Investigation on Evolutionary Scheduling Algorithm for Provisioning QOS on WiMAX Network

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***Abstract*— WiMAX is a IEEE 802.16 standards used for communication between wide range of wireless mobile de-vice. WiMAX provides and interaction between base station and subscriber station through PHY layer and MAC layer provides QoS service. In today's Internet world, many services (data, Voice, Video) require Variable bandwidth, efficient packet queuing and scheduling algorithm to achieve guaranteed network performance. Each services require different classes of QOS. Internet standard proposed different architecture which works on the packets classified in to different service class based on the QOS requirement of the application. WiMAX supports various scheduling algorithms to support varies service class. In this survey, we introduce a differentiated scheduling technique which will be an optimization over WFQ (Weighted Fair Queuing) and WFQ+(Worst case fair weighted fair queuing+), which calculate and updates the weight of the traffic flow dynamically based on burst and load. This also optimizes the calculation of virtual time and reduces the complexity, which is suitable for a advanced system.**

I. INTRODUCTION

Worldwide Interoperability for Microwave Access (WiMAX) an advanced wireless service used to provide the internet access to a wide range of customers in a conservative way. In WiMAX, scheduling technique is required when same output transmission link is shared among the multiple flows (number of packet streams called flow). Objective of a Scheduler is to provide guaranteed bandwidth, fair queuing and low complexity to transmit the packet stream to achieve required QOS.

Scheduler in WiMAX work at MAC layer, which separates the packet into different classes and allocates required resources accordingly. Scheduler allocates resources to node on each up link and down-link message transmission. Each node (SS s - Subscriber Stations) supplies the QOS requirement through the management messages like DSC (Dynamic Service Change) and DSA (Dynamic Service Addition) during connection establishment. In WiMAX, each Subscriber Station is allowed to request the required bandwidth to Base station explicitly through up-link message. Scheduler at base station checks the QoS Parameter of the SS and allocates the required data transfer capacity according to the capabilities of each SS, and broadcasts in Down-link message.

Various weighted fair queuing (WFQ)-based algorithm like packet generalized processor sharing (PGPS), which is an approximation of GPS, which explains about the rate based flow control [1], worst-case fair weighted fair queuing (WF2Q) [2] and Weighted fair Queuing [3], is a extension of the Generalized Processor Sharing algorithm, which gives fairness among competing SS and very good limits on the delay parameter. WFQ scheduler uses the complete time as a parameter to transmit packets. WF2Q scheduler uses begin and complete time of the packets as a parameters to transmit. WFQ is complex to implement compared to WF2Q+ because in WF2Q+, virtual time update is not done by GPS. Self-Clocked Fair Queuing (SCFQ) [4] algorithm uses the virtual finish time of a packet to transmit. SCFQ gives O (1) low complexity. When number of sessions increase, delay in packet transmit increases linearly.

In this survey we introduce dynamic scheduling method named Dynamic Weighted Low Complexity Fair Queuing which is an optimized over WFQ. This algorithm specifies the new technique for calculating and adjust of weight, it also reduces the complexity in calculating the Virtual time. This improves the overall results of the packet transmission of a WiMAX. This paper is composed as below.

Brief survey on some of the existing scheduling mechanisms are shown in Section II. The proposed scheduling algorithm to compute dynamic virtual completion time and weight over existing WFQ is shown in section III. Section IV shows conclusion of the new solution

II. LITERATURE SURVEY

Literature review is a composed record giving an outline of all the critical information identified with a specific topic. Many methods are found to improve the WFQ scheduling parameters like fairness, required delay and complexity for WiMAX.

In [5], author presents two differentiated

scheduling algorithms like frame-based fair queuing (FFQ) and starting potential based fair queuing (SPFQ) provides O (1) complexity to calculate the timestamps and also provides same delay and buffer requirements of WFQ. WFQ is and idle scheduling algorithm to provide properties like delay bound and fairness among the flows. But WFQ increases the delay and fairness when number of sessions increase. In frame-based fair queuing (FFQ) algorithm, adopts framing technique to recalibrate a global variable of work in the system periodically and limits any unfairness to a frame period. The SPFQ algorithm, runs the recalibration at packet boundaries, which improves fairness and maintains O (1) for calculating timestamps. Both FFQ and SPFQ are developed on the general framework of rate-proportional servers (RPSs). These algorithms will be used ATM and common networks.

In [6], to provide responsiveness and fairness for both connection oriented and connection less network, author focused on the important metric called worst-case fairness index (WFI). Worst Case Fair WFQ (WF2Q) provided bounded WFI which is improved over WFQ. However, experiments shows that WFI is height in some cases for WF2Q algorithm. In this paper author analyzes the reason for high WFI sometimes in WF2Q and with this analysis, author proposes an optimized adaptive queuing method called Delay Optimized WF2Q (DO-WF2Q). This algorithm is developed to optimize delay index (DI) along with WFI given by WF2Q. Simulations showed that DI is reduced without destroying WFI bound in DO-WF2Q, and also maintains low complexity.

In [7], implementation of packet schedulers always involves a tradeoff between complexity, delay and fairness. Here the author proposes a new algorithm called tiered-service fair queuing (TSFQ), which uses quantization and specialized queuing structures. TSFQ combines fairness, lower complexity and delay measure, all these three properties which are important for implementing the fair queuing algorithm. So author believes that deploying the TSFQ algorithm has potential to provide wide range of services to network operators.

In [8], WiMAX is connectionless broadband service based on the IEEE standard 802.16e which provided high scalability, low cost and wide coverage. WiMAX supports varies QoS based on the network and also provides various mechanisms to provide required service for the interactive based real and non-interactive applications at MAC layer. Scheduler is the important component in WiMAX which manages and allocates the available resources among all subscriber station to satisfy QoS criteria of an application. Here author proposes evaluates the idle scheduling algorithm WFQ and Opportunistic Authorized weighted Fair Queuing (OWFQ). The author suggests, an advanced WFQ method called channel and duration aware WFQ (cd-WFQ). This new method helps in reduces the transmission delay of a packet by prioritizing the packet and increasing queuing duration. With Qualnet simulator, results shows that cd-WFQ gives better average delay and fairness than OWFQ.

In [9], author describes that in high speed network providing packet scheduling with the different service classification is more expensive steps. Previously scheduler uses various techniques like timestamps rounding and flow grouping to provide optimal guaranteed service and keep the time complexity as O(1). This family of scheduler uses the per packet component which is directly related to set of groups or number of packets. No study shows the execution time of these schedulers. Here author proposes two things, firstly, he developed a new scheduler algorithm called QFQ, which is first algorithm to provide near optimal guarantees with fixed cost with respect to set of group and packet size. This method uses simple data structure and instructions which leads to faster operation. Secondly, author developed production-quality implementations of QFQ, which can be used to perform detailed performance analysis with our algorithms. Simulations and experiments shows that QFQ provides better results and perform ace when compared with the other algorithm of the same class.

In [10], major problem in advanced wireless network is to provide various services without compromising the QoS (Quality of Service) to different users at different lo-cations. WFQ is a idle algorithm which provides required bandwidth, throughput, bounded delay and fairness. However, using WFQ algorithm in wireless network is not a viable solution due to in instability in the wireless network due to weather dependent variable data rates and the location. Here author proposes a technique to combine the WFQ algorithm and the compensation methods. Compensation methods uses a techniques to swap channel access of different traffic flows which experiences variable data rate, this methods make the variable data rate transparent of traffic flows. Here author proposes three periodic compensation methods which provides maximum throughput and fairness. Author also proposes two event-driven techniques, which are distributed and executed frequently.

In [11], author proposed new algorithm called NSPFQ (new starting potential fair queuing), is an efficient and simple fair queuing algorithm. NSPFQ virtual time for a packet is calculated in O (1) complexity and it also provides properties like fairness and considerable delay. NSPFQ specifies a method to recalibrate the virtual time using rate-

proportional property. This new method re-calibrates the overall virtual time of a system to a smaller virtual start time of all head-of-line (HOL) packets in backlogged sessions. With simulator results, author shows NSPFQ method has better performance.

In [12], the author presents a study of QoS methods in sublayer of WiMAX networks. In WiMAX, QoS support is a basic criteria, and it is difficult compared to connection oriented networks, because of the variable and unusual qualities of remote connections. This paper also talks about different Quality of Service architectures, signaling methods, other access control methods proposed in WiMAX literature, operations of each architectures, and provides pros and cons after performing comparative study.

In [13], creator proposes the new algorithm called Smoothed Round Robin (SRR). Round robin algorithm schedules the packet for quantum of time form each flow. In round robin algorithm, process with lesser packets also need to wait for there turn. To avoid this problem, SRR provides the vectors of the weight to make a weight matrix along with weight spread sequence (WSS), which gives evenly distributed output, packets are scheduled using this created matrix. With weight matrix and WSS, SRR algorithm simulates the GPS (Generalized Processor Sharing) algorithm and provides the better results for the properties like short-term fairness and scheduling delay when compared to existing round robin methods. SRR also provides O(1) complexity by avoiding the maintenance of time-stamp compared to other queuing algorithms. Implementation of SRR shows that it provides the better delay for all interactive services and can be implemented in fast networks to give required QoS.

In [2], author shows the Generalized Processor Sharing (GPS) has two desirable properties: (a) Provides an service with a guaranteed delay to a flow, where traffic is compelled by leaky bucket. (b) Provides a method to allocate existing bandwidth to all backlogged flows, regardless of there traffic constraint.

The first property provide the guaranteed service traffic, whereas later one is to support the best-effort service. GPS implementation is not possible in real scenario. Many scheduling methods are developed based on the concept Generalized Processor Sharing (GPS), such as WFQ which is a idle scheduling method to provide the guaranteed delay, fairness and required throughput . WFQ is also called Packet Generalized Processor Sharing (PGPS). WFQ provides the bounded delay within one packet transmission time of the GPS. Here author shows that is a possible discrepancy between service provided by GPS algorithm and the packet WFQ, this discrepancy will affect the performance of the congestion control mechanisms which rely on the services provided GPS algorithm. This discrepancy given rise to the development of the new scheduling algorithm called Worst-case Fair Weighted Fair Queuing (WF2Q). The services provided by WF2Q algorithm is similar to that of GPS.

III. PROPOSED SYSTEM

WFQ scheduling algorithm provides properties like good delay and fairness for the packet scheduler, but complexity is very high O (N). High complexity is not suited for high speed network. WFQ algorithm assigns the static weights to the each flow which will not change to the dynamic change in the traffic passing through the subscriber station and algorithm will not reflect to the changed traffic load. Under this condition, WFQ scheduler will not handle the burst and overload which affects the performance or QoS expected from some service class. Due to static weight and the lack of response for changing network dynamics WFQ will always allocate the bandwidth to the flows even if they have small amount of data. This will restrict the other flows which are heavily loaded from transmitting and get congested. Today's real time network services require the guaranteed QoS and dynamic adaption to the changing traffic.

Our proposed system will address the above mentioned issues by amending the WFQ structure with below approaches: (i) An approach to minimize complexity in calculating virtual time. (ii) An approach to manage dynamic traffic through weight adjustment.

A. Complexity reduction

In WFQ algorithm, complexity is associated with updating virtual time periodically. In proposed algorithm, efforts applied to minimize the complexity of calculating virtual time of a packet without affecting the performance. The complexity of WFQ and WF2Q+ will be O (N) and O (log2N) to update the virtual time. In proposed, dynamic weighted fair queuing algorithm, V(t) virtual time changes at the rate of one per unit time. This will produce some discrepancy in fairness. This discrepancy can be re-calibrated by updating the overall virtual time after every packet enter and leave the system. Re-Calibration is the required bring the fairness. Fairness is the difference between services obtained from any two backlogged steams of in arbitrary duration.

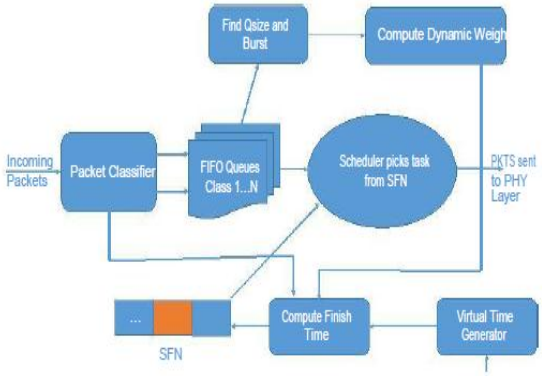

Fig. 1. Proposed Dynamic Scheduling algorithm

B. Weight adaption

In this dynamic queuing technique, scheduler observes the overall traffic loads from a multiple flow and the weighted is adjusted accordingly. Various parameter like buffer requirement, packet delay and number of active sessions will influence the weight adaption in this new scheduling algorithm. Dynamic queuing will provide more control to the scheduler to manage the output transmission link allocation than the static algorithms. Dynamic queuing algorithm takes decision instantaneously (packet-by-packet) and also capable of taking long term decision. In dynamic queuing algorithm, weight of the queue is based on the parameters like burst, queue size and the QoS requirement of an application. To provide the better QoS for a various service classes, algorithm will adjust the weight on short intervals. In this, queue weight will vary logarithmically with queue size and vary exponentially with burst size.

IV. CONCLUSIONS

The performance of proposed dynamic weighted fair queuing algorithm improves the throughput, delay, fairness and packet drop rate when compared to WF2Q+ and WRR. This implementation or simulation considers the different kind of data to measure the required results based on the QoS requirement. This modified algorithm will introduce little discrepancy among the packet scheduling compared to WF2Q+. But this discrepancy will be minimal.

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