An analysis and comparison between new buffering design with Priority Queuing (PQ) algorithm and SPBA algorithm for VoIP

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Summary
This paper showed an analysis and comparison between new buffer design with both concept buffers in the PQ algorithm and SPBA algorithm. In the PQ algorithm, there are four buffering packet are low, normal, medium and high. The buffering packet in PQ algorithm is greedy. However, fourth the buffering is not optimal used. It is caused by PQ algorithm is based on the priority, whereas this buffering just always serviced is the highest priority. While under priority are rarely or never serviced will cause other buffering rarely used. While SPBA algorithm is architecture easiest, and it does not need any resource reservation or threshold dropping, but only makes use of priority scheduling. SPBA algorithm, where incoming packets are placed into the two priority traffic classes is the high class and low class. On the SPBA algorithm is there are not available reservation sources to save the remaining packets when the explosion (burst) traffic occurred, that could result in packet drop and packet loss. Then, with the efficiency of PQ buffering algorithm, can provide greater impact to reduce delays. In the new buffering algorithm, simplify four buffering into three packets (High, Medium and Low) is proposed. In the analysis and comparison new buffering algorithm could be known problems and weaknesses of both algorithms.

Keywords:
QoS, VoIP, Fuzzy logic, and Delay

1. Introduction

This paper is focus on analysis and comparison between new buffering design with both PQ and SPBA algorithm. We showed an analysis and comparison on new buffering design to know differentiated both of buffering in PQ and SPBA algorithm. The journal has been also written and published previously in [9], [5] and [10].
Fig. 1 shows that, PQ classifies packets according to certain criteria in the IP network. PQ classifies packets to up to four classes; each associated with one of four priority queues, and gives each class an appropriate packet queue. Fourth priority queue is high, medium, normal, and low queues in order of priority. Naturally high queue for critical packets, medium queues are assigned to less-critical packets, the normal queue is for general packets, and low queue is for non-essential packet.

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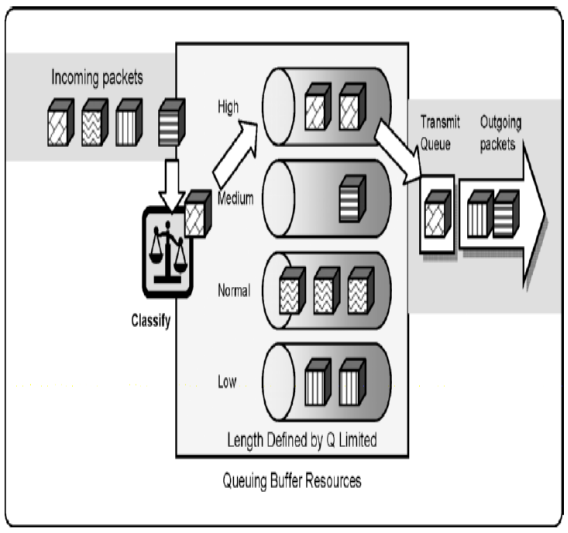
Fig. 1 Priority Queuing (PQ) schematic diagrams.



Priority Queuing (PQ) is one of many models in the Queuing Scheduling algorithms that work based on the classification and sets of data packets to one of the several output queues, based on certain criteria. Incoming packets are classified in terms of traffic ie high, medium, normal and low as shown in Fig. 2. The high priority is first serviced, followed by the medium, normal and low priority traffic, as appropriate. Higher priority traffic queue can cause starvation of lower priority bandwidth. Priority has been available for used in recent years and provide priority servicing.
Different priorities of data traffic queues in the network as shown in Fig. 2 where the voice is the highest priority, video is the medium priority, and normal priority data is the lowest priority. As the VoIP network, voice must be serviced first before the video and data.

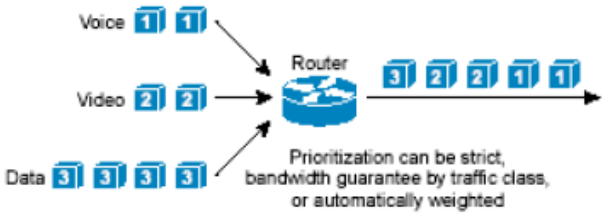


Fig. 2 Generic PQ Scheduling algorithms (Source: Kampong J. Mabe, (2005)

2. Related Works

As on classifying packet that has been written and published in the previous journal [11]. In this paper is to be continued previous journal, which has been published in [9] and [10]. After classifying the incoming packet queue and then placed in buffering packets. Many buffer management algorithms have been studied by many researchers, such as FIFO, Partial Buffer Sharing (PBS), Partial Buffer Sharing with Overwriting (PBSO), Simple priority Buffer Algorithm (SPBA) [3], greedy (Albers and Schmidt, 2004), semi-greedy, HSFOD, and optimal Offline Algorithm (OPT). After making a comparison between them and also because the techniques used are based on packet priority as well, then the Greedy algorithm and SPBA will be considered and investigated in this paper. Comparison between SPBA, PBS, and PBSO has also carried out by [5]. However, the algorithm still SPBA weaknesses that can result in dropped packets and packet loss. Comparisons have also been made between Greedy, Semi Greedy, and HSFOD algorithm by [6] which states HSFOD has the best performance. But in this case is not suitable for HSFOD priority packets. Therefore, SPBA algorithm will be studied further in this paper because it can manage the priority packet buffering and suitable for DiffServ networks as well.

Packet buffering in the PQ is a scheduling algorithm that using a greedy algorithm [6] and [5]. PQ algorithm has four different priorities of packet buffering High, Medium, Normal, and Low are greedy, because the packets sent first is always on highest priority, so that the lower buffering packet is rarely used. And also expressed by [7] that the weakness of the PQ algorithm is to serve the queue of higher priority is always full, the low priority queue never been serviced, so many packets in the buffer is idle and starve. Therefore, the buffering in PQ algorithm is not effective (greedy) caused by PQ queuing algorithm classifies incoming packets is based on priority. So that some buffering in the PQ algorithm is not optimal used and this problem will be next studied in this paper. On the other cases with incoming packets that come from of packet buffering, then forwarded to the scheduler sequentially and continuously. The output from the packet buffer will be sent to scheduling.

2.1 Priority Queuing Overview

Priority queue (PQ) is an abstract data type storing a set of integer-valued items and providing operations such as insertion of a new item and deletion of the smallest stored item. PQ has been used in many applications to improve the quality of service (QoS). According to [8] that PQ queuing scheduling algorithm is designed to provide a relatively simple method of supporting differentiated service classes. Packet is classified by the system and then placed into different priority queues. PQ queuing scheduling algorithm has four different priorities namely High, Medium, Normal, and Low priorities. High is the highest priority, and Low is the lowest priority.

Fourth queues this utilizes; High, Medium, Normal and Low. Which queue a packet goes into is determined by whatever classification that packet belongs to. Unclassified traffic is placed into the Normal queue. The higher queues have to be emptied before the lower ones. Potentially, this could cause to lower queues being starved of time to empty. High priority traffic would be time critical traffic and the packets in this queue would be forwarded before the packets in the other queues. Low priority traffic may not get forwarded at all. If a queue becomes longer than the specified limit, then subsequent packets trying to enter that queue are dropped indiscriminately (Tail Drop). Priority queuing is a method whereby the engineer can decide which packets are more likely to be thrown away rather than the router making indiscriminant decisions.

2.2 Buffering Overview

After classifying the incoming packets, it is arranged in buffering. Buffering packet is used to reduce packet loss when the traffic is burst, and ports which buffers are required to store temporarily of the packet. However, these buffers are of limited capacity so that effective buffer management strategies are important to be maximized the throughput of a router or switch.

2.3 Scheduling Overview

Incoming packet from buffering packet will be scheduled by scheduler. After scheduling packet will be sent to outgoing packet (out router/switch) based on priorities. Output from buffering packet will become input in the scheduling algorithm. It has been also described that many buffer management algorithms have been used by many researchers, like FIFO, PBS, PBSO, HSFOD, Simple Prioritized Buffering Algorithm (SPBA) [3],

greedy [4]), semi greedy and OPT. Several weaknesses [5] in SPBA algorithm like the incoming packets are dropped in optical packet node when all wavelength channels of the destined node outlet are busy and there are not resources to store (delay). While some traffic with higher priority class could need better guarantees in respect of maximum packet loss rate. Under high traffic load in the node too many priority packets could be dropped, so some control decision algorithms and resource guarantees are needed [3]

3. Problem Formulation and Experimentation Design

This paper will be involving test bed set up for the experimentation. It is important to discover the tools and equipment that needed. In this paper uses Briker VoIP operating system. Briker operating system is software, which has been bundled from Linux Debian system. A requirement of this set up has been described in a paper hardware and software requirements.
The problem found up from read literature review from journal, paper, books, and the internet with interrelated. The paper consisted of VoIP, queue scheduling algorithm, PQ algorithm fuzzy logic, Greedy and SPBA algorithm. This whole paper is justified on various problems in VoIP networks such as that caused latency (delay) and queue scheduling algorithms and problems in algorithms PQ, PQ algorithm weaknesses, and solutions will be offered.

This activity was followed by writing a literature review based on reading materials collected. Most of the reading materials taken from newspapers such as general and specific journal, proceeding, books, etc. are mainly about the delay problem in VoIP networks, problems in PQ, greedy, and SPBA algorithms. The paper also justified by the scheduling queue to be used as the proposed development to the new queue scheduling algorithm.
Literature review is a process of gathering research, relevant information, the VoIP Wire/ WLAN networks, SIP protocol and algorithm PQ. Several scenarios, practical and simulation environment proposed by many researchers have studied in order to gather information and develop the research problem. A comparative study carried out to reveal some strengths and weaknesses of current models and approaches that lead to establishing PQ algorithm for research proposals. All the existing techniques in PQ algorithm have been studied in this paper.

Based on Fig. 3, which using existing techniques in PQ algorithms (by priority) and combined with fuzzy logic is a solution that will be offered in a new queue scheduling algorithm. Detail information about this has been written in the previous journal [11]. Figure 3 illustrates in detail and draft a new queue scheduling algorithm. Multimedia data consisting of voice, video, and text (data) are prioritized, depending on the needs. So, the packet classification by PQ algorithm, consisting of four priorities, in this case the priority may be reduced to three priorities, which the voice is highest priority, video is medium priority, and data (text) is the lowest priority. After the incoming packet arrives, this packet will be classified into three classes is high for voice, video and Medium to Low to the data (text). Each packet which has been classified by the classifier is shown in Fig 3.

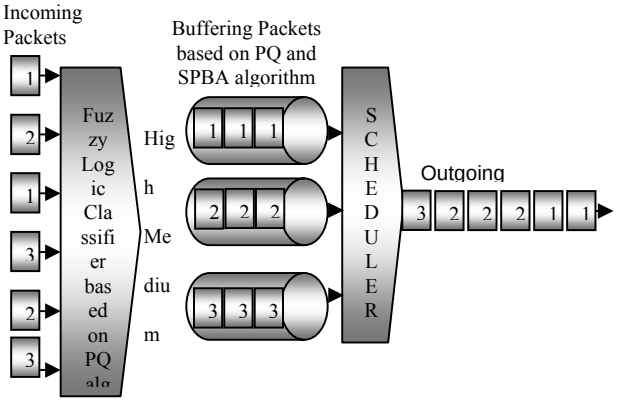


Fig 3. Detail new queuing scheduling algorithm

In VoIP network, voice is serviced first, followed by video and data before it is transmitted to other networks. In this proposal would combine the existing techniques in the PQ algorithm and Fuzzy logic. Both techniques will be applied to the new queuing scheduling algorithm. After the packet is classified, packets transmitted and regulated in the queue buffer to High (voice) placed in the High buffer, to Medium (Video) is placed in the buffer Medium, and Low (data) is placed in a low buffer. In this case, three samples of the queue will be used to make the rules. It aims to facilitate the implementation of the fuzzy logic. New queue scheduling algorithm is expected to be able to manage incoming packet based on priorities.
In this new algorithm has been described in our journal previous which incoming packets are formed use fuzzy rule namely if then rules. Fuzzy rules consist of input and output. In these case inputs are qi1, qi2, qi3,…,qin and output is qo. For example, if qi1 is High and qi2 is High and □□□ and qin is High then qo is qi1, etc. And these fuzzy rules are also valid for back queuing continuously.
As shown in previous journal [9][11] and [10] as well, there are three phases of the incoming packet data traffic among them is the queuing phase, classifying phase, and scheduling phase. First, Phase Queuing is the arrival of incoming packets at random. Incoming packet in the form of voice, video, and data (text) will come randomly and

continuously. Voice packets are marked as H, the video packets are marked as M, and data (text) are marked as L. Second, Classifying phase is where the incoming packets will be selected and classified by priority, arrival and demand. Here, there are three parameters that must be determined to classify traffic based on the data type queue (priority), time of arrival and request packet, while the PQ algorithm is only based on the priority without considering the packet arrival time which can cause a recursive (loop) and starvation. After classifying, the packet will be forwarded to the packet buffering. As in PQ buffer consists of four packets, and also this problem has been described in the introduction section. PQ algorithm is using a greedy algorithm. Therefore, in this case simplified into three packets will be proposed that packet buffering should be adjusted to three types of queues High, Medium and Low according to incoming packets as well. Packet buffering algorithm based on PQ and SPBA algorithm is illustrated as shown in Fig. 5. a and 5.b. Third, Scheduling phase is where the packets that have been selected (classified) will be scheduled in sequence that started from High, followed by medium and low. As known in the VoIP network, the voice has the highest priority to be serviced first, before video and data.

In this algorithm, each packet will be sent based on priority, arrival time, and demand. Based on priority, that means high-priority packets are always transmitted (serviced) first. Based on arrival time is if there are three packets or more of the same after a high priority is to continue next. And on request is that if many high-priority queues after the next will be forwarded.

After the incoming packet is classified, the packet will be forwarded to the packet buffering. Many algorithms (models) have been used. Justified in the introduction, this paper uses a packet buffering techniques in PQ (greedy) and SPBA algorithms have been investigated. When compared with SPBA algorithm, the simplest seems to be one of SPBA algorithm. SPBA task is to save into the buffer all the packets in the packet starting with the highest priority. This algorithm is almost similar to the PQ algorithm has four buffering packets, where PQ algorithm to store the incoming packet in the fourth buffer is also starting from the highest priority packet. However, PQ algorithm seems inefficient. While the algorithm SPBA no free slots are available that can cause dropped packets remaining. It's been two times when analyzed by [5], different algorithms SPBA with PBSO and PBS SPBA algorithms where the algorithm does not use resource reservation mechanisms and therefore, cannot be dynamically set to a temporary traffic profile.

The different between the PQ and the algorithm SPBA is each has advantages and disadvantages of them are:

- PQ buffering algorithm has four packets that can store more incoming packets, but not efficient in operation, because it was always the highest priority while serving a lower priority is never serviced so that it can lead to starvation and higher delay.
- SPBA algorithm can save the incoming packet with the highest priority, but when the incoming packet many more then can cause explosion (burst) packet because the SPBA algorithm does not have free slots to store the remaining packets.

Table 1: Comparison each buffering

	PQ algorithm	***SPBA algorithm***	***New algorithm***
Buffering Quantity	4	2	3
Name of buffering	High(H), Medium (M), Normal (N) and Low(L)	High (H) and Low(L)	High H, Medium (M) and Low(L)
Weaknesses	Buffering is not efficient, because just always first serviced cause delay	Not enough reservation which cause tail drop	-
Handling of packets	4 packages	2 packages	3 packages

Thus, the algorithm has four packets PQ buffering greedy; that is inefficient, whereas in SPBA algorithm is to use two priority classes of traffic is High Priority (HP) and Low Priority (LP) is still lacking. As shown in Figure 4.a and b, can be seen that, in the new algorithm are uses only three buffers namely High (H), Medium (M) and Low (L). In the new Packet buffering algorithm are designed there are not packets discarded (tail drops) that can cause loss of packets. To handle traffic at packet buffering H explodes (burst) is to make buffering longer than the Medium and Low packet buffering (in Figure 4.a) is proposed.

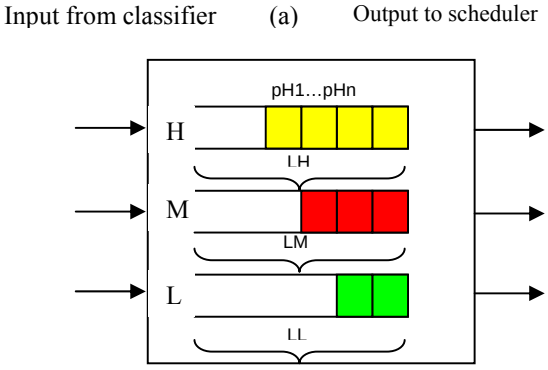


Fig. 4. (a) Buffering packet input design

4. Algorithm and Notations

As shown in Fig. 4.a and 4.b in the packet there is buffering input (incoming packet) from the classifier who will be sent to the scheduler. Packet buffering consisting of High, Medium and Low are used for the entry of the classifier packet. Packet sent to the scheduler directly without a barrier because the packet buffering mechanism there is not leaking bucket to remove the packet.

Notations of new algorithm are as follow:
H, M, L = types of packet.
pH1…pHn = the number of H packet delay.
pM1…pMn = the number of M packet delay.
pL1…pLn = the number of L packet delay.
LH = Length of buffering with Highest priorities packet
LM = Length of buffering with Medium priorities packet
LL = Length of buffering with Low priorities packet

Some algorithm for the buffering among of are:

$$LB=(LH+LM+LL)\ or \quad (1)$$

$$LB=\sum(LH+LM+LL)) \quad (2)$$

pH1, pH2,…,pHn is highest priorities packet to total number of packet =

$$\sum_{H=1}^{n} PH=1 \quad (3)$$

pM1, pM2,…,pMn is Medium priorities packet to total number of packet =

$$\sum_{M=1}^{n} PM=1 \quad (4)$$

pL1, pL2,…,pLn is Low priorities packet to total number of packet =

$$\sum_{l=1}^{n} pL=1 \quad (5)$$

Based on the comparison between the PQ and buffering SPBA algorithms, then a new algorithm is expected able to overcome the weaknesses both the algorithms. Probability occurs in this new algorithm is that if the incoming packet comes many more in the highest priority. To deal with this probability, a few steps that must be done in this algorithm include:

a. Creating long buffering packet with the highest priority more than medium and low priority. (Total buffering packets LB = 100% comprised of Length Buffer with the highest priority (LH) = 40%, Length Buffer with high priority (LM) = 30%, Length Buffer with the highest priority (LL) = 30%) because initial predictions and estimated that more facilitated voices (high priority).
b. Determining the estimated time of arrival and the incoming packet with the highest priority over medium and low priority.
c. Determine and estimate of many of the incoming packets at random in the same time (time share). In this case if there is no higher priority then packets are low will be serviced as well.

(b)

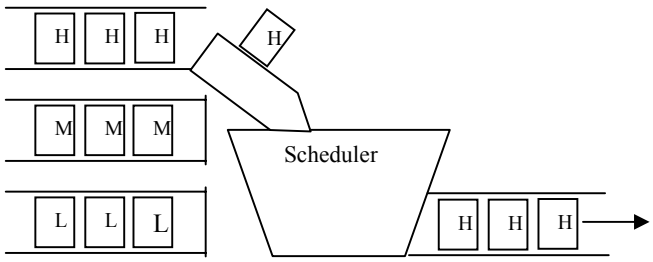


Figure 4. (b) Buffering output design and scheduling design

Based on this step can be summarized:
LB = (0.4LH+0.3LM+0.3LL)
D = LB x T (ms)
DH = LH x T (ms)
DM=LM x T (ms)
DL = LL x T (ms)
T = At-Dt (s)
TH =AtH-DtH (s)
TM =AtM-DtM (s)
TL =AtL-DtL (s)

Notations:
LB= Length Buffering packet
D = Total Packet Delay
DH = Total Packet Delay with Highest priorities
DM = Total Packet Delay with Medium priorities
DL = Total Packet Delay with Low priorities
T =Time
TH = Time of High priority packet
TM = Time of Medium priority packet
TL = Time of Low priority packet
At=Arrival time
AtH = Arrival time of High packet
AtM = Arrival time of Medium packet
AtL = Arrival time of Low packet
Dt=Departure time
DtH = Departure time of High packet

DtM = Departure time of Medium packet
DtL = Departure time of Low packet
In above formula, packet delay is determined by arrival time packet, duration time service by the classifier (services) and long time in a packet buffer. After exit from packet buffering, each packet priority (High, Medium, and Low) sent to scheduler until a packet is empty. High priority is first sent and next followed Medium and Low priorities as shown in Figure 3.
As depicted in Fig. 4.b incoming packet from packet buffering scheduled is based on priorities each packet then is sent to output ports.
This can be seen in Fig. 4.a and 4.b where the algorithm and the buffer mechanism provides three different priority classes starting from High, Medium and Low. In this mechanism is designed there is not leak against of the incoming packet that can cause packet drop and packet loss. This mechanism is in the form of the letter Y bucket. H buffer scheduler is made longer than the middle and lower buffer. The aim is to avoid burst, speedup and overlapping packets that coming from the packet buffering. So that the packet can be sent to the output port with more comfortable.

7. Conclusion

An analysis and comparison between a new buffering with PQ and SPBA algorithm for packet buffering has been conducted. On the new scheduling algorithm to reduce congestion that can cause a packet drop and packet loss has been proposed as well. Third the algorithm; queuing, buffering and scheduling are bundled into one name is queuing scheduling algorithm.
As shown in table 1, weakness both buffering algorithms can be reduced minimally. So, congestion control model (algorithm) such as queuing, buffering and scheduling algorithm for Voice over IP (VoIP). The aim of queuing algorithm is to minimize delay, while packet buffering and packet scheduling is to reduce packet drop and packet loss in wire/wireless LAN. PQ, greedy, and SPBA algorithm have been discussed, which can provide problem solving and solution. However, all methods do not satisfy for packet delay, packet drop and packet loss.
In the reality, PQ algorithm has a problem in classifying the incoming packets that can cause a recursive loop and next queue starving. Combination of existing technique in PQ algorithm and then applied into Fuzzy logic can handle weakness of existing PQ algorithm. Moreover, the new queuing algorithm can reduce delay in VoIP network.
Combination of existing technique in PQ and SPBA algorithm can handle weakness of existing PQ algorithm in buffering packet service to reduce burst packet. Burst packet can cause packet drop and packet loss.

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