of less coverage path loss, coverage and robustness improved exponentially as subscribers are added, the larger user throughput over multiple-hop paths than PMP's .

Capacity enhancement in mesh networks is quite desirable. One way to increase the capacity of the multi-hop systems is to allow concurrency among the multi-hop transmissions. For example, Wei et al. Proposed an interference-aware route construction algorithm and centralized scheduling scheme, which achieves high utilization of the WiMax Mesh network. However, their algorithm may result non-minimized interference along the path because of the entry order. And it is constrained by the format of centralized scheduling messages that the information of concurrent transmission generated by scheduling algorithm in deliver to every SS. So a lot working on improving WiMax

Mesh capacity remains for further exploration. In light of Wei et al's work, in this paper we propose a general algorithm for SSs to achieve concurrent transmission in both uplink and downlink streams based on IEEE 802.16 centralized scheduling. We compare the performances of the algorithm with different routing trees, which shows overall end-to-end throughput is significantly improved using our algorithm.

Scheduling IEEE802.16 N/W's in mesh mode.

There are two scheduling methods: distributed scheduling and centralized scheduling, or a hybrid of both can be adopted in mesh mode. When using distributed scheduling, there is no clearly defined BS in the network. Scheduling is determined in a distributed manner like an ad - hoc network. In centralized scheduling, a BS determines slot allocation for all the SSs in a centralized manner like PMP mode, and traffics from or to the BS can be relayed by other SSs through a multi-hop route which is different from PMP mode.

There are two control messages, MSH-CSCF (Mesh centralized scheduling Configuration) and MSH-CSCH (Mesh centralized scheduling), in centralized scheduling. MSH-CSCF message delivers the information of channel configuration and routing tree, while MSH-CSCH message delivers the information of bandwidth request and grant and updating of routing tree.

The BS generates MSH-CSCF and broadcasts it to all its neighbors, and all the BS neighbors shall forward (rebroadcast) this message according to its index number specified in the message. This process repeats until all SS nodes have broadcasted the MSH-CSCF message.

According to the routing tree in MSH-CSCF message, all the SSs maintain a routing tree whose root is BS and children are SSs. All SSs are eligible to transmit MSH-CSCH:Request message. The transmission order is determined with regard to the hop-count - the one with the largest hop-count is transmitted first, but retains the transmission order as listed in the routing tree for nodes with the same hop-count. Before transmitting a MSH-CSCH:Request message, an SS puts the requests from its children into its own MSH-CSCH: Request, and transmits it to father node. Thus, the BS can gather bandwidth requests from all the SSs, and assign spatial resource for SSs. These assignments (grants) are put in MSH-CSCH :Grant message, and broadcasted by BS. Then the BS's children node which has no less than one child, ordered by their appearance in the routing tree, rebroadcast the MSH-CSCH :Grant message. This process repeat until all the SSs receive MSH-CSCH: Grant.

After receiving a MSH-CSCH: Grant message, the SSs determine its actual uplink and downlink transmission time from MSH-CSCH:Grant by a common algorithm which divides the frame proportionally. In the next section, we will discuss a concurrent transmission algorithm in detail to enhance the overall throughput for centralized scheduling.

CONCURRENT TRANSMISSION

A. Link Interference

The wireless network inherently uses a shared medium to communicate with neighboring nodes. In a single-channel Time Division Duplex

(TDD) network, any unicast transmission follows the principle that there must be only one receiver among the neighborhood of a transmitter and there must be only one transmitter among the neighborhood of a receiver. As we can see in Fig. 1, the solid lines with arrow denote directional links in the routing tree. The dashed lines connect the neighboring nodes in one-hop. And the curves with arrow denote the interference by an active link. Let L(x,y) represent the link from x to y, then the interfered links by L(4,6) are L(6,4), L(2,4), L(5,2), L(4,2), L(BS,2), L(BS,1), L(3,1), i.e. when node 4 is transmitting data to node 6, the 7 links above can't be active to avoid collision. The number of interfered links by L(x,y) is given by I(x,y), so I(4,6)=7 for example.

Constructing Routing Tree

As said in Section II, the performance of centralized scheduling benefits from well-structured routing tree. To reduce the interference between links, balance traffic load, shorten the period of request and grant, the structure of routing tree plays a key role. In this section, we propose a construction algorithm based on interference to achieve the following concurrent algorithm, and to improve network performance.

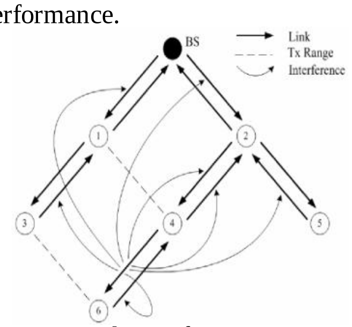

Figure1. Link interference in routing tree

Assume BS-z-y-x is a path in the routing tree, and $P_y(x)$ is the sum of uplink and downlink interference through the path from node x whose father node is y to BS. So $P_y(x)$ is calculated by

$$P_y(x) = I(x,y) + I(y,x) + P_z(y) \quad \text{.....(1)}$$

In Fig. 1, for example, $P_4(6) = I(4,6) + I(6,4) + P_2(4)$.

We suppose network begins with only one BS, and all the SSs enter the network one by one. When an SS is entering, all its neighbor nodes are eligible to be the father node of the entering SS. In order to minimize interference, the entering SS should select a father node with minimal interference.

So far we consider the minimal interference along the path, but after an SS entering the network, the interference value on the path of other SSs in the network may be changed. Therefore, the entry order impacts the construction of routing tree. Improved method to construct routing tree is to make the impacted SSs select father node once more. Fig. 2 represents the process of entering and adjustment, where SS5 is the entry node. After SS5 entered the network, $P_2(4)$=46,$P_5(4)$=30, so the father node of SS4 is adjusted from SS2 to SS5.

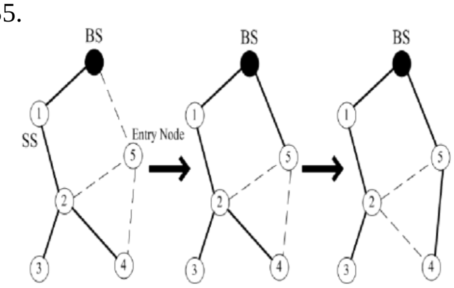

Figure 2. Construction and adjustment of routing tree

Concurrent Transmission AlgorithmAchieving spatial reuse with concurrency is an effectual method to improve the throughput in multi-hop systems. After analyzing the scheduling and construction of routing tree in WiMax Mesh networks, we propose a concurrent transmission algorithm with no collision to improve the overall end-to-end throughput.

The idea of the algorithm in uplink is described as follows. The order of transmission time determination in uplink is the same as transmission order of MSH-CSCH:Request, i.e., nodes with the biggest hop-count first, and remain the order in the routing tree for nodes with the same hop-count. The transmission time should be as early as possible on condition that no collision would happen. Considering the delay of relaying data, the transmission time of an SS should not be earlier than any of its children's. The algorithm is described as following.

$A \leftarrow \varphi$ //nodes assigned Tx time

$B \leftarrow \{1,2,....,n\}$ //nodes to be assigned

while $B \neq \varphi$

x = arg max hopcount (i) //node to be assigned

$i \quad B$

$C \leftarrow \varphi$ //interference time for

all $i \quad neighbor(x)$

$C \leftarrow C \; \{ Rx(i), Rx(i) \;\; t_{i.} \}$ end for

for all i $neighbor(fatherx)$ $C \leftarrow C \; \{Tx(i),Tx(i)$

$t_{i.}\}$end for

Conclusion

This paper focuse's on the mechanism's which can strive hard to achieve good bandwidth reservation schemes and it also entitles about the need for efficient reservation schemes and it gives an idea of making bandwidth reservation schem an efficient one. it ensures that yhe application with efficient reuse mechanism and concurrent transmission mechanisms can serve good in terms of throughput. In future we can have a better mechanism that enforces us to under go much more easier and efficient mechanism having both reservation and reuse mechanisms in contrast.

References

[1]. Jianhua He, Kun Yang and Ken Guild. "Dynamic Bandwidth Reservation Scheme for Hybrid IEEE 802.16 Wireless Networks" ICC'08 p.2571-2575.

[2] Kamal Gakhar, Mounir Achir and Annie Gravey, "Dynamic resource reservation in IEEE 802.16 broadband wireless networks", IWQoS, 2006. p.140-148

[3] J. Tao, F. Liu, Z. Zeng, and Z. Lin, Throughput enhancement in WiMax mesh networks using concurrent transmission, In Proc. IEEE Int. Conf. Wireless Commun., Netw. Mobile Comput., 2005, p. 871V874.

[4] Xiaofeng Bai, Abdallah Shami and Yinghua Ye "Robust QoS Control for Single Carrier PMP Mode IEEE 802.16 Systems",IEEE TRANSACTIONS ON MOBILE COMPUTING, VOL. 7, NO. 4, APRIL 2008, p.416-429

[5] Kamal Gakhar, Mounir Achir and Annie Gravey, "How Many Traffic Classes Do We Need In WiMAX?," WCNC 2007, p.3703-3708

[6] David Chuck and J. Morris Chang Department of Electrical and Computer Engineering Iowa State University, Ames, Iowa 50011, USA"Bandwidth Recycling in IEEE802.16 Networks"