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Optimized Uplink Scheduling Model through Novel Feedback Architecture for Wimax Network

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Abstract-Broadband Wireless Access has drawn the fine attention due to the wide range of data requirement and user mobility all the time. Moreover, WiMAX provides the best QoE (Quality of Experience) which is based on the IEEE 802.16 standards; this includes several services such as data, video and audio. However, in order to provide the effective and smooth experience i.e. QoS scheduling plays one of the critical part. In past several mechanism has been proposed for effective scheduling however, through the research it is observed that it can be furthermore improvised hence in this we propose a mechanism named as OUS (Optimized Uplink Scheduling) which helps in improvising the QoS. In here, we have proposed a novel feedback architecture and proposed optimized scheduling which helps in computing the bandwidth request this in terms helps in reducing the delay as well as jitter. Moreover, the performance evaluation is performed through extensive simulation by varying the different SS and frequency and the results analysis confirms that our mechanism performs way better than the existing algorithm.

Keywords: Wi-MaX, Scheduling, QoE, MUS, Feedback.

I. INTRODUCTION

There has been always requirement for the higher communication speed this communication speed is not only for the information transmission but also for the things to move faster and for the more efficient process, this made the development of wireless technology .moreover, there has been always need for the novel technology in the wireless communication.

In recent days, WiMAX has become one of the rising wireless technology and it delivers the broadband access services to enterprises as well as residential customers in way that is more economical. Moreover, Wi-max is nothing but an alternative to the wire technologies such as DSL, cable modems in other words it is standardized wireless version of the Ethernet [1]. WiMAX performs as similar to the WiFi but have several advantages over the WiFi such as larger distances and covers more number of users. Moreover, It overcomes physical limitation of wired technologies [2].Wireless technologies uses the radio waves as the medium, it possesses several characteristics such as mobility, reachability, roaming services, maintainability and roaming services. In a similar fashion Wi-MaX, have the some characteristics such as [3]:

- WI-MAX is Worldwide Interoperability for microwave access.
- The network in WiMAX is based on the wireless technology of MAN.
- It has mainly two types i.e. portable usage model and fixed usage model, It provides the certificate which IOE (Interoperability of the equipment) built to match the compatible standards.
- It supports the high bandwidth when the deployment of spectrum is on the larger side.

WiMAX is based on the standard of 802.16 IEEE standards and it offers better performance than the Wi-Fi in terms of range, scalability, bit rate and quality of service. Moreover, each connections in the uplink directions are mapped for schedule service.

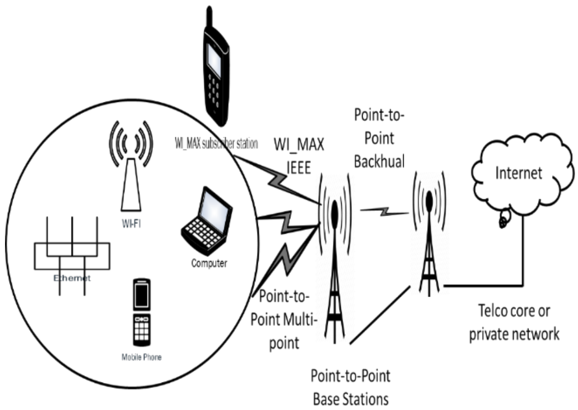

Figure I WimaX Architecture

The above figure shows the typical diagram of WiMaX architecture [4], there are two types of WiMaX deployment i.e. P2P (Point to Point) and P2M (Point to Multipoint) [5]. P2P is used where there is only two point of interest i.e. sender and receiver, In P2M is the where the distribution is from the single point to the various receiver. Bandwidth request is defined as the mechanism, which is used for SS to indicate the Base Station for the requirement of uplink band allocation. Moreover, wireless communication has become most efficient to exchange the information, this lead to increase in bandwidth. However, one of the important factor is meeting the QoS, QoS can be defined as the performance guaranteed by the particular technologies in terms of jitter, delay, throughput, collision, packet loss. In past several mechanism has been designed to achieve the highest QoS but most of them failed in several parameter such as low throughput, packet collision is more and the low packet transmission.

Hence in this paper we have proposed a mechanism named as MUS(Modified Uplink Scheduling) which improvises the QoS for URA (Uplink Resource Allocation) and this is achieved through designing novel feedback architecture, through the below point we have described the contribution of this paper.

- Our proposed mechanism is well balanced between the QoS and utilization.

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- Our methodology utilizes the WiMAX network resources
- Reduces the delay and jitter.
- Our mechanism stands firm against the different constraint.
- In our mechanism proposed feedback architecture has the where it holds the knowledge about packet mismatch rate among the arrival rate and service rate.

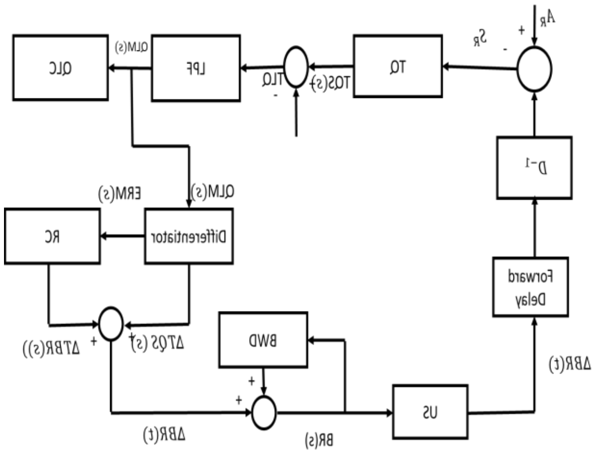
This particular research is organized in several different section; first section starts with the introduction about wireless network meanwhile later section includes the WiMax introduction and problem related to that. Meanwhile second section discusses the literature review of the several scheduling schemes discussed in past, proposed efficient scheduling is discussed in the third section and performance evaluation takes place in fourth section of this research.

II. LITERATURE SURVEY

Many existing researches has been studied and proposed few techniques, and their goal is to construct schemes and get effective scheduling approach for WiMAX. For the above purpose past established approaches utilized Weighted Fair Queuing (WFQ), Round Robin (RR) and Weighted Round Robin (WRR) algorithms [9, 10, 11, 12]. Moreover, above-mentioned algorithms are wont take details in deep with respect to WiMAX networks and these algorithms are common in these types of environment. Whatever the approaches they proposed which is categorized as channel unaware or else channel aware. Based on current information of channel state, channel-aware will make judgment. During decision time, first priority will be given to subscribers stations, which is having strong channel conditions. Overall result will give effective usage of radio resources, and also this will improve the efficiency of the system. The main issue with this technique is improper allocation. SSs having very poor condition in their channels will be waiting for significant intervals, on the other side channels having better condition will normally furnished. In terms of channel, unaware schemes, which will only concentrate on mechanisms of mac-layers and it, make assumption of ideal-channel condition. The main intension is to provide assured parameters of QoS like high delay-bound, fairness and low traffic rate. Few researches go through the past technique and made strict decision towards priority of inter-class bandwidth distribution [13]. Generally based on service-class only priority will be set, UGS > ertPS > rtPS > nrtPS > BE. In addition, setting of priority will based on few scenarios like packet-deadline or backlog-size. The bandwidth, which has been not utilized from high priority-flows, will be given to low priority-flows. This type of approach will not give any assurance towards proper bandwidth allocation. Likewise, because of strict-allocation, low-priority flows will be needy of longer-interval. In order to ignore the starvation present on low-priority flows, research [14] implemented DFPQ (Deficit-Fair Priority-Queuing that must be utilized for scheduling performed on inter class. Along with this, service class will also took under consideration in which it permits fixed no. of bandwidth in every single round. Research will not accept this scheme because this may leads to loss of real time-packets deadline. So overcome this problem, instead of using DFPQ they have designed preemptive DFPQ [15]. When rtps-queues are in non-preemptive state, they thought to set both BE and nrtps as preemptive. Non pre-emptive can utilize the additional fixed bandwidth for schedule-packets, while during this that might miss their deadlines as well. This will become very exciting when it comes to perform simulation on more frames. In research [16], they comes up with the WFQ algorithm utilization. From this algorithm, they obtained effective allocation bandwidth over real time flows. And, this will leads to longer delay. This algorithms only guaranteed on QoS in realtime-flows not for non realtime-flows [44] research says that, for inter class-allocation this research used scheduling approach WF2Q (Worst-case Fair-Weighted Fair-Queuing) [17]. Weight for every individual class is equal to Total no. of data rate in overall connection in that class. This is done by doing some modification in weight, which will leads to worst –case fairness and minimum data-rate. The main unsatisfied thing in this approach is complexity of O(n) as well as its not suitable for networks with high speed data. Little Research shows that above research which fails to implement easy and simple fair queuing method in WiMAX. They also claim that latency rate-control algorithm best for WiMAX scheduling. [18] Which also proposes WRR in order to perform intra-class-scheduling. Here in this they also mentioned that order of slots should specified by BS to reduce the delay and max. Jitter. The satisfactory result in this research is O(1) complexity and very simple model. In this approach, they have not mentioned how the weights are taken. Sometime it may leads to unfair allocation due to heterogeneous packet-size. Research [19] they established scheduling algorithm called channel-aware algorithm in BWA-system. They claims that DTPQ (Delay Threshold Priority-Queuing) performs best when there is presence of both non-real-time as well as real-time traffic. Instead of selecting fixed delay, this research choose ATBPQ (adaptive threshold-based priority queuing), which will concentrate on both channel-state condition and deadlines for users. Research [48], they implemented the TBBS (token-bucket based-scheduling) , in order to ignore the classes of low-priority-classes. They increase the bandwidth range, for every service-class, they set bandwidth maximum. Whenever it happens, priority will be reduced and service class become threshold. There is information about the fairness allocation. Research [20] designed algorithm called dynamic bandwidth-allocation, in which in each and every service class they considered the QoS requirements. Utility function utilize the weight assigned to each class, which is to evaluate the optimal scheduling. The main disadvantage of this method is it is built based on relay mode, so this will not be effective when it comes to point to multipoint-networks. Research [21] presented a method based on feedback got from channel state via CQI (Channel Quality Indicator). There is feedback mechanism located at MAC layer receiver side. This will give the reviews to transmitter. This feedback will convert the payload by fragmentation. The resultant value of the dynamic modification of size of the PDU gives corrupted and dropped packets. So, it determines high throughput and low end-2-end delay. Here QoS give for real time traffic.

III. PROPOSED METHODOLOGY

System Model



$$TLQ = ps\frac{TD - AD}{D} \qquad (1)$$

Figure II proposed architecture

The above diagram presents the proposed model of our approach, it shows the completely architectural view of our work, this contains the several parameter such as BR (Bandwidth Request), TQ (Transmission Queue), HPF (High Pass Filter), scheduler, controller. Here one of the side represents the bandwidth request from the SS and other side represents the BA (Bandwidth Allocation) by BS. Moreover, SS computes the BR with the help of RC and QLC, hence based on the BR the SR is computed through the US (Uplink scheduler). Moreover, the FWD (Forward Delay) and BCD (Backward Delay) is presented.

Let's consider a model of PMP (Point to mulit-point) architecture where the transmission takes place only among the subscriber and base station and where BS is responsible for all the communication that has taken place among them. Here all the transmission are directly affects the SoQoS (set of QoS) such as minimum traffic rate, tolerable delay. The connection among the subscriber can be of two type i.e. uplink or downlink and denoted by UPL (uplink) and DWL (Downlink).

OUB (Optimized Uplink Bandwidth)-Resource Allocation Algorithm

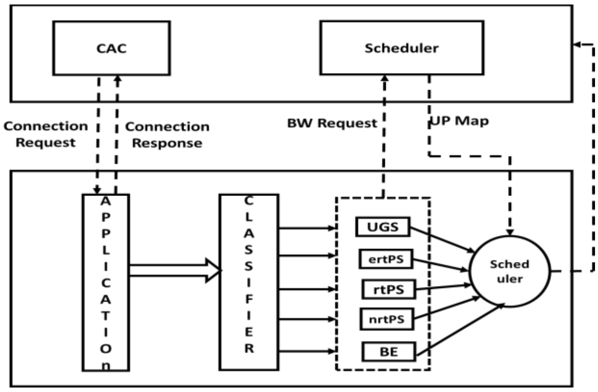


Figure III Modified uplink architecture

Moreover, QoS architecture for uplink direction is given in fig1, Here the traffic streams are parted into the five types of service requests. Moreover the Subscriber station pass out the acknowledge, in return the BS schedules the resources of the network such that the request from the SS can be managed throughout the given network. Hence, this scheduling is broadcasted through the UL Map, UL MaP is the one, which identifies the TT (Transmission Time) for each service. Bandwidth Request Algorithm In this particular section we develop an optimized BRA (Bandwidth Request Allocation) algorithm this is parted into two parts i.e. in first part we develop the design process and later part of the same includes the algorithm.

Target Delay

This is used for determining the bandwidth amount request, in here instead of reducing the delay we allow the target the value for increasing the efficiency for the bandwidth used. Moreover we set the M2M (Mac to MAc) between the subscriber station and base stations and it is denoted by TD. Moreover TLQ is represented though the below eqation.

TLQ is byte which is computed in terms of T_{ref} and T_a, meanwhile the delay is considered through below equation.

$$QD = TD - AD \qquad (2)$$

AD is extra delay at the given mac layer. Moreover TQS (Transmission Queue Size) can be denoted through TQS and the extra bandwidth as $\Delta TQS(s)$, for the ideal delay requirement there should be marginal increment in $\Delta TQS(s)$, $\Delta TQS(s)$ is computed using three different technique.

- Basic method: in here if δ_b amount of bandwidth is added if TQS crosses the threshold value and minimize the allocated bandwidth if it fails to reach the minimum value.
- Through the limit: In here, upper as well as lower limit is set for$\Delta TQS(s)$, this helps in avoiding any change.
- Through the function: In here, function is considered for the computation, here there is increase in $\Delta TQS(s)$ due to increase in inconsistency.

Novel Feedback Architecture

This approach is used for making the response fast as we know that the BRC (Bandwidth Request Control) is based on the queue length and hence it responds very slow. In here two types of approach is used i.e. Rate and QL (Queue Length). Let's consider the two terminology i.e. PSR (Service Rate) and PAR (Packet Arrival Rate) these both are denoted by S_R and A_R respectively. ΔBR is the Extra bandwidth , moreover the below equation calculates the mismatch in queue length, this in term gives the edge to compute.

$$QLM = TQS(s) - TLQ \qquad (3)$$

Mismatch in IoR (Information of Rate) is computed through the below equation which helps in computation of the$\Delta TBR(s)$.

$$ERM = A_R - S_R \quad (4)$$

The below equation represents the generalized form of total Extra bandwidth request which has the two particular component i.e. ΔTBR and ΔTQS as rate based and queue based.

$$\Delta BR = \Delta TQS(s) + \Delta TBR(s) = f(QLM(s)) + g(ERM(s)), \quad (5)$$

Algorithm

Lets consider the two linear function p () and q () in the above equation where C_{queue} and C_{rate} are the two constant Control Gain and $C_r e_r(t)$ acts as the saturation function.

$$\Delta BR(s) = [C_q QLM(s) + C_r ERM(s)]_{-}^{+}, \quad (6)$$

Moreover the mismatch rate discussed earlier is given through the below equation, this is computed in terms of QLM (Queue Length Mismatch).

$$ERM(s) = A_R(s) - S_R(s) = \frac{d}{dt}(TQS(s)) = \frac{d}{dt}ERM(s), \ for\ 0 < TQS(s) < MQS \quad (7)$$

MQS Denotes the maximum size of queue observed. For further evaluation of algorithm transformation has to be taken place from CT (Continuous time)-function to the DT (Discrete function) and this is done through sampling the interval of allocated bandwidth which is depicted in the below equation.

$$\Delta BA[i] = \Delta BA(iD) \quad (8)$$

i is positive integer, below equation is the first order derivative of equation.

$$ERM = \frac{d}{dt} \approx \frac{ERM[i] - ERM[i-1]}{D} \quad (9)$$

Moreover, the QLE (Queue Length Error) is calculated to get rid of unanticipated change, and denoted as $ERM[i]$.

$$QLM[i] = (1 - wt)ERM[i-1] + wtERM[i], \quad (10)$$

w is the weigh factor and the BR(Bandwidth Request) is computed through the below equation

$$\Delta BA[i] = \left[\left(C_q + \frac{C_r}{C_a}\right)\bar{T}[n] - \frac{C_r}{D}QLM[i] - 1\right]_{-}^{+} \quad (11)$$

The above equation describes the either reduction or increase in BR in given interval, once the $\Delta B[n]$ ios computed the SS gives the acknowledgement to the BS about the BR. Moreover if $\Delta B[n]$ is greater than zero then it is carried through the aggregated and incremented modes else if it is less than zero then the BR is computed through the below equation.

$$BA[i] = maximum(BA[i-1] + \Delta BA[i],\ BA_{minimum}\ ), \quad (12)$$

Optimization

The above problem is solo9ved through the minimizing the non-used bandwidth allocation and the network capacity which is given through the below equation.

$$minimize \sum_i |A_R - S_R| \quad (13)$$

$A_R(s)$ Indicates the arrival rate flow f, $s_f(s)$ is the service rate of the same, moreover target delay is given by $TD_{,f}$ $d_f(s)$ is the M2M delay. Moreover, the wastage of bandwidth is reduced through stopping the buffer underflow. Above equation represents the optimization problem.

System Function

Here we have consider the CT (Continuous Time)-Model

$$QLM(s) = A_R - S_R \quad (14)$$

The above equation is rephrases from the equation 4 and similarly below equation is obtained from the equation 6.

$$QLM(s) = \frac{wt}{T_a}(QLM(s) - QLM(s - D)), \quad (15)$$

Similarly (16) is derived from equation 4 and equation 5 by ignoring the saturation function for controlling model.

$$\Delta BA(\dot{s}) = C_q QLM(s) + C_r QLM(s), \quad (16)$$

Moreover (17) is the modified version of (8), in here we have assumed

$$BA(s) = \dot{\Delta} BA(s)/D \quad (17)$$

$$S_R(s) = \propto \frac{BA(s - D)}{D} \quad (18)$$

Eq (13) is computed by assuming the BA[i]>=BA_{min} $\forall n$and equation 14 represents the service rate of SS, it is the total bandwidth allocated. Though the below equation we investigate the stability of the proposed architecture, this is achieved through performing the integral transform on the equation (14)-(18).moreover the below equation. This particular function depends on the two parameter i.e. weight actor and allocation interval.

$$f(T) = \frac{QLM(T)}{A(T)} = \frac{T^3 + \frac{1}{T_a)}T^2 + \frac{\omega t}{T_a^2}T}{T^4 + \frac{1}{T_a}T^3 + \frac{\omega}{T_a^2}T^2 + \frac{\propto \omega}{T_a^4}(C_r T + C_q)} \quad (19)$$

IV. PERFORMANCE EVALUATION

In this section, we evaluate our mechanism of modified scheduling, in order to evaluate the performance, we have used the system configuration as windows 10 of 64bit loaded with 8GB

RAM and 2GB NVidia graphics i.e. CUDA enabled. Simulation is done through the .Net framework and it is programmed by using C sharp language. Moreover, Point-to-Point architecture has been used, this architecture is composition of several base station and subscriber station

SIMULATION PARAMETER

Table 1 simulation parameter

Network Parameter	Value
Network Size	50m * 50m
Number of base station per region	1
Number of subscriber station	50, 60 &70
Modulation scheme	QPSK, QAM-16, QAM-64
Coding rates	QPSK (3/4), QAM-16 (1/2, 3/4), and QAM-64 (2/3, 3/4).
Number of Frequency Channels	7
Number of time slots	8 µs
Bandwidth	9 to 27 Mbps
Message information size	27 bytes

Successful Packet Transmission

In this sub section of the performance evaluation, we present the graphical analysis of successful packet transmission comparison of existing and proposed system. Moreover, this is done by varying the number of subscriber and number of frequency slot. Fig4, Fig5 and Fig 6 shows the successful packet transmission of 50, 60 and 70 subscriber stations. These graphs are varied through the time interval, in the below figure graph is plotted as packet transmitted vs time interval. Through the graph, we observe that our model performs better than the existing one.

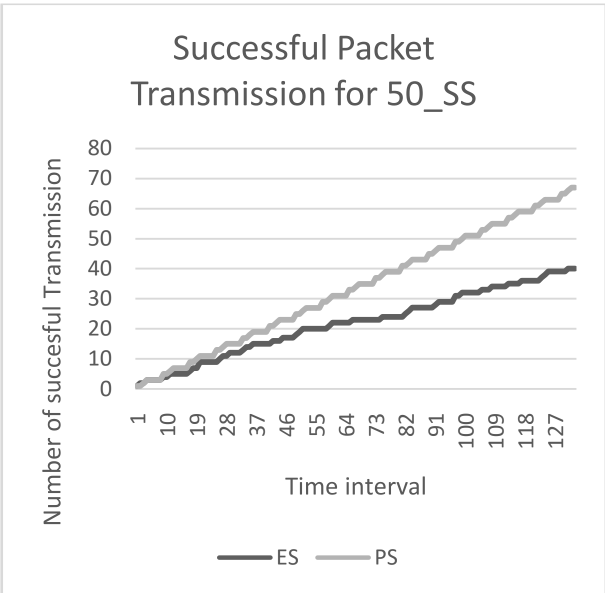


Figure 4: packet transmission in case of 50 SS (Subscriber station)

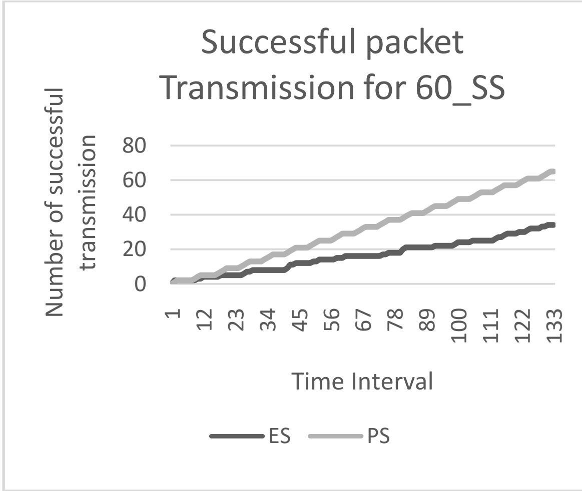


Figure 5: packet transmission for 60 SS

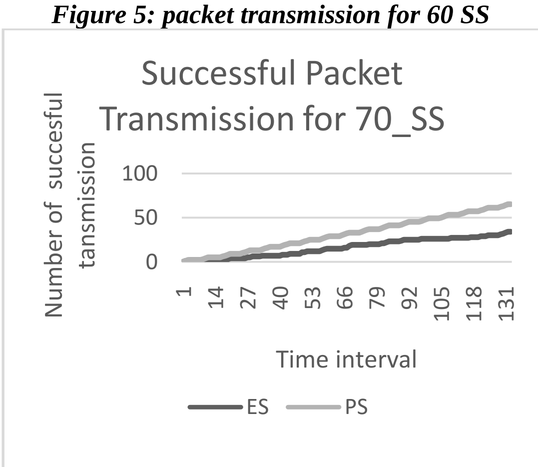


Figure 6: packet Transmission for 70 SS

Frequency Variation

In below graph i.e. fig 7, fig 8 and fig9, comparison is done by varying the frequency. X-axis depicts the time interval and y-axis depicts the packet transmitted. Here the subscriber station is kept constant i.e. 20 and frequency slot is varied as 10, 12 and 14 respectively. Moreover, with the different time interval we see that the packet transmission is more than the existing this clearly shows the efficient mechanism.

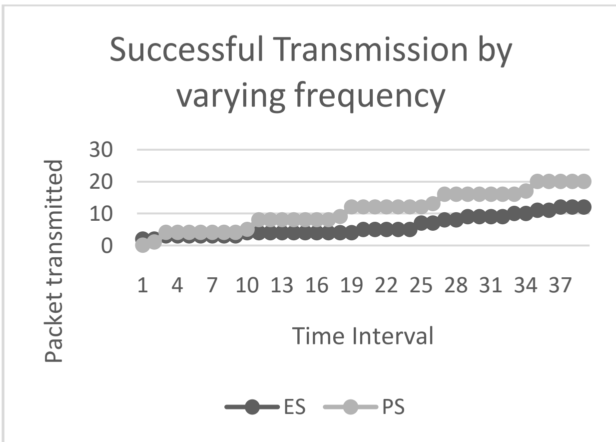


Figure 7: Packet Transmission for frequency 10

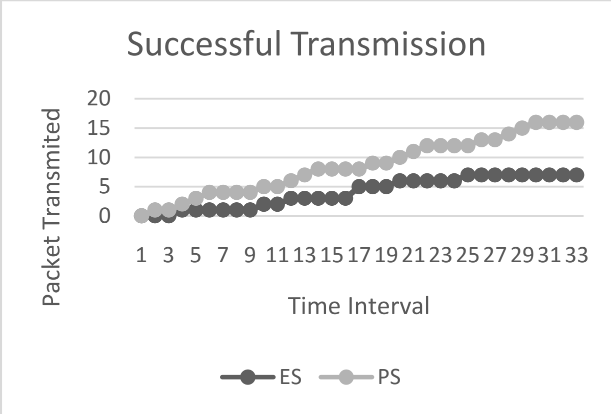


Figure 8: packet transmission for frequency 12

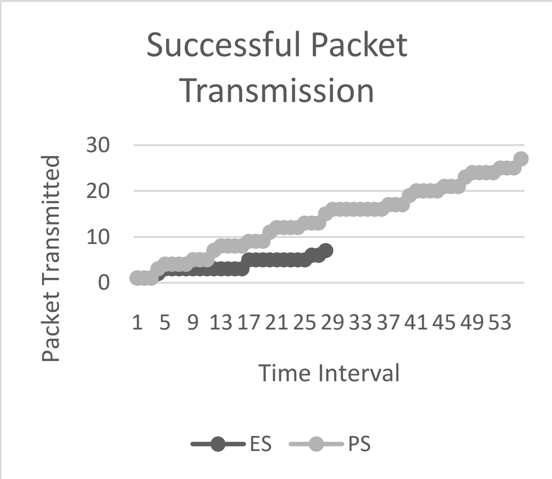


Figure 9: packet transmission for frequency 14

Packet Collision

Packet Collision is nothing but the result of any two packets on the same network trying to transmit the data at same time. It is one of the eminent parameter for comparing the performance evaluation of any mechanism. Fig 10 show the Average packet collision by varying the subscriber station i.e. 50, 60 and 70, from graph it is clear that the packet collision in proposed mechanism is marginally less than the existing, this particular analysis gives the more advantage.

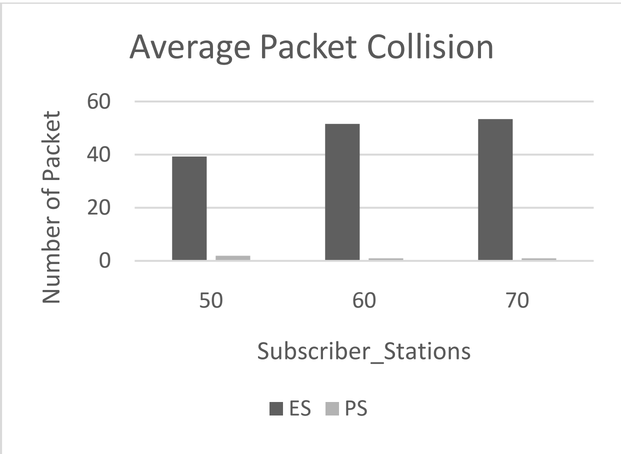


Figure 9: Average Packet collision comparison with different SS (subscriber station)

Average throughput

Throughput is defined as the rate of production, higher throughput indicates mechanism that is more efficient, hence this is consider as one of the parameter to evaluate our mechanism. In the below graph the computed throughput is compared with the existing mechanism and our mechanism shows the marginal improvement when compared to the existing mechanism.

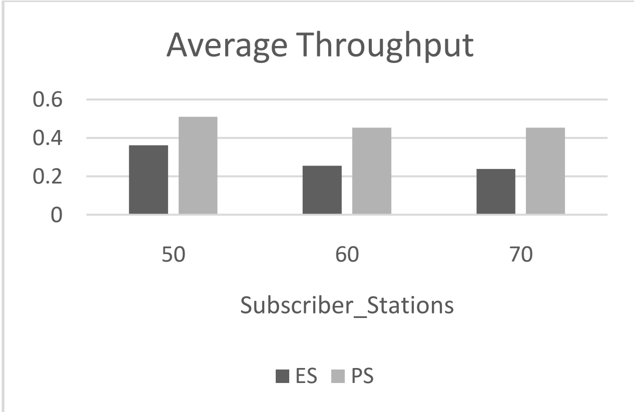


Figure 10 Average Packet throughput comparison by varying different subscriber station

V. CONCLUSION

The acceptance as well as contribution of WiMAX in the real time scenario has led for the possibility of implementation in various ways. However maintaining high QoS is main concern in the real time scenario, hence in this paper we have proposed scheduling algorithm named MUS (Modified Uplink Scheduling) model for the WiMaX network, which helps in achieving the higher QOS. The main aim of our mechanism is to increase the throughput and minimize the packet loss and delay. In order to achieve the two-way architecture is constructed i.e. novel feedback architecture. Moreover, In order to prove the efficiency of our algorithm we have performed the simulation by using various scenario. In this entire scenario, our mechanism outperform the existing mechanism.

Moreover in coming future channel condition has to be looked and the cure for faulty channel and moreover the bandwidth wastage also can be another aspect one should look into, moreover in future the scheduler has to be designed in such a way that can have the dynamic approach.

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