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Research Article

Improving the quality of Service based on fair distribution of load and Request in IEEE 802.16 using Scheduling Algorithms

Nitin Anthony Luther[Ȧ*], Rajeev Paulus[Ȧ], A.K Jaiswal[Ȧ] and Aditi Agarwal[Ȧ]

[Ȧ]Electronics &Communication, SHIATS, Allahabad, India

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Abstract

An escalation in interest of Worldwide Interoperability for Microwave Access (WIMAX) networks has been substantiated due to its high data rate, wide area coverage and differentiation of Quality of service. Adequate schedulers play a preeminent role in rendering these operational specifications. In this paper we abduce weighted round robin scheduling algorithm that not only fulfills the quality of service requirement but also provides a fair scheduling for real-time services. In this work, a comprehensive study was carried out of scheduling algorithms such as Weighted Round robin, round robin, strict priority and weighted fair queuing, analyzing and appraising the performance of schedulers individually in order to support the different QoS classes. The simulation is carried out via Qualnet 6.1 simulator and the results implied that Weighted Round Robin out performs other schedulers and provides higher service standard to support the different QoS requirement.

Keywords: *IEEE 802.16 (WIMAX), QoS, Qualnet, Scheduling Algorithm.*

1. Introduction

Worldwide Interoperability for Microwave Access or WIMAX is a wireless communication technology based on IEEE 802.16 standard. It is used as an alternative to cable and DSL, providing data-on-the-go and uses standard broadband wireless access technology capable of last-mile delivery of information (Nagaraju, *et al*, 2009) Standards for BWA (broadband wireless access) are being developed under IEEE project 802, working group 16 which is also widely acknowledged as IEEE 802.16(WIMAX).

WIMAX standards prevalently intends in providing high speed and better performance service at various characteristic levels along with its anticipated level of QoS requirements. The main test for BWA networks is in providing quality of service (QoS) concurrently to services with very different characteristics. In other words, it is unable identify how to proficiently schedule the network traffic related to different applications in order to meet their specific requirements. QoS support in wireless networks is a much more difficult task than in wired networks, because the attributes of a wireless link are variable and unpredictable, both in a time-dependent basis plus a location dependent basis (Kumar, *et al*, 2012).In multi-service communication system such as WIMAX, the scheduling scheme aids as a fundamental mechanism which helps in acknowledging an essential impact on the QoS performance of each type of service. Especially, when the network channel is under heavy congestion .The scheduling scheme in particularly plays an important role in an objective to achieve a satisfactory performance for each queue in which the packets are scheduled for that particular channel. Simply applying adaptable scheduling may enlarge the performance of WIMAX but may fail to consider the QoS requirements of the queues subject to attain fairness in scheduling. Hence, it is a tough challenge to select a potent QoS scheduling scheme that can increase the system throughput by taking benefit of adaptable resource allocation without losing the ability of affirming QoS for queues with different QoS requirements (Hou, *et al*, 2007).After analyzing the need for improving QoS in WIMAX, this paper conducts an effective study on scheduling algorithms like Round Robin (RR), Weighted Round Robin (WRR), Strict Priority and Weighted Fair Queuing comparing which is better in terms of delay, throughput and fairness and the results shows that WRR scheduling algorithm can provide high service standards to support the QoS required by different type of traffic as well as different type of user by providing fair distribution of load and requests in between applicable resources.

2. IEEE 802.16 standard.

An Elemental WIMAX network comprises of a base station (BS) and multiple subscriber stations (SS). The BS schedules the traffic flow, communication between BS and SSs are bidirectional. Route between the BS and SS are classified into two types of communication channels such as Down-Link (DL) channel – from BS to SS and an Up-

*Corresponding author: **Nitin Anthony Luther**

link (UL) channel – from SS to BS. Downlink channel is in broadcast mode and uplink channel is shared by various Subscriber stations. The standard supports two duplex mode, Time Division Duplex (TDD) and Frequency Division Duplex (FDD).The TDD frame comprises of downlink and uplink subframes, the duration and the number of subframe slots are resolved by the BS scheduler. The downlink subframe has downlink map (DL map) containing information about the duration of sub frames and which time slot belongs to a particular SS. As the downlink channel and uplink map (UL map) has vital of information element (IE) which includes transmission opportunities (European Telecommunications European Telecommunications Standards Institute, 2005). The communication of WIMAX network is shown in figure.1.

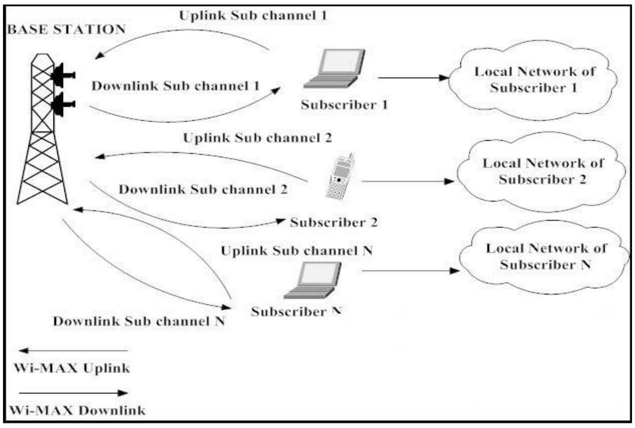

Fig.1.WIMAX communication.

2.1 PHY and MAC LAYERS.

Transmission is simple in downlink because only the BS transmits during the associated sub-frame. Data are transmitted to all the SSs each SS receives the packets which are destined to itself. For the UL, the BS determines the number of slots which are to be allocated for each SS in the correspondent sub-frame. This information is then broadcasted by the BS through a ULMAP message at the beginning of each frame. The UL-MAP contains specific data (Information Element – IE) that include the transmission opportunities, which is defined as the time slots during which the SS can transmit during the UL sub-frame. Upon receiving the UL-MAP message, the stations then transmit the data in predefined time slots as shown in the IE. A scheduling module for the UL is mandatory to be kept in the BS in order to determine the IEs using the bandwidth requests (BW-Request) sent by the SS (Moraes, *et al*, 2005) (Cicconetti, *et al*, 2006).

2.2 Quality of Service.

WIMAX packets traversing in the MAC interface are identified by service flow ID. A service flow is a unidirectional flow of specific data packets defined by traffic behavior and specific QoS requirements. A Service class allows the Operators to plan the SSs with a Service Class Name at the BS. It also allows higher layers protocols to create a service flow by its Service Class Name. The standard makes it expedient to address such QoS requirements by defining five different QoS service classes. The traffic flow in IEEE 802.16 is shown in Figure.2. (Ndiki, *et al*, 2010)(Tang, *et al*, 2007).

2.2.1. Unsolicited grant services (UGS) is designed for constant bit rate traffic (CBR) in order to support real time applications with strict delay requirements. Such applications generate fixed size packets at periodic intervals

- BW-Request: Not required.
- Uplink Scheduler: BS determines the IEs for the UL-MAP it allocates a fixed numbers of time slots in each time frame.

2.2.2. Real time polling services (rtPS) - is used to support real time Variable Bit Rate (VBR) applications that generate fixed size data packets such as MPEG Video or VOIP with silence suppression.

- BW-Request: uses only in the contention-free mode. The current queue size that represents the current bandwidth demand is included in the BW-Request.
- Uplink Scheduler: Not defined in the current IEEE 802.16.

2.2.3. Non-real time polling service (nrtPS) - is used for delay tolerant applications that do not have specific delay requirements.

- BW-request: uses either contention-free mode or contention mode. Current queue size is included in BW-request.
- Uplink scheduler: Not defined in current IEEE 802.16.

2.2.4. Best effort service (BS); similar to nrtPS where the service is not ensured for bandwidth or delay. SS uses contention and unicast request opportunities to send bandwidth request.

- BW-request: uses only contention mode. Current queue size is included in BW request.
- Uplink scheduler: Not defined in current IEEE 802.16 (Tang, *et al*, 2007)

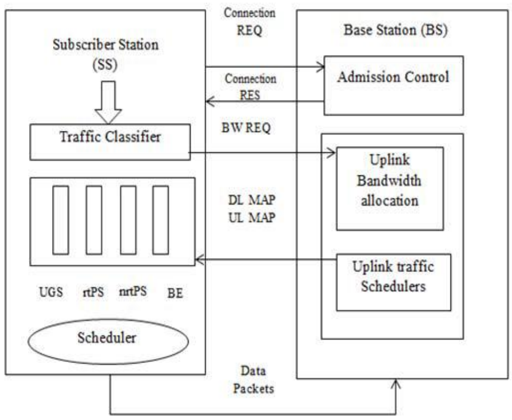

Fig.2 WIMAX traffic flow.

3. QoS Scheduling Algorithm.

As in the case of alternative wireless technologies, it is anticipated that an air interface will be the biggest system hindrance with WIMAX, too. Thus the BS scheduler should make sure that insufficient resources are to be used effectively. Excelling QoS certainty can be provided by higher complexity in both control plane and data plane, in order to achieve better QoS for reducing unwanted complexity in network, developers need to do their best in the aim of delivering a meaningful QoS (Lakkakorpi, et al, 2008) by choosing an efficient scheduling algorithm, the scheduling algorithms used in this paper are (Mardini, *et al*, 2006), (Rashwan, *et al*, 2009), (Kumar, *et al*, 2011).

- Strict-Priority (SP) - is a basic scheduling algorithm that serves all the higher priority traffic of the SSs first. In the lower classes of service a starvation occurs between the SSs especially when more loads of higher classes is present. But occasionally, it is possible that the behaviors of the lower-class may disturb or delay the behaviors of the higher-class in SP scheduling algorithm under some illegitimate mixing of the traffics and over a high speed links
- Weighted Fair Queuing (WFQ) -each flow is provided separate weight having different bandwidth in a way that intercepts monopolization of the bandwidth by flows giving fair scheduling for different flows supporting variable length packets by assuming the conceptual approach of the generalized processor sharing (GPS) system by calculating and assigning an end time to each packet.
- Round Robin (RR) - newly advent packets queue up by flow such that each flow has its specific queue. The scheduler polls each flow queue in a cyclic order and serves a packet from any-empty buffer encountered. RR does offer greater fairness and better bandwidth utilization, and are of great interest when considering other scenarios than the high-speed point-to-point scenario. However, since RR is an attempt to treat all flows equally, it will lead to the lack of flexibility which is essential if certain flows are supported to be treated better than other.
- Weighted Round Robin (WRR) - weighted round robin provides an uncluttered and persuasive way of focusing on fairly allocating the load in between applicable resources in an attempt to evenly distribute the requests. In WRR scheduling algorithm each destination is accredit a value that represents the performance of that server. The weight determines how many more or less requests are forwarded in the server's way. Weighted Round Robin works in an analogous way to round robin, but is capable of assigning more requests to nodes with a greater 'weight'. Figure.3 shows the implementation of weight in WRR.

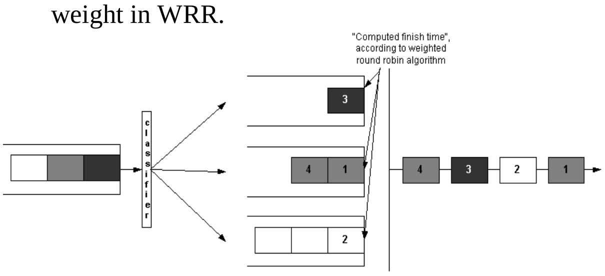

Fig.3.WIMAX traffic flow

There are two ways how to implement different weights for queues

a) Sending multiple packets during one visitation of the scheduler. The number of packets corresponds with assigned weight.
b) Multiple visits of the scheduler according to the weight of service class.

WRR queuing can be implemented in hardware, so it has lower computing requirements and can be used in high-speed nodes in network. The visitation and choosing packets for output from each queue ensures all services to get some portion of the output capacity. It prevents starvation. The output capacity is allocated according to number of packets. Their size is not calculated. This means only rough control over the output bandwidth allocated to each queue. When one queue is empty, WRR divides the bandwidth allocated to that queue is divided to the remaining queues according to their weights (Balogh, et al, 2011).

4. Simulation Model.

The simulation study determines the performance of various different algorithms present in a mobile WIMAX network. The simulation has been performed using QualNet 6.1 version.

Table.1 Simulation parameters

No. of Nodes	30
Transmission power	30dbm
MAC	802.16
Start time, End Time	0,0
Number of items sent	0
Simulation time	500sec
Mobility	Random Wave-point
Bandwidth	2.4Ghz
Packet Size	512bits
Application	CBR

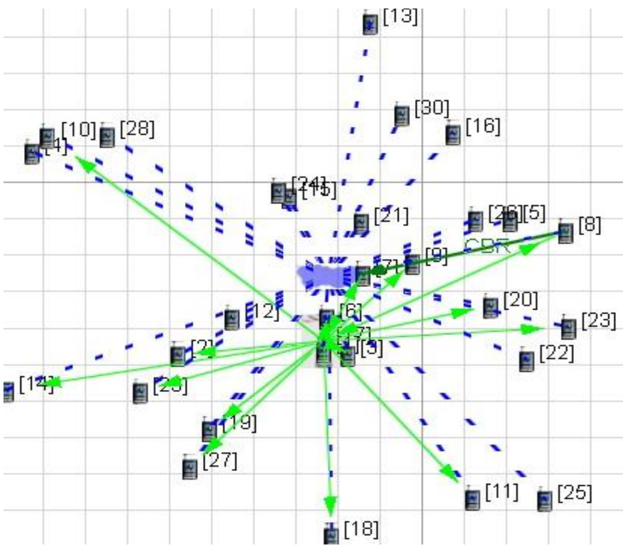

Fig.4. Animation view of scenario

To analyze the performance of Round Robin, Weighted Round Robin, Strict Priority and Weighted Fair Queing scheduling algorithm, both qualitative and quantitative metrics are needed. The main focus of this paper is to achieve maximum quality of service, fair allocation of loads and to evenly distribute the request by comparing the scheduling algorithms in three different metrics defining the quality of service of WIMAX which are Throughput, Average End to End delay and Jitter.

5. Results

Three different experiments were carried out, in which scheduling algorithms like RR, WRR, SP and WFQ are compared in the matrices like Throughput, Average End to End Delay and jitter which characterizes the quality of service. The weighted round robin proves to be better in the above mentioned performance metrics.

WRR shares N sessions for each weight $a_{ji,\ queue}$ j in WRR is represented as

$$WRR_{j\,=}\ (a_{j1}, a_{j2\ldots}\, a_{jn}) \quad (5.1)$$

WRR schedule of a queue j guarantees that every connection in the queue j receives a_{ji} services. In every $\sum^{N}_{i=1} a_{ii}$ time slots.
WRR serves a number of packets for each non empty queue as:

Number = normalized (weight/mean packet size (5.2)

The results of experiment 1, 2 and3 are shown in Figure.6, Figure.7, and Figure.8 respectively.

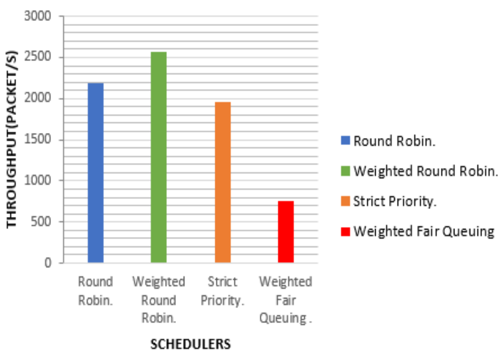

Fig.6 Average overall throughput.

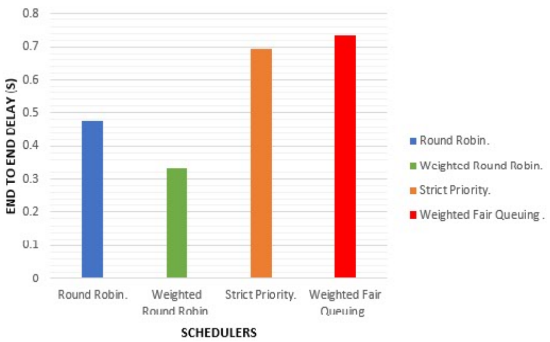

Fig.7 Average End-to-End Delay

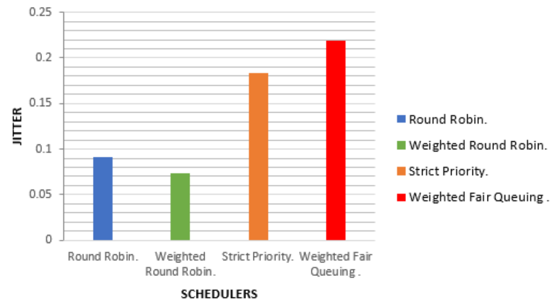

Fig.8 Average Jitter

6. Conclusion

WIMAX network (802.16) assures the choicest available quality of service for data services as well as multimedia. In this paper, we have performed a study of WiMax scheduling algorithm like Round Robin, Weighted Round Robin, Strict Priority and Weighted Fair queuing. A simulation study was used to compare different scheduling algorithms for the matrices like throughput, average end to end delay and jitter. In this, Weighted Round Robin has got the best value among all the matrices and out performs the rest of the scheduling algorithms in terms of fair allocation of load and packets. Further research in the field of scheduling algorithms can help in introducing new algorithms which may improve many other factors like resilience, bandwidth and packet delivery ratio.

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