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SCHEDULING ALGORITHM FOR MULTI-USER DIVERSITY IN URBAN AREA

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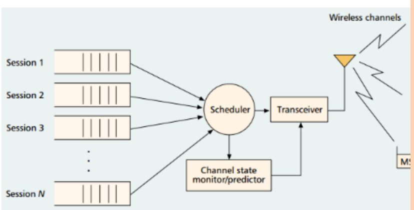
Graphical abstract



Abstract

Generally knew that population density in the city is coupled with an increase in ownership of smart phones equipped with a wireless system which allows everyone to have access to the internet at any time anywhere. However, most of the wireless cellular network depending on the network to reliably and efficiently distribute data to a large number of users. We demystify the problem of radio resource sharing by users with different requirements. We present four types of scheduling algorithm which is adopted for allocating system resource. Here we will analyze the wireless connection attribute such as fairness, throughput and delay occur during users demanding for different services. Max Rate and Round Robin algorithm were used as a reference for analysing throughput and fairness respectively. Meanwhile, Proportionally Fair Scheduling and rate Craving Greedy attain in the concept of multiuser diversity by improving the throughput without deal fairness. Our scope is based on the urban area and pedestrian uses because only one fading channel that were used – Filtered Gaussian Noise. Common technique that used to transmit signals in wireless is OFDM. The performance of these algorithms is analyzed and compared through MATLAB computer simulations.

Keywords: Algorithms, fairness, throughput, delay, multiuser diversity.

1.0 INTRODUCTION

In our rapidly growing wireless environment, scheduling algorithm is the most important component in ensuring the quality of service (QoS) parameter such as fairness, throughput and delay met its target for many applications. Providing QoS guarantees becomes challenging with added complexity of wireless and mobile networks. At the same time, entities such as the rapidly growing internet is being used by many users added with various deals of mobile applications. The emergence of various applications with differences in service quality requirements emphasizes the need network capabilities to support different level of service compared to a single best effort level of service. For this reason, an effort has been applied to the task of finding ways to provide reliable network performance while at the same time utilizing the total network resources in efficient manner.

By employing scheduling algorithms, all applications can meet the wide-ranging QoS requirements. Schedulers operate across different flows in order to ensure that reserved throughputs and bounds on delays and loss rates are met [1]. As illustrated in Figure 1, the function of a scheduling algorithm is to select the session whose head-offline (HOL) packet is to be transmitted next. This selection process is based on the QoS requirements of each session. Each mobile station (MS) can support one or more sessions at any given time [2].

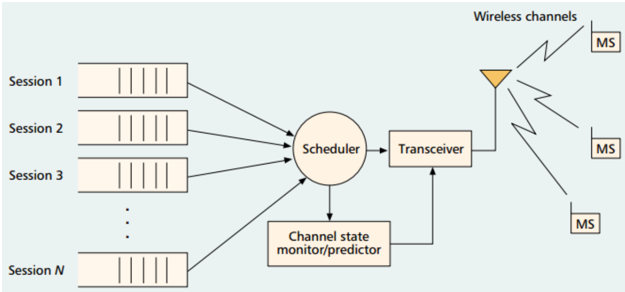


Figure 1 A typical wireless scheduler

Basically, we have a general idea of the concept of multiuser diversity in a wireless coverage area gets. However the problem is wireless coverage is limited by the available bandwidth because the implementation of the latest wireless technology does not provide the same bandwidth as a wired connection [3]. To conserve the throughput of multiple packet-data service for users who shares the wireless channel while maintaining fairness, many scheduling algorithm was performed in various scenario. Fairness is also a key feature of the wireless environment, where system resources are shared in a variety of situations of various scheduling policies are introduced and discussed. Meanwhile, the throughput is the most important part of the information system since it is considered within a framework that optimizes the system performance that measure of how much information can be transmitted and received per unit time with a negligible probability of error [4].

2.0 THEORY

Approach to simulation of fading radio channels is to construct a fading signal from in-phase and quadrature Gaussian noise sources. The output of the simulation brings out envelope of a complex Gaussian noise process that has a Rayleigh PDF. As an addition to this approach, by applying the appropriate filtering to the Gaussian noise sources provides the Doppler spectrum of the channel of interest [5].

OFDM is a technique that we used for the transmission of signals over wireless channels. Frequency-selective channel were converts by OFDM into a parallel collection of frequency flat sub-channels [6]. In order to maintain orthogonally of time domain waveform, the separation of sub-carrier must be minimum so that signal spectra corresponding to the different sub-carriers overlap in frequency. That is why available bandwidth was used efficiently. If the information from the channel can be get from the transmitter, meaning that OFDM transmitter can adapt the signal with strategy to match the channel.Radio wave propagation in urban areas is complicated areas and the analytical description of this process cannot be presented without some simplifications for the real radio link situation. Besides that, urban communication channel is approximately stationary in time [7].Round Robin (RR) and Max Rate algorithms will take into account to improve fairness and throughput respectively [8]. Proportional Fair Scheduling (PFS) and Rate Craving Greedy (RCG) algorithm will maximize system throughput and maintain fairness.

Multiuser diversity happen when there is a multiple access wireless network. It can be obtained by exploiting the time-varying characteristic of the users' channels by maximizing the total information-theoretic capacity. Then, the optimal strategy will schedule at any one time when the only user with the best channel transmit to the BS [9]. Diversity gain arises from the fact that in a system with many users [10], channels vary independently and there is likely to be a user whose channel is near its peak at any one time.

3.0 RESULTS AND DISCUSSION

We now present some of the simulation results in Figure 2 to Figure 4. In this section, we evaluated the performance of probability that a user is transmitting less than demand vector rate (Rmin). Three different scenarios have been considered to see the improvement of the probability delay. The channel was set to 16 sub-carriers in order for each sub-carrier can reach about 25 Kb per time slot according to filtered Gaussian noise that act physically as MS.

When users are transmitting video of 64 Kb per time slot, the deadline of these packets is one time slot. Meaning that one user need at least 3 sub-carriers at each time slot to satisfy QoS requirements. From the script, we set the system to 5 users with zero probability of service as the measurement for the user to ensure their happiness level when the system is serve.

From Figure 2, we present the result of the first scenario, which is the probability of a user is transmitting video less than Rmin with equal channel response average; (a) 5 users, (b) 10 users, (c) 15 users, (d) 20 users, (e) 25 users.

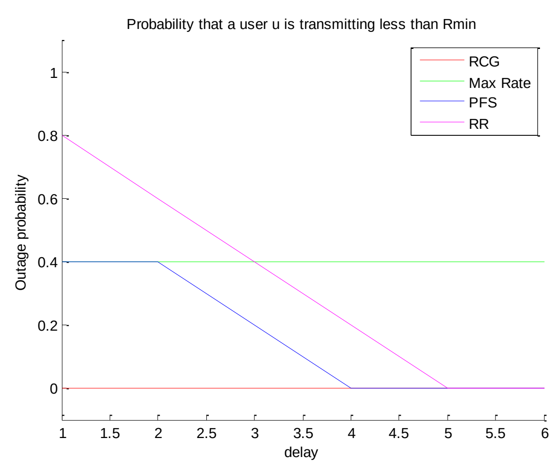


Figure 2(a) 5 users transmitting video of 64 Kb

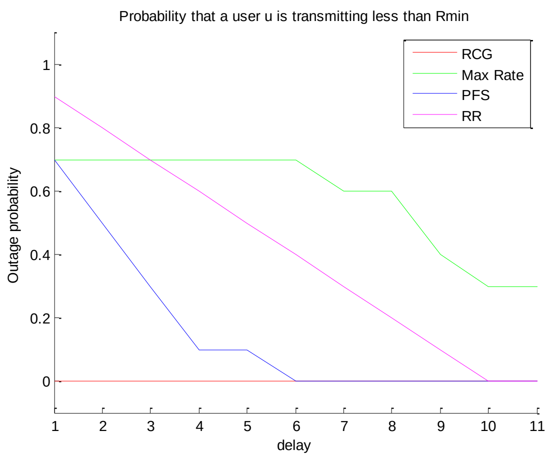


Figure 2(b) 10 users transmitting video of 64 Kb

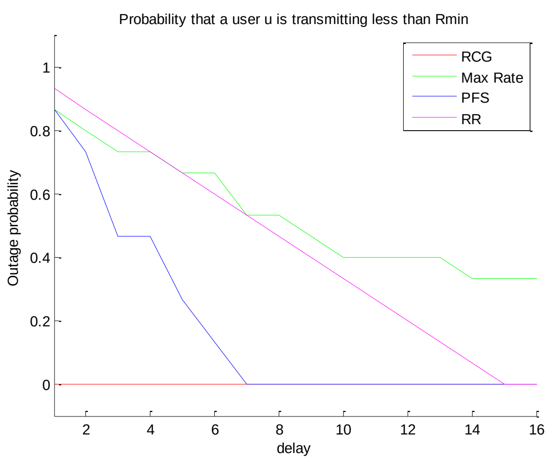


Figure 2(c) 15 users transmitting video of 64 Kb

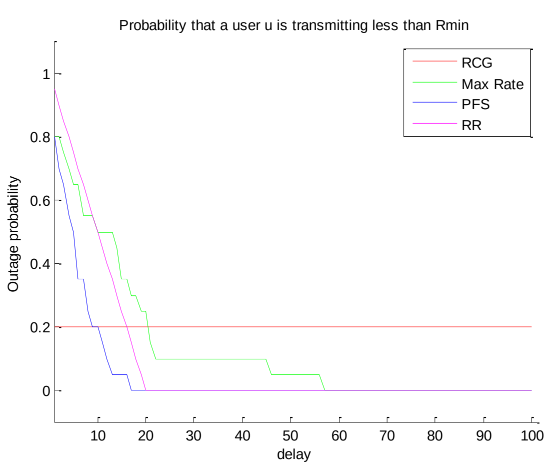


Figure 2(d) 20 users transmitting video of 64 Kb

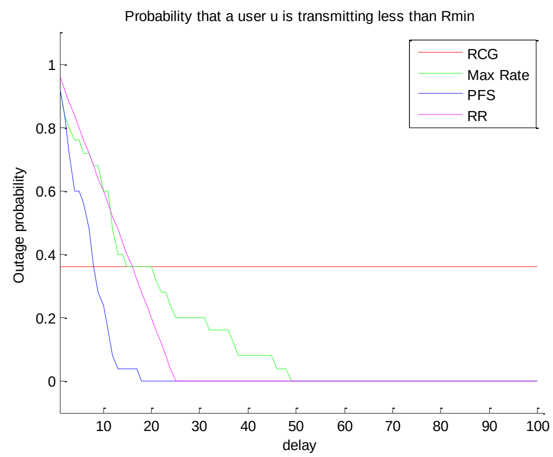


Figure 2(e) 25 users transmitting video of 64 Kb

In Figure 3, we present the result of the second scenario, where users are transmitting data of 16 Kb, we must make sure that one user cannot have more than 4 time slots without transmitting in order to achieve QoS so that probability of one user is less than Rmin. Figure 4 below are the probability of a user is transmitting data less than Rmin with equal channel response average; (a) 5 users, (b) 10 users, (c) 15 users, (d) 20 users, (e) 25 users.

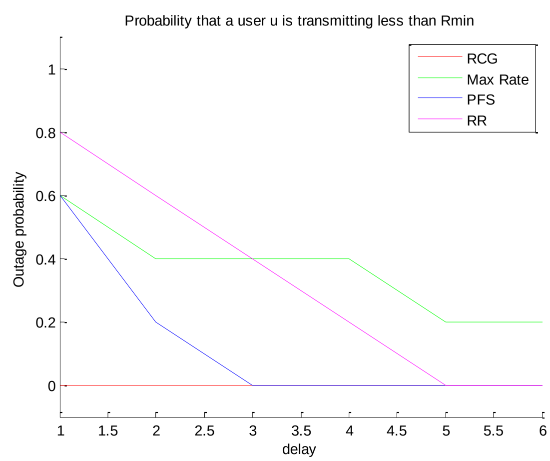


Figure 3(a) 5 users transmitting data of 16 Kb

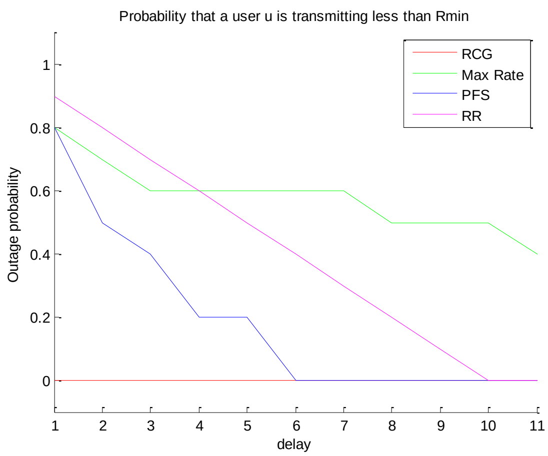


Figure 3(b) 10 users transmitting data of 16 Kb

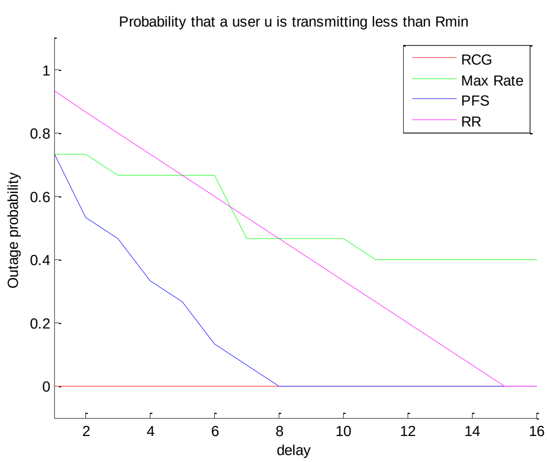


Figure 3(c) 15 users transmitting data of 16 Kb

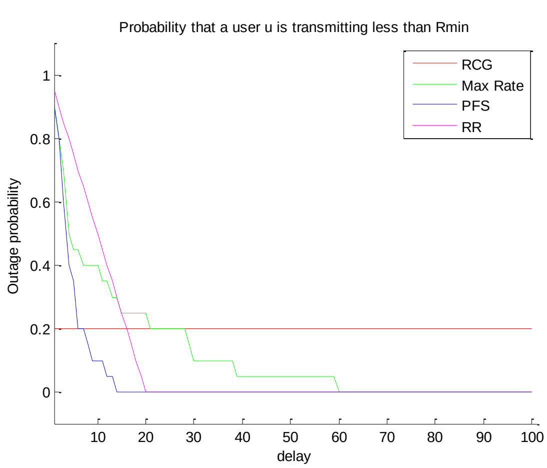


Figure 3(d) 20 users transmitting data of 16 Kb

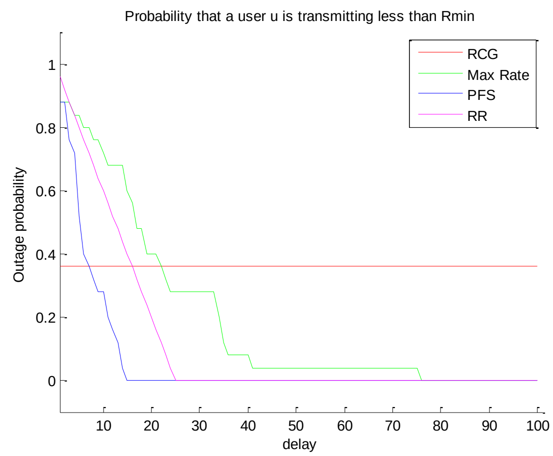


Figure 3(e) 25 users transmitting data of 16 Kb

In Figure 4, we present the result of the third scenario, where 10% of users are transmitting voice, constant rate, 64 Kb per time slot, 40% of users are transmitting voice, constant rate, 16 Kb per time slot and 50% of users are transmitting data, exponentially distributed rate, with a mean of 30 Kb per time slot. Figure 5 below are the probability of a user is transmitting less than Rmin with equal channel response average; (a) 5 users, (b) 10 users, (c) 15 users, (d) 20 users, (e) 25 users.

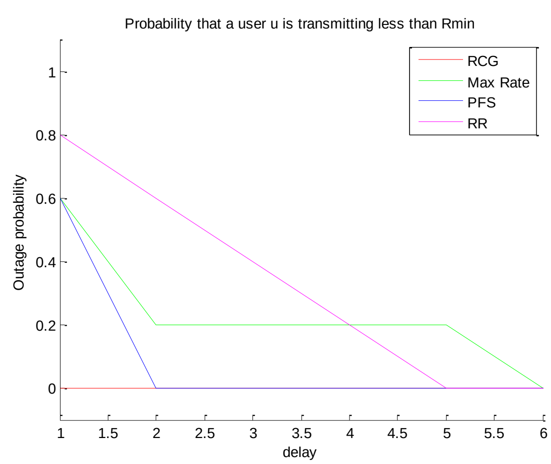


Figure 4(a) 5 users of mix scenario

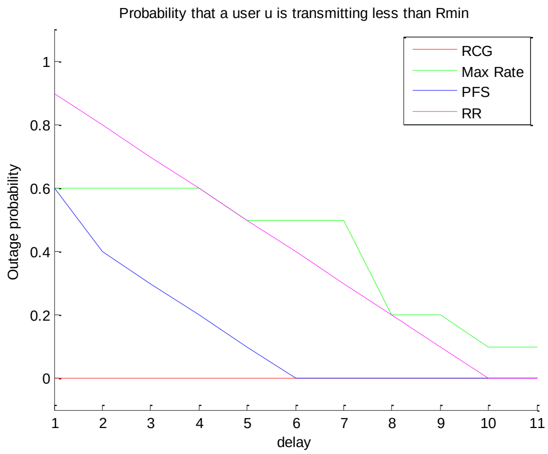


Figure 4(b) 10 users of mix scenario

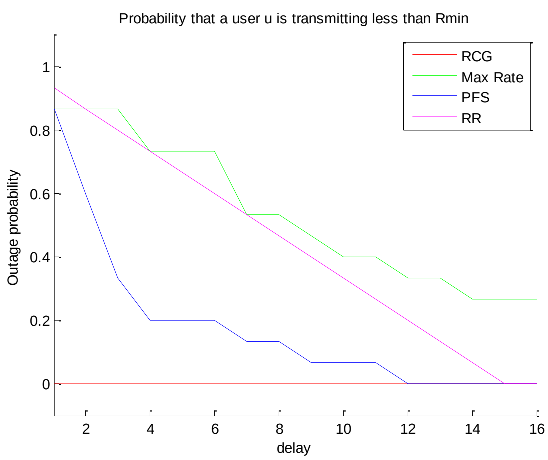


Figure 4(c) 15 users of mix scenario

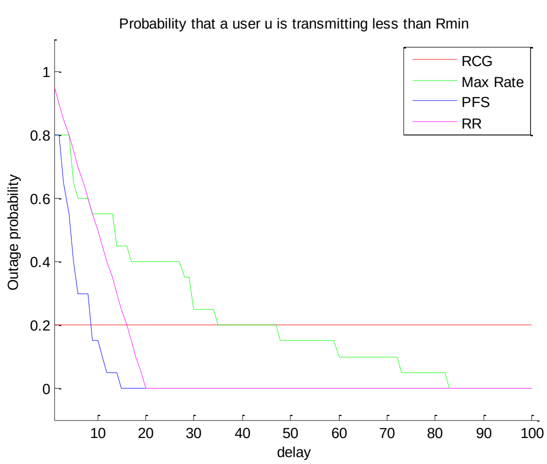


Figure 4(d) 20 users of mix scenario

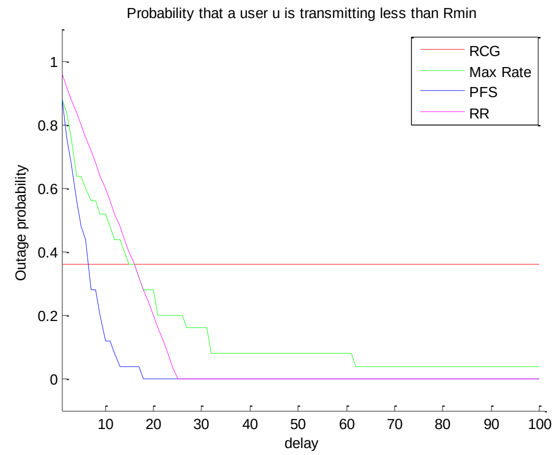


Figure 4(e) 25 users of mix scenario

From Figure 2 to Figure 4, we can see the result of different scheduling algorithm. When we allocate the system resources using RR algorithm, the packet deadline should be so time slots as users in the system in order to be able to give service to all users at least one time and be able to avoid packet drop.RR algorithm allocates all sub-carriers to one user at each time slot and this amount of data is enough to satisfy the data requirements, so the delay in time slots, according to this algorithm, is equal to the number of users in the system. The larger the number of users in the system, the larger the delay, so if we want to reach QoS, our system will only accept so users as the delay restriction. In results showed, RR algorithm has a linear behaviour. It means that at each time slot, each user gets data enough to satisfy demanded data service.

If we allocate the system resources using RCG algorithm, we can see that when there are sub-carrier enough to satisfy demanded services by users, the algorithm reaches zero delay, so we can say that RCG algorithm carry out QoS. For example when there are 5 users transmitting voice (see Figure 2 (a)) there are sub-carriers enough to serve users without waiting. But the larger the number of users in the system, satisfying data requirements for all users is more difficult, because RCG algorithm allocates more sub-carriers to users who are demanding more data, so the larger the users, the larger the probability that one user does not get sub-carriers enough because the system resources are limited. As we can see in Figure 2(d,e), Figure 3(d,e) and Figure 4(d,e), RCG algorithm does not reach zero probability because at least there is one user who does not get sub-carriers enough.

As we can see in Figure 2 to Figure 4, according to delay requirements, PFS algorithm has the best behaviour. It reaches zero probability faster than the other algorithms because there are no users without getting service in all time slots simulated and the sub-carriers allocated to users are enough in order to satisfy data requirements. The larger the number of users in the system, the larger the delay, so if we want to carry out QoS, we have to limit the number of users.

Max Rate algorithm allocates sub-carriers to users who reach the strongest SNR at each time slot, so when all users have the same channel response average, is probably that one user gets resources enough to satisfy data requirements in few time slots. For example when users are transmitting voice, in Figure 3, we can see that the delay is no much more than the delay according to PFS algorithm, so we can say that Max Rate algorithm achieves good results comparing with PFS algorithm in scenarios where all users have the same channel response average.

4.0 CONCLUSIONS

In this paper we have simulate and evaluate the result of the scheduling algorithm for multiuser diversity. We analyse the performance of the proposed scheduling policy based on the QOS criteria - fairness, throughput, and delay because based on facts, Max Rate and Round Robin be the reference for maximum throughput but the result will be either fair or unfair but this is not count in the concept of multiuser diversity. Hence, we didn't get the better throughput system.

However, PFS and RCG exploit the idea of multiuser diversity but they don't work the same. RCG computes the number of sub-carries each user need according to rate requirements and adapts them to achieve the same number of subcarriers that the system can offer, remove subcarriers from the user who is transmitting less data. Subcarriers are allocated according to channel response getting rise to multiuser diversity. Meaning that when there are no demanding users requests for application services, but with different data rate, user with less transmit data wouldn't not get serve.

PFS algorithm does not take into account the needs of rate requirement. It keeps track of average throughput users in the past window of length t_c and allocating sub-carriers to users who have the largest R/T. This algorithm takes sub-carriers independently of each other and have demonstrated PFS policies that have a low t_c parameter, achieved good results in throughput, fairness and delay compared to RCG with mixed scenario and if no sub-carrier sufficient to meet all users.A lot of work has been done throughout the report and also the design suggests several extensions which are showed in the next points:

- Playing with different parameters to simulate different scenarios and different channel responses so we can analyse more accurately the algorithm's behaviour.
- Extend OFDM to OFDMA in scheduling algorithm so that in can be implement for LTE.

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