

# Scheduling Algorithms Implemented For Resource Allocation in Ofdma-Femtocell Based Systems with QoS Constraints for CBR and VBR Data Transmission

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**Abstract**— In this work we consider the problem of resource allocation for proportional fairness of long term received rates of data users and quality of service for real time sessions in an OFDMA-Femtocells based system. The network allocates available subchannels and subcarriers to individual users based on long term average received rates, quality of service (QoS) based rate constraints and channel conditions. The PF scheme generalizes the basic idea of proportional fair scheduling (PFS) algorithm and considers not only the network traffic, but also the user throughput and packet delay before making the final decision. Compared with the traditional MLWDF and Greedy scheduling, the proposed PF scheduler algorithm can obtain larger system throughput for Constant bit data and lower average packet delay with approximately the same user fairness and MLWDF and Greedy will show better results for the VBR. Simulation results verify that the PF, MLWDF and Greedy schemes are able to make a better tradeoff between system throughput and user fairness and will minimize the PLR in comparison to each other. In this paper, we consider all the three Quality of Service (QoS) parameters namely: (i) packet loss rate (PLR), (ii) fairness and (iii) sum throughput. Corresponding to the three metrics we propose a scheduling strategy which has three stages. From the quality of service (QoS) perspective of real time traffic, it is necessary to give main concern to minimize packet loss rate (PLR) which maximize fairness and maximize throughput simultaneously. LTE simulation model are presented that is considered in this paper.

**Index Terms**—Orthogonal Frequency Division Multiple Access, Physical Resource Block, Femtocell Management system, Femtocell, User Equipment, Proportional Fair, Maximum Weighted Delay First, Home Node, Packet Loss Ratio, Variable bit rate, Constant bit rate.

## 1 INTRODUCTION

Increasing number of users demanding wireless Internet access and a growing number of wireless applications require high speed transmission and efficient utilization of system resources such as power and bandwidth. Recently, technologies like Wi-Max (based on IEEE 802.16 standard) and Long Term Evolution of 3GPP LTE standards are standardized to address these challenges. Orthogonal frequency division multiple access is a multi-carrier transmission technique which is the preferred as the transmission technology in next generation broadband wireless access networks which is based on a large number of orthogonal subcarriers, each of which works at a different frequency. OFDM is originally proposed to combat intersymbol interference and frequency selective fading. However, it also has a potential for a multiple access scheme, where the subcarriers are shared among the competing users. Within orthogonal frequency division multiplexing access (OFDMA) framework, the resource allocated to the users appear in three proportions: Time slots, frequency, and power. This requires the scheduler to operate with higher degree of freedom and more flexibility and potentially higher multiplexing capacity. This also decreases the resource allocation problem and makes the problem less. Resource scheduling is one of the important problems in wireless communication research. A reasonable scheduling algorithm can not only greatly improve the system throughput but also guarantee the QoS requirements and fairness among users. Proper scheduling strategies can be applied in OFDMA-Femtocell systems, and so that the multiuser diversity in both time and frequency domains can be achieved. Resource scheduling becomes a important factor and challenging when the relay techniques are introduced into the OFDMA-Femtocell networks systems. The purpose of the resource scheduling in relay based OFDMA based femtocell networks is to achieve reliable and high-speed communication. In, the relay based cellular systems, the optimal subchannel and subcarrier allocation

and selection problem is studied and a fast heuristic method based on the sorted sub-channel gains is proposed in [7]. However, the average packet delay and loss of each user is not considered in the scheme. Inspired by the basic idea of the traditional proportional fair scheduling, i.e., the scheduler allocates the resources among the users not according to their request rates but based on the rates normalized by their respective average throughputs. In our proposed scheme, a reasonable decision can be made due to considering not only the user data rate but also the packet loss ratio, fairness and throughput during the scheduling process. Simulation results demonstrate that our scheduling scheme can make a better tradeoff between system throughput and user fairness, throughput and PLR in comparison to other schemes such as MLWDF and Greedy for CBR but for VBR MLWDF and Greedy do justice.

## 2 PROBLEM STATEMENT

There are three main issues that need to be considered in multiple access resource allocation. The first one is cell spectral efficiency, which means achieving maximum total throughput with available bandwidth and power. The second issue is fairness. Last, but not the least is Packet-loss Ratio (PLR) which verifies the QoS. The QoS attained in both CBR and VBR is different. MLWDF and Greedy are designed basically for VBR transmission and for CBR PF is assigned.

## 3 PROBLEM MODELLING

In this a network model is suggested which has the FMS, Femtocell Management System which administrate the Femtocells attached with it. With Femtocells mobile devices such as laptops, mobile phones etc. which are known as User's Equipment are connected to the FMS via DSL. This is shown in figure 1. The methods described to allocate fixed subchannels to a femtocell, where a subchannel is composed

of several PRBs within the same frequency band. Certain PRBs in the allocated subchannels may be used by the femtocell, depending on the traffic conditions. If the PRBs in the subchannels are not fully utilized, the remaining PRBs cannot be reused by other femtocells and are wasted. Through the proposed PF algorithm, all PRBs in a frame can be assigned in fixed channel assignment. By, this PRB efficiency can be improved and can be assigned to more femtocells.

Femtocell possesses a self-organization strategies in which femtocell organize them automatically. This is a very crucial and important stage in femtocell. It involves both self-configuration and self-initialization process within it as shown in figure 2.

## 4 PROPOSED METHOD

PF scheduling algorithm has also been proposed for High Data Rate system and it selects a user according to the ratio of the user current channel rate and the user average channel rate, which provides high-quality performance in terms of fairness, throughput and PLR for CBR. Proportional fair is a compromise-based scheduling algorithm. It's based upon maintaining a balance between two competing interests: Trying to maximize total [wired/wireless network] throughput while at the same time allowing all users at least a minimal level of service. This is done by assigning each data flow a data rate or a scheduling priority (depending on the implementation) that is inversely proportional to its anticipated resource consumption. However, when variable bit rate (VBR) traffic is considered under different channel conditions for user, PF scheduler's performance decrease. MLWDF scheduling algorithm selects a user according to the user current channel condition, user packet delay and user Quality of Service (QoS) requirement. Most existing scheduling algorithms for packet data systems select one user to service with full transmit power in each time slot. However, this is not optimal when the traffic is busy and there are delay constraints. The Modified Largest Weighted Delay First (MLWDF) rule has been shown to be throughput-optimal for single-user dynamic time slot allocation, i.e., it is able to keep all the queues stable if at all this is feasible to do with any algorithm. However, when variable bit rate (VBR) traffic is considered under different traffic conditions for the user, schedulers' performance decrease. Scheduler cannot guarantee the QoS requirement to be achieved in some cases and PF scheduler cannot achieve a good fairness among the users in VBR traffic and MLWDF scheduler in CBR traffic. So, in this work, we also propose a new scheduling algorithm i.e. Greedy Algorithm to enhance M-LWDF and PF schedulers performance. Greedy scheduler algorithm selects a user according to the input traffic characteristic, current channel condition and user QoS requirement which consists of a delay value with a maximum violation probability. Properties of the scheduling algorithm are investigated through simulations with constant bit rate (CBR) and VBR flows and performance comparisons with M-LWDF and PF schedulers and Greedy are made. The results show performance of the proposed schedulers by comparison. Greedy algorithms construct a

solution piece by piece by always choosing the next piece that offers the most obvious and immediate benefit without considering the future consequences. A greedy algorithm for an optimization problem always makes the choice that looks best at the moment and adds it to the current sub solution. Greedy algorithm will be used for providing resources such as coverage signals, finding path, femtocells requests from different connections with different number of PRBs etc. according to the Quality classes required by users. M-LWDF scheduler cannot guarantee the QoS requirement to be achieved in some cases and PF scheduler cannot achieve a good fairness among the users in VBR traffic. So, in this work, we only propose PF schedulers for CBR fairness and compared its fairness with the MLWDF and Greedy which are for VBR. Proposed scheduler selects a user according to the user input traffic characteristic, channel condition and user QoS requirement. Properties of the proposed scheduling algorithm are investigated through simulations with constant bit rate (CBR) and VBR flows and performance comparisons with M-LWDF and PF schedulers and Greedy are made for CBR data only. The results show performance of the proposed schedulers by comparison.

## 5 SIMULATION RESULTS

Simulation has been done on LTE-Sim which has been designed for 3GPP LTE networks especially for OFDMA-Femtocell networks. Here, we have considered the system for 20 users. For this, we need to install Linux in our system. LTE is used to simulate LTE networks. It encompasses numerous aspects of LTE networks including E-UTRAN and EPS. It supports single and multi-cell environments with QoS management, user mobility, handover procedures etc. LTE-Sim has been written in C++, using object-oriented paradigm, as an event-driven simulator. Its main classes handle network devices, protocol stack entities, physical layer and network topology. In creating a basic scenario the following criteria should be followed: (i) Create an instance for simulator, network manager, flows manager and frame manager components. (ii) Create cell, E Node B and UE objects using methods of the network manager class. (iii) Create applications defining for each of them the data radio bearer type (GBR or non-GBR), IP class Identifiers, QoS parameters. (iv) Create four basic LTE-Sim components (network manager, frame manager, flow manager and the simulator).

Main LTE Performance Parameters:

Peak data rate	Downlink: 100mbps Uplink: 50mbps
Spectral Efficiency	2-4 times better than 3G networks
Cell-edge bit rate	Increased
User plane latency	Below 5ms for 5MHz B.W. or higher
Mobility	Optimized for low mobility up to 15km/h High performance for speed up to 120km/h Maintaining connection up to 350km/h

Scalable B.W. RRM	From 1.4 to 20 MHz Enhanced support for end to end efficient transmission
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#### Discussion of the results:

The first Result 1 is shown between the fairness and the number of users by infinite buffer. As, it is clear from the below result that the fairness index is increasing when the number of users are up to 10. As, the number of users are increasing and reaches upto 15 a slight decrement is noticed. And, finally when the number of users crosses 15, a huge decrement is noticed. Fairness is the term used for the transmission of data properly without interference, packet loss and in a faired/good manner. Result 1 shown below. As, it is clear from the result that MLWDF and Greedy have the almost similar results for the same number of users. But, PF is showing better result in comparison to both for constant bit data.

The next Result 2 is shown for the packet loss ratio (PLR) and the number of users for infinite buffer. This is also for the infinite buffer criteria which is for constant bit data transfer. As, it clear from the result that PLR is maximum for the MLWDF and it is less for Greedy. As the numbers of users are increasing PLR is increasing. But, in case of PF scheduling it gives a straight line at the base which shows that the PLR is minimum for the CBR data.

Now, the Results 3 are shown for the VBR throughput data verses Number of users. As, MLWDF and Greedy are designed for VBR data transmission only and PF is designed for transmission for the CBR data. So, the result for the infinite buffer for CBR data gives the better result in comparison to MLWDF and Greedy as it will satisfy the demands of the traffic.

The Result 4, is for the cell spectral efficiency. In this, the spectral efficiency is better for PF than MLWDF and Greedy. As, our cells are fully utilized in case of CBR transimission.

Here, the Result 5 is for the video delay vs number of users. As, it is clear from the graph that the delay in MLWDF and Greedy is negotiable but it is very large in case PF.As, PF is designed for CBR data so it carries a large delay as all the data is transmitted at the same time. But in case of Greedy and MLWDF data transmitted is VBR. So, we have minimized the delay in VBR in comparison to CBR data transmission. The data considered here for the transmission is the Video which is bursty data. From this result it is clear that that the delay is negotiable even when the number of users are increasing in case of MLWDF and Greedy. But, as the number of users are increasing in case of CBR data i.e. PF will be assigned the delay is increasing as the number of users are increasing. Here, the data considered bursty i.e. video transmission.

Now, the Result 6 is for the video fairness index in which the fairness is decreasing for the MLWDF and greedy but it have a constant video fairness index for the PF scheduler. As, the fairness index for the video high stream data fairness is maintained for CBR data. Due to constant bit rate data the fairness is maintained because it has to transmit data at constant bit rate which avoids interference, data loss, fading etc. But, for the Variable bit rate data stream the Greedy

provides better result in comparison to MLWDF which is also designed for Variable bit rate data. So, fairness is maintained at its best in the PF for CBR.

Next, the Result 7 is shown for Video Packet Loss Ratio (PLR) and the graph is shown between the PLR and Number of Users. In case of PF, the packet loss is higher and is increasing at a faster rate as the number of users will increase. As, PF is made best for the Constant bit data transfer so, it will not be able to maintain a high data stream traffic i.e. video and packets/data will be lost during transmission. Greedy is doing best for VBR data transmission in comparison to MLWDF as the numbers of users are increasing.

The Result 8 is shown between the Video-VBR Throughput vs the number of users. As, it is clear from the result that the throughput of the variable bit rate data is increasing as the number of users are increasing in case of video or high stream data. But, in case of PF which is for the CBR (Constant bit rate) data is not increasing as the number of users are increasing. Instead, it is maintained constant at a particular level. So, in MLWDF and Greedy the throughput is not degrading which is best as for our result. For, Variable bit rate data these two scheduling strategies are working well and providing the best results.

The next Result 9 is for the VOIP Delay vs the number of users. Let us clear about VOIP. Voice over IP (VoIP) commonly refers to the communication technology and transmission technique which involved in the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks. Internet telephony refers to communications services such as voice communication, fax, SMS, or voice-messaging applications that are transported via an IP network. It is clear from the graph that VOIP delay is maximum for CBR data assigned by PF. But, for the variable rate data MLWDF and Greedy are providing no delay. Both the scheduling are giving the same results for it (the lines are at the base). Hence, both are working best for VOIP delay. In this, the increment in the number of users is not affecting the delay.

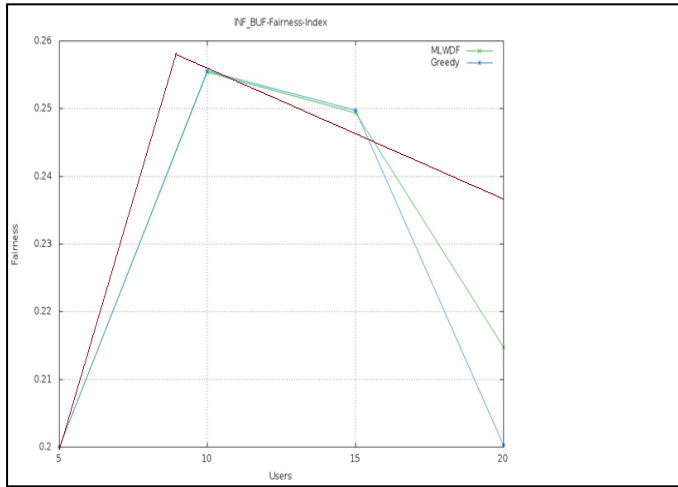
In Result 10, it is for the VOIP Fairness Index vs the number of Users. In case of fewer users i.e. 10, the fairness of VOIP is good and is decreasing after words when the numbers of users are increasing. This is the case of MLWDF and Greedy. But, if we see the PF it is giving the constant fairness throughout the transmission. In it the fairness is not decreasing with the number of users. It is stabilized. In graph it is clear that the MLWDF and Greedy are providing almost the same results for the same number of users.

The next Result 11 is in between the VOIP-VBR throughput and the users. Now, it is clear from the result that VOIP-VBR throughput is increasing for the case of Greedy and MLWDF. But, it is low and constant for the CBR type data.

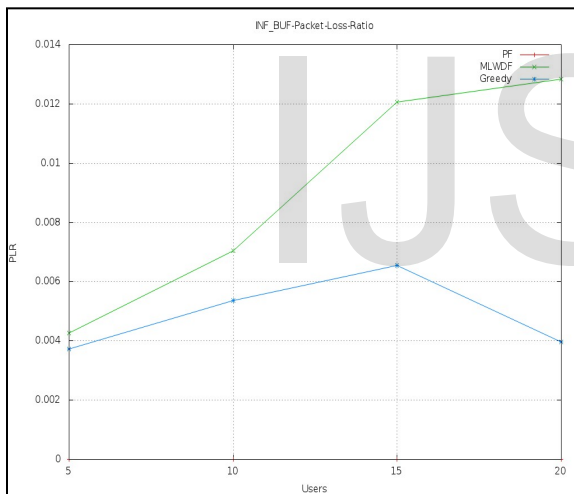
The next and final Result 12 is in between the VOIP Packet loss ratio and the number of users. From the graph below it is clear that the packets are lost more in constant bit data transfer in comparison to variable bit data transfer. As, PF works best for the CBR data and MLWDF and Greedy works best for the VBR type of data. And from graph it is clear that the packets are lost in the PF with the increase in the number of users. But,

for the MLWDF and Greedy less or negotiable packets are lost with the increase in the number of users.

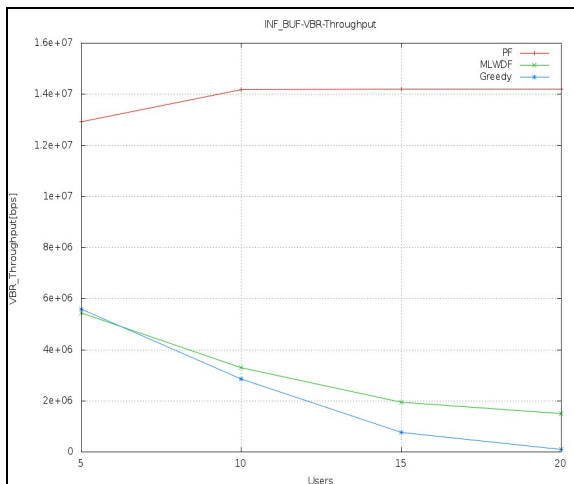
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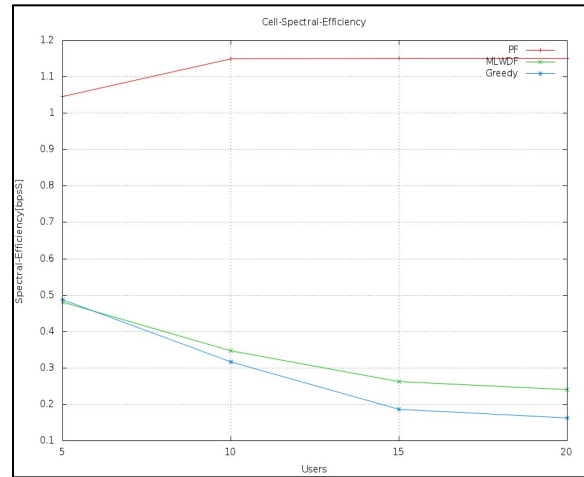
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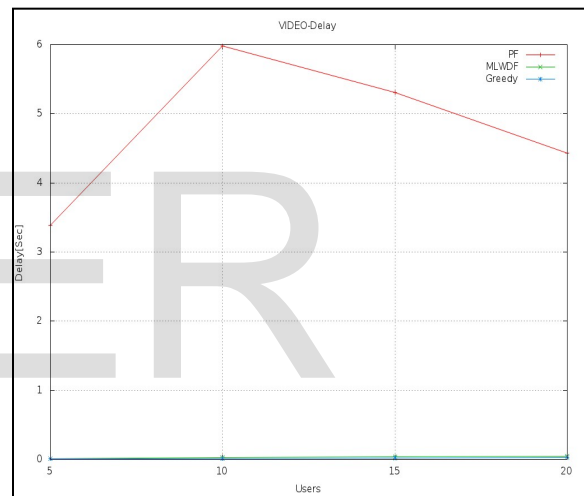
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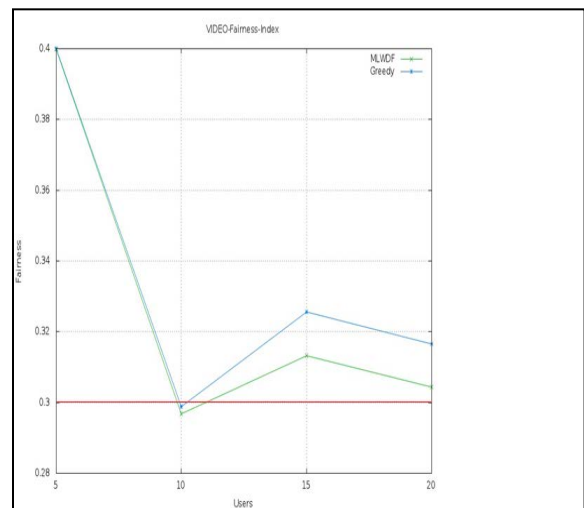
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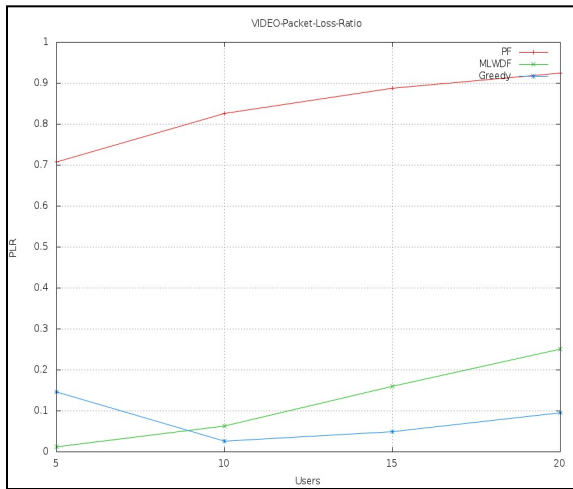
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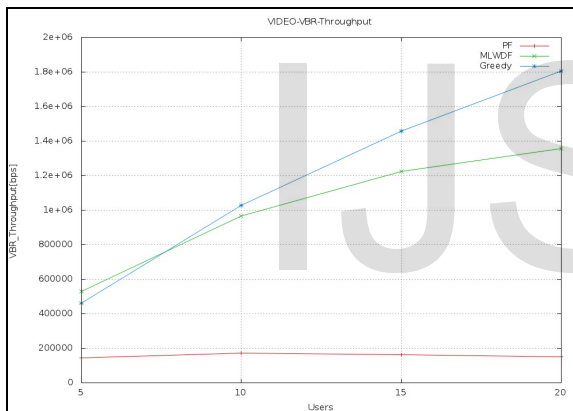
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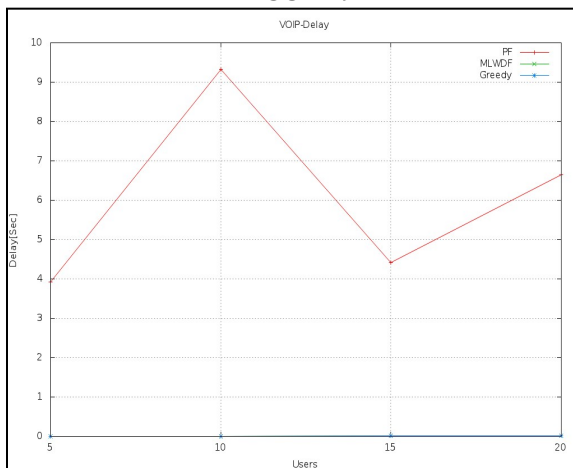
**RESULT 7**



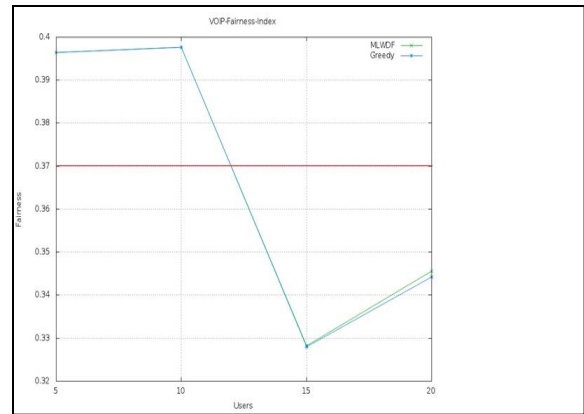
**RESULT 8**



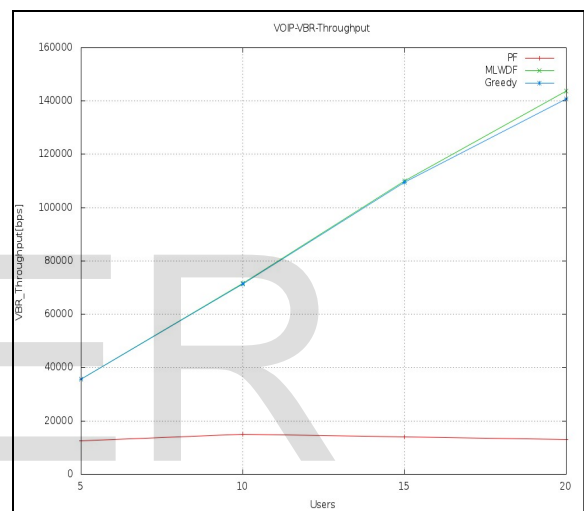
**RESULT 9**



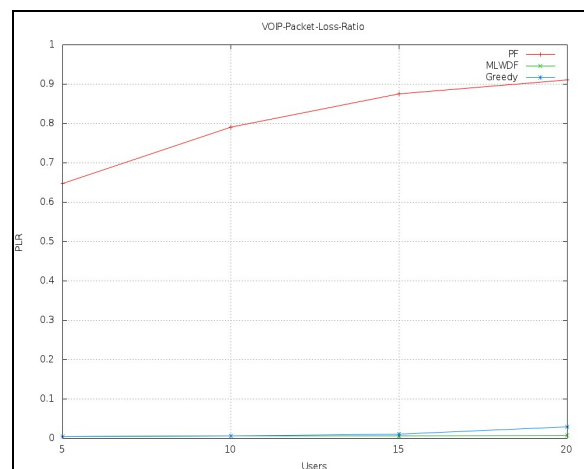
**RESULT 10**



**RESULT 11**



**RESULT 12**



**6 CONCLUSION**

As, our suggested approaches are designed for both the Constant bit data transmission and as well as for the Variable

bit data transfer. MLWDF, Greedy and PF are the three approaches on which work is done. PF deals with the CBR data transfer and MLWDF and Greedy are designed for the VBR type data transfer. For different applications, all the three schedulers are designed. It is clear that from the results that PF is doing best for the CBR type data and other two are working best for the VBR type data. Different applications are designed considering all the three schedulers. And, comparison is done to differentiate among them and noticed that PF is giving best results for the CBR type data and MLWDF and Greedy are working best for the VBR type data.

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