

An Efficient Scheduling Algorithm to Minimize Latency in WiMAX Network

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ABSTRACT

WiMAX (World Wide Interoperability for mobile access) 802.16 standard is a real revolution in wireless metropolitan area networks (wireless MANs) that enables high-speed access to data, video and voice services. WiMAX networks are providing a crucial element in order to satisfy on-demand media with high data rates. This crucial element is the QoS and service classes attached per application. Scheduling is the process to support QoS, so different schedulers are in literature to support different QoS parameters. The existing schedulers prioritize the traffic from UGS to rtPS, nrtPS and be in last, so the traffic with lower priority suffers the most and the parameter latency increases, so the paper consider this gap and proposed a technique which minimizes latency and thus improves throughput and reduces the packet losses.

Keywords: WiMAX, IEEE802.16, QoS, Scheduling algorithms.

INTRODUCTION:

WiMAX (Worldwide Interoperability for Microwave Access), is a cell-based technology aimed at providing last-mile wireless broadband access at a cheaper cost. The "last mile" is the final leg of delivering connectivity from the service provider to the customer [1]. This leg is typically seen as an expensive undertaking because of the considerable costs of wires and cables. The core of WiMAX technology is specified by the IEEE 802.16 standard that provides specifications for the Medium Access Control (MAC) and Physical (PHY) layers [2]. It

supports high bandwidth and hundreds of users per channel at speeds similar to currently seen for DSL, Cable or a T1 connection. The technology promises to provide a range of 30 miles as an alternative to wired broadband like cable and DSL. It could potentially provide broadband access to remote places. Use point-to-multipoint (P2MP) architecture. It is designed for delivering broadband seamless quality multimedia services to the end users. WiMAX combines the familiarity of Wi-Fi with the mobility of cellular that will deliver personal mobile broadband.

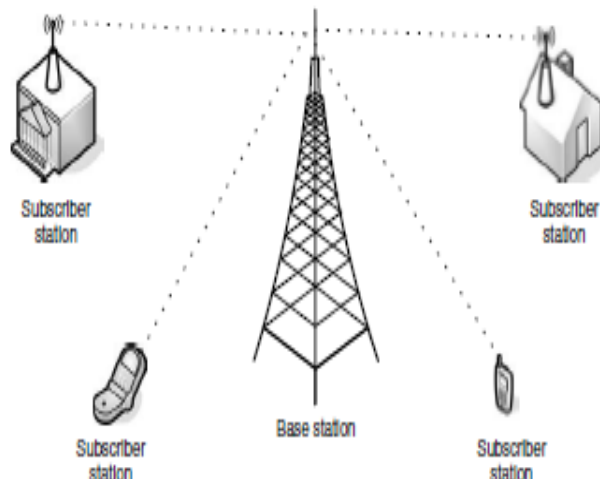


Figure1: Point-to-multipoint WiMAX network

IEEE 802.16 architecture includes one Base Station (BS) and multiple Subscriber Stations (SS). Communication occurs in two directions: from BS to SS is called Downlink and from SS to BS is called Uplink. When downlink BS broadcast data to all subscribers and subscribers select packets destined for it. While Uplink channel is shared by multiple SSs and to ensure this sharing this channel is slotted and these slots are allocated by BS to various SSs in one uplink frame by using Time Division Duplexing (TDD) or Frequency Division Duplexing (FDD) [3]. A scheduling module is necessary to provide QoS for each class [4].

Thus a paper gives an introduction to QoS architecture and its services in section I, a literature of these scheduling mechanism and scheduling algorithms is discussed in section II, the comparison of scheduling algorithms in section III, the proposed algorithm is discussed in section fourth followed by a conclusion.

1. QoS Architecture for IEEE 802.16

In figure 2. [3] IEEE 802.16 defines the following four types of service flow with the distinct QoS requirement [5]:

Unsolicited Grant Service (UGS): It is designed for services which require Constant Bit Rate (CBR) such as voice application and T1/E1.

Real -Time Polling Service (rtPS): It is designed for services which generate variable size data packets, but delay requirements should be met e.g. MPEG video.

Non-Real-Time Polling Service (nrtPS): It is designed for services which require good average data rate performance but can tolerate delay e.g. FTP.

Best Effort (BE) service: It is designed for services which don't require any specific QoS guarantee e.g. HTTP and Web Browsing [6].

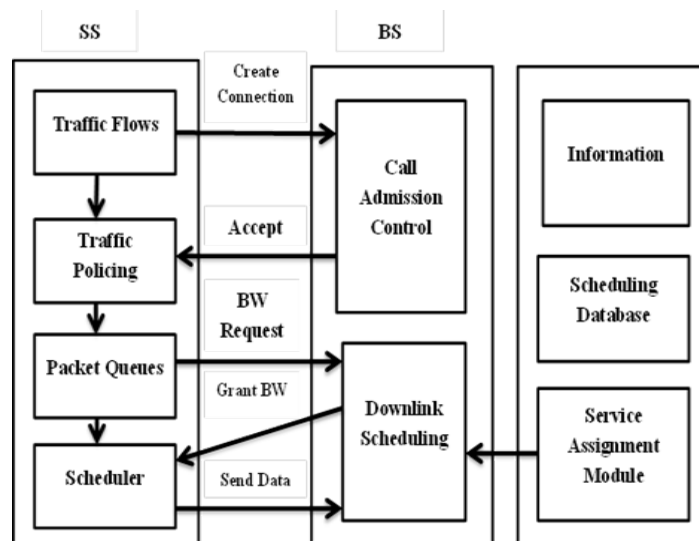


Figure 2: QoS Architecture [3]

2. LITERATURE REVIEW:

Table 1: Literature Review

Author	Research Methodology	Conclusion
Sahar Ghazal et al 2008 [7]	This Paper provides a performance analysis of three types of connections defined in the standard (UGS, rtPS, and nrtPS). Different levels of priority and blocking Probabilities are assigned to each class of service This performance analysis has been done using an analytical model for evaluating admission control (AC) for the previous mentioned classes in WiMAX network.	Analyzed the performance of the admission control of UGS, rtPS, and nrtPS. We notice that the probability of blocking of a connection is higher for lower priority service, classes, and delay of the UGS service class is much affected by the increase of the size of a contention window.

Joseph Thaliath et al 2009 [8]	In this paper, the authors have proposed a new BS node scheduling algorithm, in which the packets for all SS of a particular priority are transmitted sequentially. Service Class Downlink Scheduling (SCDS), they have compared the results for Round-robin scheduling algorithm of existing architecture with SCDS.	It has been found that SCDS provides considerable reduction in real time traffic's average delay and increase throughput.
You-Chiun Wang et al 2012 [9]	Propose a priority-based scheduling algorithm to arrange resources for downlink traffics in an IEEE 802.16 broadband wireless network. The scheme is to differentiate the Mobile subscriber stations with good and bad channel conditions, and to differentiate the urgent, real-time traffics from the non-real-time ones.	Simulation results show that scheduling algorithm can increase the network throughput, maintain the long-term fairness, and keep packet dropping ratios of real-time traffics low, as compared with existing results.
Jenhui Chen et al 2009 [10]	To reduce the delay time of packets efficiently as an important purpose, they proposed a downlink delay-minimized scheduling (DDMS) algorithm for the reduction corresponding delay time for mobile stations (MSs). By the proposed scheme, the system throughput of the BS improves.	Simulation results show that our DDMS algorithm outperforms to reduce the delay time, throughput and dropping rate. DDMS also improves the throughput by considering the relationship of system resources for real-time services (B_r) and required Resource (n_i, k) for being transmitting real-time packets.
Cheng-Yi Pan et al 2012 [11]	This paper proposes an efficient downlink scheduling algorithm, which allocate the bandwidth on the basis of queue-length estimation, the comparison of the proposed scheme with DRR and WRR by estimating the performance of system on the basis of different parameters such as average delay, loss rate and throughput. The proposed hybrid scheme uses a combination of classic Scheduling algorithms in order to better satisfy the QoS requirements.	Have shown that the proposed scheme has better performance than the other Scheduling algorithms. The proposed algorithm can provide QoS guarantee by achieving a minimum throughput guarantee and also maintain small delays and loss rate.

3. COMPARISON OF SCHEDULING ALGORITHMS:

Table 2: Scheduling algorithms comparison [14], [15]

Algorithm	Advantage	Disadvantage
Proportional Fair algorithm (PF)	<ul style="list-style-type: none"> ➤ Fairness in Scheduling ➤ Priority Based Simple Implementation ➤ Multi-user Diversity Gain 	No QoS Guarantee
EDF	Focusing on efficiency	Unfit for non-real time applications
WRR	Suitable for non-real time applications	Does not perform well in variable packet size
Cross layer downlink scheduling	<ul style="list-style-type: none"> ➤ Scheduling all service flow types ➤ Good throughput ➤ High Frame utilization 	Can be implemented only at the base station

Cross-layer scheduling for OFDMA networks	Improved packet loss rate, delay	The spectral efficiency of the system degrades about OFDMA networks 0.3bps/Hz.
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4. PROPOSED ALGORITHM:

The proposed scheduling algorithm is presented to minimize the latency and is to provide the best possible end-to-end performance for the applications. In the proposed algorithm, The WiMAX model takes one BS which has the information about user’s application’s parameters. We make a combination of two techniques of scheduling namely Greedy Latency and SJF. The Scheduling performance can be analyzed on the following criteria:

- 1. Throughput:** Throughput is defined as the measure of data rate (bits per second) generated by the application. To calculate throughput the size of each packet was added. The total time was calculated by the difference between the time taken to start the first packet and the last packet to reach the destination. Data is taken from all three Service flows for throughput are presented in a single chart. Since the UGS traffic has less packet loss the throughput is high. The throughput of rtPS and BE are very similar. UGS is designed with constant bit rate traffic, in which uniform bandwidth is allocated by BS to SS.
- 2. Turnaround Time:** Turnaround time is the difference of time between the time of arrival of process and time of dispatch of the process.
- 3. Waiting Time:** It is the amount of time a process waits in the ready queue.
- 4. Response Time:** This is the amount of time takes from when a request was submitted until the first response is produced not output.

In real-time video streaming applications, the packets that exceed the latency requirements of the QoS are not useful when they arrive at their destinations [12]. These packets are likely to be discarded by the receiver and transmitting them is a waste of resources. Therefore, in Greedy-Latency [13], the HOL (head of line) packet is considered for scheduling only if it is not expired, which is determined from the ratio of the HOL packet latency (d_k) to the allowed maximum latency (T_k). This value represents the packet latency ratio and is denoted by α . If α is less than 1, it is used in combination with user’s average SNR to modify the normal scheduling decision of the Greedy algorithm; which is only based on SNR values. In the case that α is greater than 1, the packet is

considered expired and must be dropped from the corresponding queue. The key benefit of this packet dropping policy is a more efficient usage of bandwidth. Next, the calculated utility values for all non-dropped HOL packets are sorted. Finally the processes are scheduled according to the SJF algorithm in which the shortest amongst the entire ready queue process is executed first rest all are preempted [14]. The benefit of this is that waiting time is minimal for the shorter jobs. All the calculations will be done using Mat lab.

It can be observed that the problem with minimizing latency is resolved to keep the waiting time in considerations, so that the other users demanding different processes or application have, not to wait for longer time, thus the parameters, response time, called latency, turnaround time, which is the time to complete a single process and the waiting time all are improved using the combination of proposed scheduling algorithm Greedy Latency and Shortest Job First (SJF).

CONCLUSION:

The paper discussed about the wireless technique WiMAX and its scheduling classes which support QoS of different applications like media, VoIP, voice, video, etc. The paper gives a comparative table of existing algorithms and its advantages and disadvantages. The paper focuses on the latency parameter and proposed a technique which minimizes latency and reduces waiting time of traffic with lower priority. The proposed technique improves the throughput and reduces packet loss.

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