MOBILE WIMAX RADIO RESOURCES MANAGEMENT SIMULATION

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ABSTRACT

Mobile WiMAX (IEEE 802.16e) is broadband wireless system based on OFDMA (Orthogonal Frequency-Division Multiple Access). It is suitable for last mile connection in areas where is not possible to build ADSL infrastructure and provides broadband connection for nomadic users. Its main advantage compared to Wi-Fi is the opportunity of very powerful handling with radio resources and QoS (Quality of Service). This article investigates possible techniques of managing QoS on lower part of OSI model, mainly on PHY and MAC layers.

1. INTRODUCTION

The article deals with RRM (Radio Resources Management) functions that play a very important role in Mobile WiMAX system. These functions are responsible for supplying optimum coverage, ensuring efficient use of physical resources, keeping the desired QoS and providing the maximum planned capacity. Now there is an approach of accessing Mobile WiMAX specific MAC and PHY layers and using its associated parameters in simulations to achieve main goal with best results. Main problem of early simulations and ideas was how complex model should be proposed. The level of integrating real parameters into simulated environment is very important. Too few parameters lead to very simple model and unusable output data and many parameters lead to long simulation times respectively. Careful decision has to be made in choosing parameters. There were two different attempts described in this article.

2. WIMAX AND ISO MODEL

Mobile WiMAX [1-4] has defined only two layers, compared to original ISO/OSI model which has seven layers of access. The model is depicted on Figure 1. Model simplification was made by joining two or more layers from original ISO. Every layer has its own purpose but usually it is good to join them, because related layers could be managed by one function macroblock.

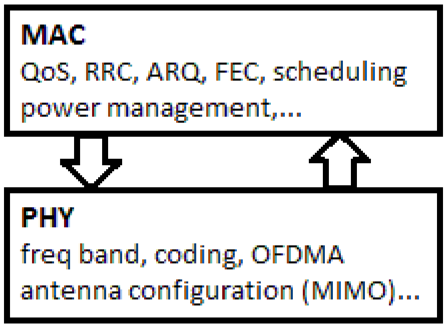

Figure 1: WiMAX ISO/OSI layer model

2.1. PHYSICAL LAYER

This layer has low level access to link medium, which is in case of WiMAX radio environment. Physical layer tasks are: FEC coding, modulation, mapping in OFDMA symbols, measuring link quality etc.

At first there were attempts to make simulation [4-6], which was able to generate random number of users and random data and then mapped all in OFDMA symbols (Figure 2) with parameters in Table 1 and 2.

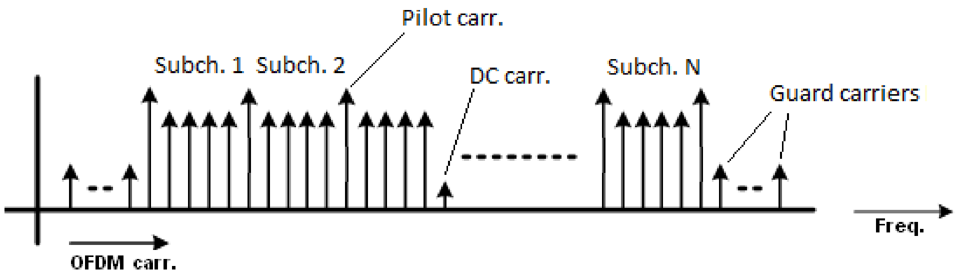

Figure 2: OFDMA symbol mapping

Table 1: Simulated OFDMA symbol parameters

Parameters	Values			
Channel Bandwidth [MHz]	1.25	5	10	20
OFDM carr. (N_{fft})	128	512	1024	2048
Number of sub-channels	2	8	16	32
Modulation	QPSK	16QAM	64QAM	

Table 2: OFDMA symbol sub-carrier allocation

System Bandwidth	5MHz	10MHz
Data carriers	360	720
Pilot carriers	60	120
Null carriers	92	184

2.2. MAC - MEDIUM ACCESS LAYER

This layer is last available for deeper tryouts of simulating. Primary function is radio resource management and ARQ (Automatic Repeat Request). Second function is receiving packets from the upper layer (these packets are called MAC service data units - MSDUs) and organizing them into MAC protocol data units (MPDUs) for transmission over the air. It is designed for point-to-multipoint (PMP) applications, so it needs to be aware of all connected users and is ideal for implementing QoS in it.

3. RESOURCE ALLOCATION ALGORITHM

With pure priority-based allocation [8] some user always has to wait for users with higher priority to send their data and it dramatically prolongs the sending time. In high traffic there is even possibility not to be able send data for very long time. This needed to be solved.

3.1. PRIORITY QUEUE WITH ADDITONAL CONDITIONS FOR DECIDING

My current attempt is to organize all user requests in queue (Table 3.) and implement additional aspects when sorting users. For now algorithm considers payload priority together with time spent in queue without sending any data. The more time in queue, the more will be counted priority higher than base priority determined only by payload priority and insertion moment. There are four levels of payload priority (1 highest-VoIP, 4 lowest - WWW) and promotion of priority due to long time in queue is made after number of cycles specified for every payload priority level separately (Table 4.). When cycle counter reaches desired number, counted priority is increased (in fact the number is decreased by 1 – lower number means higher priority), queue is sorted and user is moved up.

Giving WWW payload the lowest priority with longest expected delay times could appear as wrong decision, but there is important to realize that time needed to send one data unit (amount of data in one OFDMA downlink frame) takes 5 milliseconds. So 100 milliseconds which is maximum average delay time for best-effort payload type is exceeded as far as after 20 times spent in queue.

There is no implementation of handling data with repeat request. Simply giving them highest priority and promoting immediately to the first place is not common, because when one user has poor connection quality and much transfer errors, his repeated data could slow down other transfers [5].

As seen from Table 3, user 7 is highlighted, because he was preferred before user 4, due to his long time in queue. This gives opportunity to be served in known maximum time even for lowest priority users. More accurate decision depending additionally on maximum delay time will have to be implemented in future to better match specifications [1, 8].

Table 3: Output allocation matrix from QoS algorithm

User	Payload priority	Time in queue	Counted priority	Relative payload size	Sum/free	Unit number
1	1	0	1	0.1	0.95/0.05	1
5	1	1	2	0.3		
7	**3**	**5**	**3**	**0.25**		
4	2	1	4	0.3		
6	4	2	5	0.4	0.8 / 0.2	2
3	4	1	6	0.4		
2	4	0	7	0.3	0.6 / 0.4	3
8	4	0	8	0.3		

Table 4: Values of promotion thresholds for different payload priorities

Priority	1	2	3	4
Promotion threshold	-	3	5	10

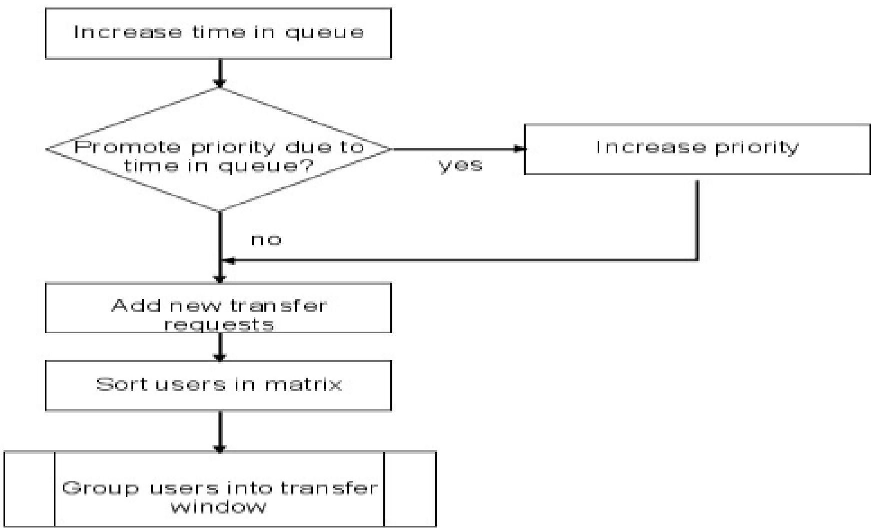

Figure 3: Promotion algorithm based on time spent in queue

Last step is counting number of users whose payloads could be transferred in one data unit (OFDMA downlink frame). Capacity of unit is variable and depends on downlink/uplink ratio and used coding scheme. Relative payload value is result of dividing user data and unit size (1). Then relative payload size of every user (starting from the first in queue) is incremented as far as the size reaches size of unit. User whose payload gets over will be served in next unit.

$$relative\_payload = \frac{unit\_size}{user\_data\_size} \quad (1)$$

For now there is no implementation of handling remaining space in unit when sum of relative sizes does not fully match available space as could be seen for example in unit 3. This will be improved by using optimized inserting of user payloads which will maximize use of network resources.

4. CONCLUSION

This article deals with simulating QoS in Mobile WiMAX (IEEE 802.16e). Current early state takes all transfer requests, inserts into matrix and sorts them depending on payload priority and time spent in queue without sending data. This gives chance to send data in a finite maximum time even to user with lowest priority. Further development state will include handling of data marked for repeated sending by ARQ and also grant maximum allowed time spent in queue specifically for every payload type (for example VoIP has small payload sizes and very short allowed delay time) .

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