Performance Comparison of Scheduling Algorithms for WiMAX Networks

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Abstract — In the recent research years there has been lot of researcher's research in wireless broadband service like WiMAX (Worldwide Interoperability for Microwave Access) is one of the latest technologies in the Wireless World. Broadband wireless access industry has seen very significant growth inpresent time due to its unique advantages compared to wired technology like rapid deployment and easy configuration, high scalability, lower maintenance cost, lower investment and also end-user preference. But as this industry has grown, different alternatives also emerged to capture available market. WiMAX seems to be the solution as it is able to provide easy deployment, high speed data rate and wide range coverage. Most importantly, WiMAX is to deliver wireless communications with Quality of Service (QoS) that can support all kinds of real-time application in wireless networks that includes priority scheduling and queuing for bandwidth allocation that is based on traffic scheduling algorithms within wireless networks. In this paper, performance comparison of Proportional Fair (PF) Scheduling, Weighted Round Robin (WRR) Scheduling, and Self-Clocked-Fair (SCF) Scheduling through OPNET simulation. Finally, Proportional Fair (PF) Scheduling provides better performance compare to WRR and SCF Scheduling algorithms and also increasing throughput (mbps), reducing end-to-end delay (ms) and packet loss with traffic load (kbps) is increased.

Keywords: Scheduling Algorithm, IEEE 802.16e, WiMAX, QoS, WRR, SCF.

I. INTRODUCTION

The 802.16 normal square measure generally brought up conversationally as "WiMAX", "mobile WiMAX", "802.16d" and "802.16e". Their formal names are 1st is 802.16-2004 is additionally called 802.16d that refers to the social unit that has developed that normal. It's generally brought up as "fixed WiMAX," since it's no support for quality. The second is 802.16e-2005, typically abbreviated to 802.16e, is Associate in nursing modification to 802.16-2004. It introduced support for quality, among alternative things and is so conjointly called "mobile WiMAX". Worldwide ability for Microwave Access (WiMAX) networks were expected to be the most Broadband Wireless Access (BWA) technology that provided many services like information, voice, and video services as well as completely different categories of Quality of Services (QoS), that successively were outlined by IEEE 802.16 standard. Programing in WiMAX became one in all the foremost difficult problems, since it absolutely was accountable for distributing accessible resources of the network among all users; this leaded to the demand of constructing and coming up with high economical programing algorithms so as to enhance the network utilization, to extend the network output, and to reduce the end-to-end delay. WiMAX is one in all the foremost necessary broadband wireless technologies and is anticipated to be a viable various to ancient wired broadband techniques because of its price potency. It's necessary to produce Quality of Service (QoS) warranted with completely different characteristics, quite difficult, however, for Broadband Wireless Access (BWA) networks. Therefore, a good programing is vital for the WiMAX system.

RESEARCH CHALLENGES: Scheduling algorithms serve as an important component in any communication network to satisfy the QoS requirements. The design is especially challenged by the limited capacity and dynamic channel status that are inherent in wireless communication systems. To design an MAC layer protocol which can optimize the system performance, the following features and criteria should be concerned.

Bandwidth Utilization: Efficient bandwidth utilization is the most important in the algorithm design. The algorithm must utilize the channel efficiently. This implies that the scheduler should not assign a transmission slot to a connection with a currently bad link.

QoS Requirements: The proposed algorithm should support different applications to exploit better QoS. To support delay-sensitive applications, the algorithm provides the delay bound provisioning. The long-term throughput should be guaranteed for all connections when the sufficient bandwidth is provided.

Fairness: The algorithm should assign available resource fairly across connections. The fairness should be provided for both short term and long term.

Implementation complexity: In a high-speed network, the scheduling decision making process must be completed very rapidly, and the reconfiguration process in response to any network state variation. Therefore, the amount of time available to the scheduler is limited. A low-complexity algorithm is necessary.

Scalability: The algorithm should operate efficiently as the number of connections or users sharing the channel increases.

II. RELATED WORKS

A fundamental of WiMAX Understanding Broadband Wireless Networking have been studied and discussed by JG Andrews, et. al. (2007). On traffic characteristics of a broadband wireless internet access have been discussed and analyzed by R Pries, et. al. (2009). Packet scheduling for QoS support in IEEE 802.16 broadband wireless access systems have been investigated by K Wongthavarawatet. al. (2003). Quality of service support in IEEE 802.16 networks have been discussed by C Cicconetti, et. al. (2006). Various Scheduling algorithms for IEEE 802.16 networks have been studied and discussed by JF Borin, et. al. (2008). Dynamic QoS-based bandwidth allocation framework for broadband wireless networks have been discussed and analyzed by E Amir, and N Nasser, (2011). A survey and key issues scheduling in IEEE 802.16e mobile WIMAX networks have been studied and discussed by C So-In, et. al. (2009). An adaptive downlink and uplink channel split ratio determination for TCP-based best effort traffic in TDD-based WiMAX networks have been analyzed by CH Chiang et. al. (2009). Energy saving mechanism in the IEEE 802.16e wireless MAN have been analyzed by Y. Xiao, et. al. (2005). Energy management in the IEEE 802.16e Medium Access Control have discussed and analyzed by Y. Zhang et. al. (2006). Performance Modeling of Energy Management Mechanism in IEEE 802.16e Mobile WiMAX have been investigated by Y. Zhang, et. al. (2007). Performance Evaluation of Energy-Saving Mechanism Based on Probabilistic Sleep Interval Decision Algorithm in IEEE 802.16e have been analyzed by J.R. Lee et. al. (2007). Maximizing Unavailability Interval for Energy Saving in IEEE 802.16e Wireless MANs have been developed by T.C. Chen, et. al. (2009). Energy-efficient packet scheduling algorithms for real-time communications in a mobile WiMAX system have been analyzed by S.L. Tsaoet. al. (2008). A Maximal Power-Conserving Scheduling Algorithm for Broadband Wireless Networks have been discussed and developed by H.L. Tseng, et. al. (2008). Energy Efficient Scheduling with QoS Guarantee for IEEE 802.16e Broadband Wireless Access Networks have been developed by S.C. Huang et. al. (2010). Performance Evaluation of an Uplink Scheduling Algorithm in WiMAX have been analyzed by Yekanlu E. et. al. (2009). Analyzing the Throughput and QoS Performance of a WiMAX Link in an Urban Environment have been developed by ZarrarYousaf, F. et. al. (2009). A survey on scheduling in IEEE 802. 16 mesh modes have been studied and discussed by Miray K, et. al. (2011). Comparative studies of scheduling algorithms in WiMAX have been analyzed by Sabri A. (2011). An overview of scheduling strategies for PMP mode in IEEE 802.16 have been studied and analyzed by Murrawat S, et. al. (2012). Comparative studies of scheduling algorithms for WiMAX have been analyzed by Jain A, (2008). Ensuring the QoS requirements in 802.16 scheduling have been discussed by Sayenko A, et. al. (2006). Flexible resource allocation in IEEE 802.16 wireless metropolitan area networks have been developed by Xergias AS, et. al. (2010). Comparison of WiMAX scheduling algorithms and proposals for the rtps QoS class have been analyzed by Loutfi, Belghith A, et. al (2008). Performance evaluations for scheduling algorithms in WiMAX network have been investigated by Cherng JL et. al. (2012). Quality of service scheduling for 802.16 broadband wireless access systems have been discussed by Sun J, et. al. (2006). Delay character of a novel architecture for IEEE 802.16 systems have been analyzed by Liu N, et. al. (2005). Uplink scheduling with quality of service in IEEE 802.16 networks have been discussed by Freitag J et. al. (2007).

III. PERFORMANCE COMPARISON

The main focus of in this research performance comparison of various scheduling algorithm for WiMAX network, In order to specify high network performance and also efficient scheduling algorithm is essential as it manages and controls the provision of an efficient level of QoS support. Although many scheduling algorithms have been proposed for WiMAX network, the design ofthe algorithms are challenged by having to support different levels of services, fairness and implementation complexity. In this study, Proportional Fair (PF) and Weighted Round Robin (WRR), and Self-Clocked-Fair (SCF) scheduling algorithms in WiMAX wireless network are investigated. These algorithms which are considered the most dominant and popular, furthermore, these common packet scheduling schemes provides QoS support for real time applications in IEEE 802.16 system.

Proportional Fair (PF) Scheduling: Proportional Fair (PF) was proposed by Qualcomm Company, which was realized in the IS-856 standard for the downlink traffic scheduling (also known as High Data Rate(HDR)). It is devised to avoid conflict between full use (by selecting user with highest data rate) and fairness. It does this by maintaining trade-off between system throughput and starvation of low priority users. This algorithm is based on one priority function. The PF provides a good tradeoff between system utility and fairness by selecting the user with highest instantaneous data rate relative to its average data rate. The PF was designed specifically for the service class and hence does not guarantee any QoS requirement such as delay, jitter and latency. Let $\mu_i(t)$ be the data rate supported by the channel of user i where i = 1, 2, . . . ,N at time instant t. Assume that the data rate remains constant over a time slot and $\overline{\mu_i}$ be the average data rate supported by user i. Let j be the selected user, the scheduling rule is given by the formula,

$$j = \underset{i}{\arg max} \frac{\mu_i(t)}{\overline{\mu_i}}$$

Weighted Round Robin (WRR) Scheduling: It is a scheduling algorithm implemented for resource sharing in a computeror network. In fact, WRR is an extension of the Round Robin (RR) algorithm. In a network, WRR serves a number of packets that are computed by normalizing weight of data divided by the average of packet size from nonempty connection queue. It begins by classifying packets into a variety of service classes followed by assigning a queue that is determined by the different percentage of bandwidth. Finally, it is serviced in round robin order. Since the bandwidth is assigned according to the weights, the algorithm will not provide good performance in the presence of variable size packets. However, WRR method makes certain that all service classes have access to at least some configured amount of network bandwidth to avoid bandwidth starvation.

Self-Clocked-Fair (SCF) Scheduling: It is an efficient queuing scheme which satisfies the Quality of Services (QoS) in broadband implementation. The algorithm is based on the concept of virtual time that adopts the concept of an internally generated virtual time as the index of work in progress. It links virtual time to the work progress in the Fluid-flow Fair Queuing (FFQ). As virtual time function is involved in determining the order of which packet should be served next, the virtual time that is produced depends very much on the progress of work in the actual packet based queuing system. This scheme is efficient for the internal generation of virtual time as it involves negligible overhead. This is because virtual time is easily computed from the packet situated at the head of the queue. In addition, the SCF algorithm can accomplish easier implementation and it can maintain the fairness attribute in virtual time function.

IV. RESULTS AND DISCUSSION

OPNET Simulation: OPNET is a research oriented network simulation tool. It provides a comprehensive development environment for modeling and simulation of deployed wired and wireless networks. OPNET simulation enables users to create customized models and to simulate various network scenarios. The wireless module is used to create models for wireless scenarios such as WiMAX. This simulation is object-oriented and employs a hierarchical approach to model communication networks. It provides graphical user interfaces known as editors to capture the specifications of deployed networks, equipment, and protocols. OPNET simulator 15.0 to simulate the WiMAX and also provides high-fidelity modeling, simulation, and analysis of wireless networks such as interference, transmitter/receiver characteristics, and full protocol stack, including MAC, routing, higher layer protocols, and applications. It also has the ability to incorporate node mobility and interconnect wire line transport networks. The simulation parameters are listed in table 1.

Table 1: Simulation Parameters.

Parameters	Value
BS range radius	1000
MS range radius	500
Frequency band	2.4
Channel bandwidth	20
Frame duration	20
FFT size	2048
Number of MS	10-50
Number of BS	1
BS transmit power	20/5
MS transmit power	15/1.5
Simulation time	500 s

End-to-End Delay: This performance metric represents the average delay between the time when the data packet was originated at the source node and the time it reaches the destination node.

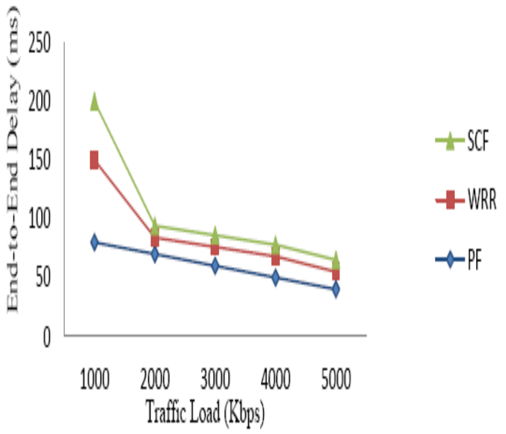

Figure 1. End-to-End Delay (ms) Vs. Traffic Load (Kbps.)

Throughput: Average throughput represents the amount of data transmitted by user per unit time. The value is expressed in Mbps.

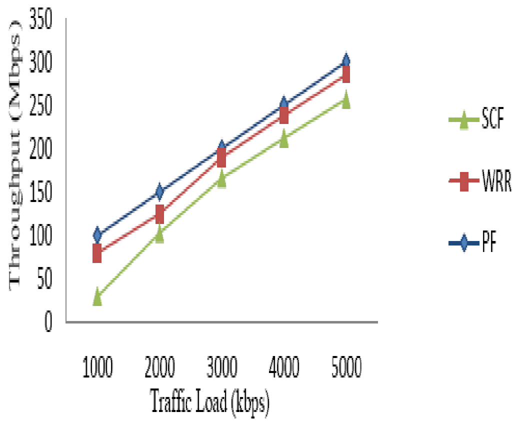

Figure 2. Throughput (Mbps) Vs. Traffic Load (Kbps.)

Packet Loss: This parameter specifies the allowed percentage of dropped packets from the queue due to reaching the maximum delay requirements without service.

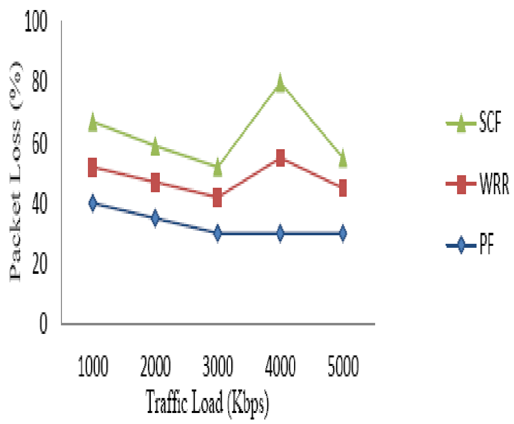

Figure 3. Packet Loss (%) Vs. Traffic Load (Kbps.)

V. CONCLUSION

WiMAX is one of the most emerging technologies for Broadband Wireless Access (BWA) in metropolitan areas by providing an exciting addition to the current broadband techniques for the last-mile access. It is demonstrated that WiMAX is a viable alternative to the cable modem technologies due to its high resource utilization, easy implementation and low cost. Furthermore, WiMAX not only enhances the existing features of the competitive cabled access networks, but provides high data rate applications with a variety of Quality of Service (QoS) requirements. In this paper, performance comparison of Proportional Fair (PF) Scheduling, Weighted Round Robin (WRR) scheduling, and Self-Clocked-Fair (SCF) scheduling through OPNET simulation. Finally, Proportional Fair (PF) Scheduling provides better performance compare to WRR and SCF Scheduling algorithms and also increasing throughput (mbps), reducing end-to-end delay (ms) and packet loss with traffic load (kbps) is increased.

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