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Enhanced Priority Load-Aware Scheduling Algorithm for Wireless Broadband Networks

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ABSTRACT

WiMAX, one of the emerging wireless broadband networks, was designed to support traffic from applications with diverse QoS requirements. In WiMAX, an efficient resource management technique such as scheduling is required for the proper allocation of network resources to these data streams. This article proposes an enhanced priority load-aware scheduling (EPLAS) algorithm to improve the performance of WiMAX networks. The proposed scheme adaptively determines the weight of each queue based on the queue load. It also introduces a packet drop control mechanism that reduces the packet drop rate and increases the average throughput of the network by prioritizing packets with the earliest deadlines within each queue. The performance of EPLAS was evaluated against other benchmark schemes using several simulation experiments. The results revealed that EPLAS performed significantly better than the benchmark algorithms in terms of average delay, average packet drop ratio, and average throughput.

KEYWORDS

Enhanced PLAS, EPLAS, PLAS, Priority Load-Aware Scheduling, Scheduling, Wimax, Wireless Broadband Networks, WRR

INTRODUCTION

Recently, there have been significant advances in wireless broadband technologies to meet the growing demand for high-speed delivery of multimedia services. WiMAX is one such technology designed to provide high-speed internet access over a metropolitan area with a 15-km radius at about 70 Mbps (Nie, Wang & Pack, 2012). Its low cost of installation and flexibility have made it adoptable not only by small businesses but also by residential users. The technology presents some specifications at both the media access control (MAC) and the physical (PHY) layer of the network reference model. At the PHY layer, WiMAX uses orthogonal frequency division multiplexing (OFDM) (Rajeem & Fernando, 2010). OFDM removes delay spread, inter symbol interference, and multi-paths from communication channels to enable speedy transmission of multimedia services. On the other hand, the MAC layer supports quality of service (QoS) classes for proper utilization of network resources

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(Wu, Huang & Huang, 2012). The MAC layer classifies traffic into different classes based on QoS requirements such as delay, bandwidth, jitter, latency, and throughput. To guarantee these requirements and ensure efficient utilization of the often scarce network resources among these classes, a scheduling algorithm is required.

Scheduling is a technique used for the sharing of network resources among competing subscriber stations (SSs). It controls bandwidth allocation and determines the order by which packets are transmitted from different classes (Chin-Ling & Cheng-Yi, 2012). Several scheduling algorithms have been proposed for resource management in WiMAX (Nie et al., 2011; Ahmad, Hamma, & Nasir, 2019; Naik, Dora, & De, 2019). Priority load-aware scheduling (PLAS) is one such algorithm and was designed to provide QoS requirements for each class. It employs a mechanism that prioritizes real-time traffic over non-real-time traffic. The algorithm introduces a dynamic weight, which is computed according to load of each class. It computes and multiplies a priority value and the load-aware weighted round-robin (LAWRR) weight of each class (Saidu, Subramaniam, & Jaafar, 2014). The resultant value becomes the priority weight of the class. The weight value allows the scheduler to serve more packets from the real-time traffic than other traffics in every service round. However, the excess weights allocated to non-real-time traffic cause an increase in the delay of real-time traffic under heavy and equal burst traffic. Also, because packets are served in round-robin (RR) fashion and since the real-time traffics have low tolerance for delay (Mohammed, Saidu & Abdulazeez, 2018), PLAS will increase packet loss and decrease average throughput due to its failure to prioritize packets within each queue according to their deadlines.

In this paper, the authors propose a new scheduling scheme, enhanced priority load-aware scheduling (EPLAS) as an extension of PLAS to improve network performance. The EPLAS algorithm adaptively computes queue weight values and employs packet drop control mechanism to reduce both delay and packet drop rate and to increase throughput of real-time traffic. The performance of EPLAS is evaluated against LAWRR, PLAS, and CBS using simulation experiments. The results reveal that EPLAS performs better in terms of delay, packet drop rate, and throughput.

The rest of this paper is organized as follows: In the Related Works section, an overview of some related scheduling schemes in WiMAX is presented; Problem Definition section, presents the problem, Proposed Algorithm section, describes the proposed EPLAS algorithm; Simulation Result section, presents the simulation results; and the Conclusion section, concludes the paper.

RELATED WORKS

Several scheduling and resource allocation schemes have been proposed for different broadband networks (Iaad, Mustapha, Taoufik, Samer, & Xavier, 2019). Comsa et al. (2018) proposed a smart scheduling scheme to improve the performance of 5G networks. It guarantees the varying QoS requirements different traffics. The scheme employs reinforcement learning and neural network to determine the resource allocation and service order of the contending traffics. The schemes in Comsa et al. (2019a); Comsa et al. (2019b); Comsa De-Domenico and Ktenas (2019); and Comsa et al. (2020) were also proposed for resource allocation in 5G networks. Some of the scheduling schemes proposed for LTE networks includes: Avocanh, Abdennebi, and Ben-Othman (2014); Khan, Martini, Bharucha, and Auer (2012); Zou, Trestian, & Muntean, (2013a), and Zou, Trestian, and Muntean (2013b). This research work however, focuses mainly on WiMAX, therefore we present a review of some of the related scheduling algorithms in WiMAX networks as follows.

The RR algorithm (Hahne, 1991) was proposed to separate traffic streams according to their priorities. RR separates traffic into different queues based on their QoS requirements. It serves packets from all queues moving from high- to low-priority queues in a cyclic manner. The algorithm repeats the same process until all packets are served from all the queues. RR allocates equal resources to all queues. Therefore, it is fair for traffic streams with the same QoS requirements. However, it causes an