PRIORITY BASED SCHEDULING FOR RESOURCE ALLOCATION OF MOBILE OPERATORS IN MOBILE NETWORK

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Abstract- Nowadays, a number of mobile users who use mobile phone are increasing rapidly in mobile network. There are many researches that focus on improving Quality of Services (QoS) using many scheduling algorithms by addressing the resources sharing problem. The optimal resource scheduling of mobile networks for various mobile users in different mobile operators is a demanding problem. The Quality of Experience (QoE) of mixed users in different mobile operators is still remained. Therefore, in this paper, the framework of a new scheduling method in mobile network is proposed to satisfy efficient QoS such as fairness and delay for mobile users who use voice service. In the system, Priority based Round Robin (PRR) scheduling adaptively balances between mobile operators and reduces delay of voice users for QoE in mobile network.

Keywords- QoS, QoE, PRR

I. INTRODUCTION

Today, with the growing increases of mobile operators in Myanmar such as MPT, Ooredoo and Telenor, many mobile users have became much demands. Moreover, the mobile network shares the resource among mobile operators which serve voice applications to mobile users on the same core network. The resource sharing of multiple mobile operators in mobile networks, namely 2G, 3G and so on is paramount because they consume many mobile network's resources. In this paper, QoS is considered as a main issue for mixed mobile users to be fairness and to get least delay for their voice service. The paper proposes a better mobile operator management and scheduling technique for many voice users to solve their QoE requirements and to be fairness between operators in the core mobile network. Although many researches aims for improving QoS with various scheduling techniques in wireless environment, the requirements of resource allocation for mobile users in mobile environment is still necessary to solve QoE issues for voice users such as fairness, and delay. Some of the popular scheuling methods include Round Robin (RR), Opportunistic and so on. Some emphasis on throughput, some are for fairness, some are for delay. However, each has both good points and drawbacks.

Therefore, the paper mainly considers fairness of mobile operators and delay of voice users in mobile network. It proposes scheduling algorithms for both mobile operators and voice users to get notonly fairness butalso minimum delay, limiting the delay of users close to Base Station (BS).

II. ANALYSIS OF SCHEDULING METHODS

Through the past decades, many schedulers were introduced to improve the performance of mobile applications. The new method should efficiently be fairness and give a low delay to enhance the performance of mobile service over mobile network. Therefore, we analyze many queuing algorithms such as Class Based Weighted Fair Queuing (CBWFQ), RR and Strict Priority (SP) to solve above requirements; each method has each function such as fairness, delay, and so on.

Firstly, CBWFQ provides a solution to WFQ's limitations by providing user defined traffic classes instead of individual flows. Unlike standard WFQ, CBWFQ allows the system to define traffic classes and apply parameters, such as bandwidth and queue-limits, to these classes. CBWFQ queues are only held to their minimum bandwidth guarantee during periods of congestion, and can thus exceed this minimum when the bandwidth is available. Incoming packets are filtered and IP packets that meet the match criteria such as protocols, IP addresses, TCP and UDP ports for a class are placed in their corresponding class queue. After defining a class according to its filter, the characteristics of the class such as bandwidth and maximum packet limit must be assigned. The CBWFQ uses the class weights to ensure that each class is serviced fairly. The key disadvantage with CBWFQ is that no mechanism exists to provide a strict-priority queue for real-time traffic, such as VoIP, Video conferencing and so on.

Next, Round Robin scheduling is one of the oldest, simplest, fairest and most widely used scheduling algorithms, designed especially for time-sharing systems. RR scheme is a choice to compensate the drawbacks of FCFS which also has low implementation complexity. Newly arrival packets queue up by flow such that each flow has its respective queue. The scheduler polls each flow queue in a cyclic order and serves a packet from any-empty buffer encountered. It do offers greater fairness

and better bandwidth utilization, are of great interest. However, it gives same time interval for all packets and the lack of flexibility if certain flows are supported to be treated better than other ones [2] [3].
Lastly, SP [3] is another classical service discipline which assigns classes to each flow. Different classes may be associated to different QoS level and have different priority. The eligible packets associated to the flow with higher-priority classes are send ahead of ones associated to the flow with lower-priority classes. Strict priority suffers from the same problem as that of FCFS, since a lower-priority packet may also wait arbitrarily long time to be sent.

However, there are disadvantage of methods for mobile operators that provide voice service of mobile phone users to give fairly priority assignment for channel allocation in mobile core network. Therefore, Priority based RR scheduling algorithm is proposed by contributing traditional RR with priority value solving the drawback of CBWFQ and SP, which solves operator management issue in order to improve fairness and delay for mobile users.

III. SYSTEM DESIGNS

The system focuses on scheduling and queuing algorithm for operators that operate with voice traffic for mobile phone users in mobile environment. Firstly, the approach targets the classifying of different mobile users according to their operator into suitable queues in core network. Secondly, it schedules mobile operators and mobile users to be fairness and to be less delay using PRR with Delay Threshold (DT) scheduling algorithm.

For queue fairness, the delay is unbalanced depending on the number of packets in each operator queue because resources are distributed unfairly. The unbalanced queuing delay of mobile operators increases the delay of mobile phone users. Therefore, it presents a high level overview of two major parts: classification, and scheduling for each operator and mobile users in associated operator with priority value.

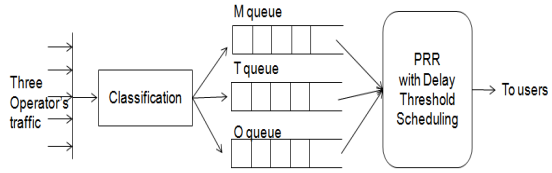


Fig 1. Detail system architecture

Figure 1 explains detail system architecture. The system classifies incoming traffic according to their operator type into three groups. All operators have mobile users who use voice traffic. Then, it fairly schedules each queue depending on priority scheduling methods for fair resource allocation with same scheduling time interval. Next, DT scheduling with priority value schedules mobile users in associated operator to get minimum delay.

IV. PRIORITY CALCULATION

The dominant component of delay [4] is the queuing delay considering that the transmission delay and the transmission overhead which includes back off, and retransmissions are very small. We neglect the transmission delay in this system. Furthermore, the transmission delay is the same in the queues assuming that they use the same transmission rate. Therefore, we need to balance the queuing delay among mobile operators for balanced downlink delay. Thus, it is shown that PRR balances the queuing delay with fairness between them.

In this paper, we compute the queuing delay by multiplying the transmission time by the queue size according to little's law $D_{system} = Q_{system} / \mu_{system}$ [5]. Let it be the queuing delay of each operator D_{op} and transmission rate of each operator μ_{op} as follows:

$$D_{system} = Q_{system} \cdot \frac{1}{\mu_{system}} \quad (1)$$

$$D_{op} = Q_{op} \cdot \frac{1}{\mu_{op}} \quad (2)$$

Then, we consider three operators as in Myanmar such as MPT, Telenor, and Ooredoo. We get the optimal P value for balancing the delay of three queues in the system as follows:

$$D_{system} = D_{op} \quad (3)$$

$$Q_{op} \cdot \frac{1}{P \cdot \mu_{op}} = Q_{system} \cdot \frac{1}{\mu_{system}} \quad (4)$$

Then,

$$P = \frac{Q_{op}}{Q_{system}} \quad \text{if } Q_{system} \neq Q_{op} \quad (5)$$

$$P = 1 \quad \text{if } Q_{system} = Q_{op} \quad (6)$$

Priority P is the ratio of the queue size of each operator which is the number of packets in each operator, and the queue size of the system which is the number of maximum accepted packets in each queue. Therefore, we get as below for each operator:

$$P = \frac{Q_m}{Q_{\max}} \quad Q_{\max} \neq Q_m \quad (7)$$

$$P = \frac{Q_t}{Q_{\max}} \quad Q_{\max} \neq Q_t \quad (8)$$

$$P = \frac{Q_o}{Q_{\max}} \quad Q_{\max} \neq Q_o \quad (9)$$

$$P = 1 \quad Q_{\max} = Q_m, Q_t, Q_o \quad (10)$$

Where, Q_M means the queue size of MPT mobile operator, Q_t is the queue size of Telenor operator, Q_o is the queue size of Ooredoo operator. When both queue size is equal, $Q_M = Q_U$, P results one which means highest priority value for each operator. Otherwise, P results less than one which means each operator gets the associated priority value for its mobile users. In meanwhile, in order to balance between queue delay and fair resource distribution, the proposed scheduler utilizes PRR scheduling which improves the property of Round Robin (RR) with priority of the queue. The priority of each operator changes adaptively depends on the number of packets in each operator's queue because each queue's user volume changes.

Therefore, the system uses PRR to select dynamically the chance of each operator for scheduling users of each one within same time interval according to queue priority not to be queuing delay for delay aware traffic because it can adaptively change the number of packets in each queue.

V. PRIORITY ROUND ROBIN SCHEDULING

In wireless system, how to design the packet scheduling algorithm to improve resource efficiency with all users' QoE requirements by providing methods of resource allocation and multiplexing at the packet level is not only an important problem, but also a complex problem. Therefore, the system calculates the probability value of each queue for three operators as first step in each same time interval as explained above, and calculate priority value for scheduling each operator with PRR, and then implements Delay Threshold scheduling method for mobile users by multiplying the corresponded priority value from above queuing equation.

The paper proposes a PRR scheduling method using exponential moving average method for priority calculation of delay sensitive traffic of each mobile user in three mobile operators in the same time interval. We use this method to get fair priority value of each queue from above probability value that is calculated by little law queuing theory. In PRR, we considers the past priority value again by exponential moving average theory when the three or two queue sizes are the same. Otherwise, current priority value is taken as described below equation:

$$P_k(t+1) = \begin{Bmatrix} (1-1/t_c)P_k(t-1) + 1/t_c P_k(t) \\ (1-1/t_c)P_k(t) \end{Bmatrix}$$

$$when \begin{Bmatrix} Q_1 = Q_2 = Q_3, Q_1 = Q_2 \\ Q_2 = Q_3, Q_1 = Q_3 \\ \\ Q \neq Q_n \end{Bmatrix} \quad (11)$$

$$k(t) = \underset{1 \le k \le K}{sort} \{P_{k1}(t), P_{k2}(t), P_{k3}(t)\} \quad (12)$$

where $sort$ denotes the argument of descending order of each queue's priority, k is the index of operator, $k(t)$ is the selected operator at time t. $P_k(t)$ represents the priority value of each operator k at time t. $P_k(t-1)$ represents the priority value of each operator k at previous time interval. $P_k(t+1)$ represents the priority value of each operator k at next time interval. Q is the queue size of each operator. t_c is a time constant adjusted to maintain fairness over a pre-determined time horizon.

VI. DELAY THRESHOLD SCHEDULING

In our research, the popular delay threshold QoS metric [8], [9] will be employed for real time traffic. To define residual time metric, the ratio of a packet's time in the system to the delay threshold of the packet is multiplied with priority value of related queue, i.e, the biggest value for each user to allocate the resource is given by

$$DR = \max\left\{P_k * \left(d^l{}_{k,j} / d^{th}_{k,j} - d^{av}{}_{k,j}\right)\right\} \quad (13)$$

Where max denotes the maximum value of each user in associated queue at each time interval. $d^l_{k,j}$ is the delay encountered by a packet at the head of the jth stream of the kth operator at lth subchannel. $d^{th}_{k,j}$ represents the delay threshold for packets at the jth stream of the kth operator. $d^{av}{}_{k,j}$ represents the average delay for packets at jth stream of the kth operator.

VII. PERFORMANCE EVALUATION

The results show queue priority of three queues to be optimal resource allocation and fairness between them considering queue size as described in Figure 2. As shown in Table 1, it compares the delay which mobile users in an operator experienced with one in other operators depending on number of packets in each operator. According to the results, queue priority dynamically changes scheduling of three queues at a time interval due to the queue size. Therefore, it leads to fair channel allocation between queues whereas using round robin scheduling which roundly schedules three queues in order at any time.

When the system considers three different queues size, processing delay is more than different two queues which rotate one by one at time interval because three queues has sorting step for three queues' rotation priority as presented in Table 2. However, when queue priority of three queues is fair for them, queue priority of two queues is direct

proportional between them, i.e, if queue 1 is high priority, queue 2 is low priority. Therefore, when more queues, the less delay in my system. It will be significant fair when the system has many queues as described in Table 2. Focusing on user's delay in each queue, RR schedules FIFO style without considering queuing delay for voice application. In outcomes of experiment, it schedules users in each queue with weight value to be fairness and not too much delay at each time interval.

Table I. Delay Vs Packets for each user in each queue

packet	user's delay of Q1	user's delay of Q2	user's delay of Q3
10	0.00151	0.0102	0.0153
20	0.0114	0.0229	0.0344
30	0.0088	0.0178	0.0267
40	0.0063	0.0126	0.0202
50	0.00502	0.0081	0.0161
60	0.00118	0.0007	0.00148
70	0.0041	0.0032	0.00275
80	0.000049	0.0002	0.00014
90	0.034	0.0283	0.0227
100	0.0651	0.0542	0.0434

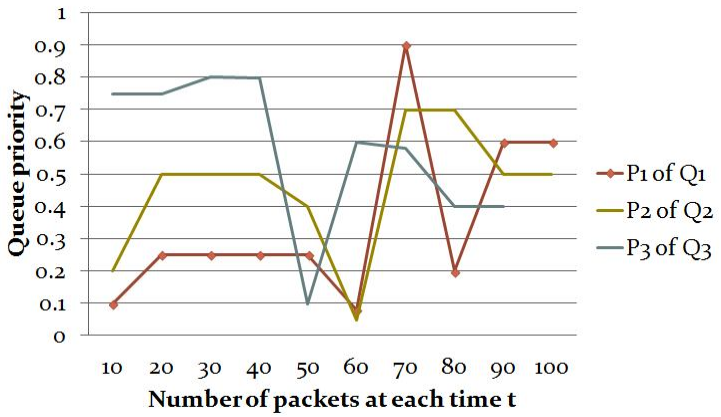


Fig 3. Queue Priority Vs Packets of each queue

Table II. Queue Priority for different number of Queues

packet	For three queues			For Two queues	
	P1 of Q1	P2 of Q2	P3 of Q3	P1 of Q1	P2 of Q2
10	0.099	0.199	0.299	0.099	0.901
20	0.249	0.499	0.749	0.1999	0.801
30	0.249	0.499	0.748	0.299	0.701
40	0.249	0.499	0.799	0.399	0.601
50	0.249	0.399	0.798	0.399	0.601
60	0.079	0.049	0.099	0.599	0.401
70	0.899	0.699	0.599	0.699	0.301
80	0.199	0.698	0.58	0.799	0.201
90	0.599	0.499	0.399	0.899	0.101
100	0.599	0.499	0.399	0.899	0.101

CONCLUSIONS

This paper proposes the framework of operator management in Myanmar with Priority based scheduling that takes the advantages of RR to get fairness between operators and DT scheduling for delay sensitive traffic of mobile users to be less delay in mobile network.

The scheme has likely more performance with a high degree of compatibility with existing scheduling methods for delay sensitive traffic such as voice and video and so on. As a future work, we will investigate and implement the framework to be satisfied with QoS parameters with real wireless environment, and consider not only voice but also internet traffic for mobile users in each operator.

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