An Adaptive QoS Management based on Priority Control for Home Networking

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Abstract: – As network technology is growing very rapidly, many people have had PCs and used Internet service with high-speed modems at home. So providing high quality network services in home and connecting home devices together in a network become a main issue in home networking. There are mainly three kinds of data traffic types in home network; control network data, Internet data, and high-speed multimedia stream data. A key technology in home networking is how to guarantee the quality of three kinds of services between WAN and Home networks, and also within Home networks. In this paper, we propose an efficient and adaptive quality of service (QoS) management using priority control.

Key-Words: - Priority control, Quality of service, Class of service, Home networking

1 Introduction

The past few years have witnessed rapidly growing sales of consumer digital media devices: digital video cameras, digital still cameras, MP3 players, DVD players and jukeboxes. Many portable telephone system use digital technologies. While Usage of Digital TV is growing, some companies have introduced home media centers to act as home servers for audio and video media. On the other side, the number of homes using multiple PCs and Internet service with high-speed modems has being increasing. Corresponding service providers are offering broadband access services by cable modem, several types of digital subscriber line (DSL), fixed wireless, one- and two-way satellite, power line, and several types of fiber.

To fulfill the user's needs, the home network will need to support five categories of digital applications: data service, telephone service, audio service, video service, and automation [1]. One of the key technologies in home networking is to ensure quality of service (QoS) between WAN and home networks, and also within Home networks. Many kinds of QoS algorithm already proposed and now applied in several systems focused on the method how it works efficiently to shape the traffic with fixed priority [3], [6], [7].

In this paper, we classify home network traffics into three classes, and propose a novel adaptive QoS management to guarantee QoS. We are interested in the method how to provide high QoS for the current service, and we accomplish the simulation to validate our proposed algorithm. We can see that priority control of our architecture is efficient and adaptive to user traffic.

This paper is organized as follows. In Section 2, we define three kinds of traffic classes and in Section 3, we propose an adaptive QoS management algorithm, which provide fair and efficient priority control of the three classes based on the traffic usages. Section 4 includes the simulation result of the algorithm and discussions about the results. Also, we make conclusion in Section 5.

2 Traffic Classification

Home network services can be divided into three classes: low speed data services, medium bandwidth data services and high bandwidth data services. Low speed data services provide control, monitoring, measurement, and alarms services. Medium bandwidth data services provide voice telephony service, baby monitor service, and Internet data service. Also high bandwidth data services provide computer data service, video and audio service, etc [2].

We define three kinds of traffic classes according to performance requirements and QoS priority. Table 1 shows classes and features where the value of 2 is the highest and the value of 0 means the lowest.

Table 1. Classes and features.

	Class 1	Class 2	Class 3
packet size	0	2	1
importance	2	1	0
initial Priority	2	1	0
real time	2	1	0
traffic burst	0	2	1
main services	control, automation	video, audio	data service

Class 1 service is the most basic service and provides a signaling system for Class 2 and 3 services. For instance, Class 1 service might serve stand-alone functions such as lighting control, energy management, security monitoring, and also manage signaling paths for Class 2 and 3 services. Managing network or backbone for basic home control functions and for supporting Class 2 and 3 services.

In summary, Class 1 service is a signaling overlay network or backbone for basic home control functions and for supporting Class 2 and 3 services. Control information or data information may be carried on the Class 1. Class 2 and 3 provide mainly data services and multimedia data services, which need more bandwidth than Class 1 services.

3 QoS Algorithm

QoS algorithm consists of two main levels: priority point estimation and adaptive priority control. In priority point estimation level, it gives class the point calculated upon traffic usage variation. In adaptive priority control level, it assigns priority with class point that is provided through the way of weighted value different from each class.

3.1 Priority Point Estimation

Fig. 1 shows priority point estimation, which gives point value to each class based on the value of deviation, D. Each class has PCB and obtained by the following method. We assume that number of interfaces are $1, 2, \ldots, n$, packet count time is T_{count}, total usage of bandwidth is BW_T, and class packet sizes from each interface are $L_1, L_2, \ldots, L_n$. Also, we define PCB as

$$PCB = \frac{\sum_{i=1}^{n} L_n}{BW_T \times T_{count}} \times 100\% \cdot \quad (1)$$

Each PCB deviation is obtained by

$$D_* = PCB_{current} - PCB_{old} \cdot \quad (2)$$

The total PCB deviation is

$$D_T = |D_1| + |D_2| + |D_3| \cdot \quad (3)$$

And if total deviation exceeds the deviation threshold, D_{th}, then it gives more point to each class.

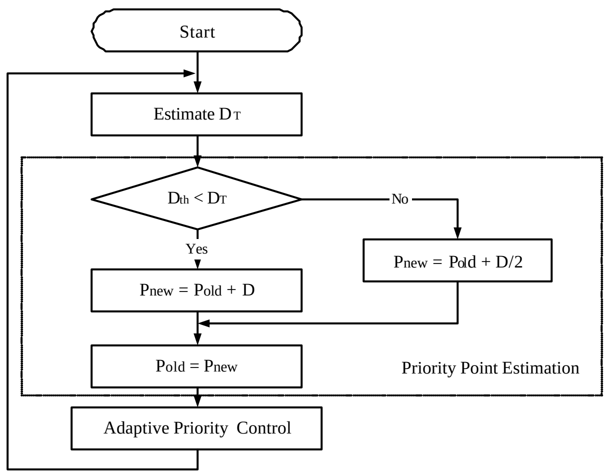


Fig. 1. Flowchart of priority point estimation

3.2 Adaptive Priority Control

In this level, it allocates priority to each class based on the point from above level. Shown in Fig. 2, if a class obtains the biggest value of point, then the class obtains the highest priority. On the other side, if a class obtains the smallest value of point, then the class obtains the lowest priority. But it has some problems that a class may always have the highest priority and there is no meaning of classes. So we provide priority policy algorithm to each class to make each class have characteristics. Priority 2 is the highest priority and priority 0 is the lowest priority.

Table 2. Each class priority policy.

Class	Initial priority	policy
Class 1	Priority 2	Privilege
Class 2	Priority 1	Normal
Class 3	Priority 0	Penalty

Privilege policy makes priority down in case that a class has continuous lower priority then initial priority. In case that a class has two-level low priority, then it makes priority down immediately but a class has middle priority once and next time two-level low priority. If a class has initial priority then it has the priority immediately. For example, in case that priority 2 goes down to 0, then a class has priority 1 once and next time has priority 0.

Penalty policy is the opposite case of Privilege policy. Penalty policy makes priority up in case that a class has continuous higher priority then initial priority. In case that a class has two-level high priority, then it make priority up immediately but a class has middle priority once and next time two-level high priority. If a class has initial priority then it has the priority immediately. For example, in case that priority 0 goes up to 2, then a class has priority 1 once and next time has priority 2.

In this case it may happen that two classes have same priority (priority collision). Then priority collision policy makes each priority state go to initial priority state but a class has continuity information. For example, if class 3 has priority 1, and at the same time other class has priority 1, then class 3 has initial priority 0. However it may have priority 1 immediately if class 3 has priority 1 next time.

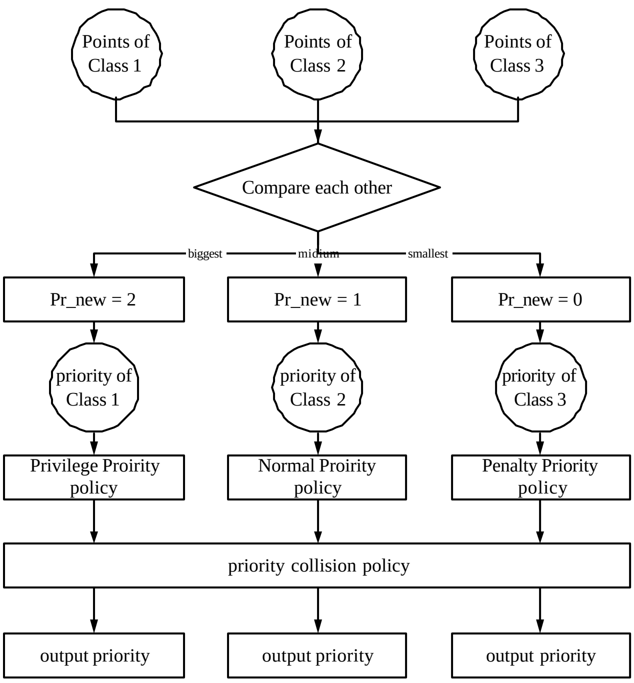


Fig. 2. Flowchart of adaptive priority control.

4 Simulation Result

Now, we accomplish simulations to evaluate the performance of our QoS management algorithm. We use virtual PBW for modeling each input data, and examine the output of adaptive priority as a result. To simulate our algorithm, it need to set some initial values; T_{count} is 20sec and D_{th} is 20. Fig. 3 shows each class input PBW. Initial PBW1 value is 30, PBW2 value is 40, and PBW3 value is 30. As Fig. 3 shows, during first few T_{count}, class 2 has most portion of bandwidth. On the other hand, during last few T_{count}, class 3 has most portion of bandwidth.

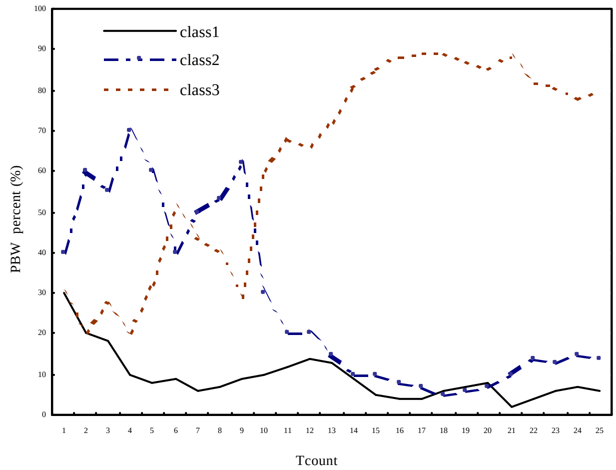


Fig. 3. Each class input PBWs.

Fig.4 shows final output priority as result of our algorithm. The result is the output from adaptive priority control process.

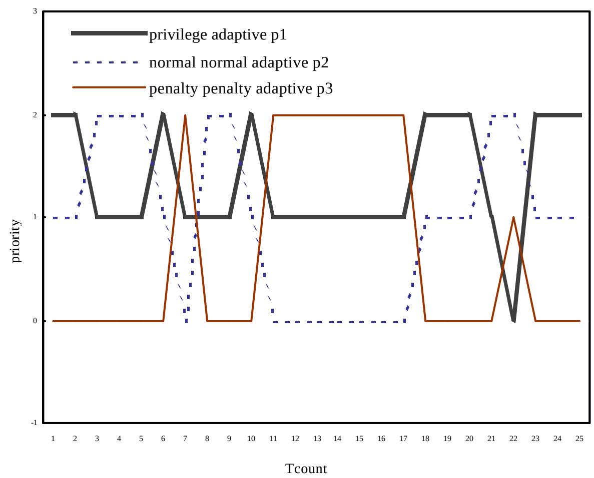
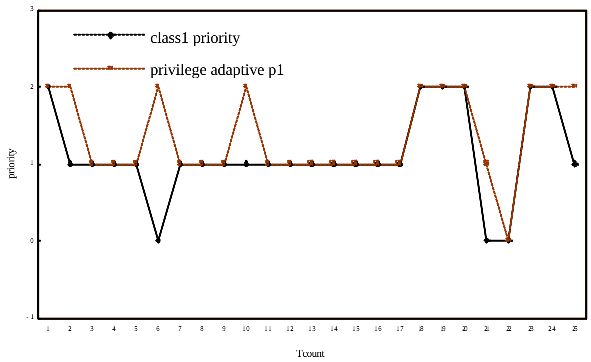
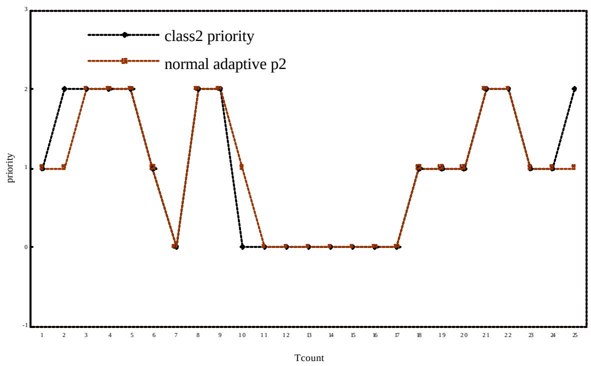


Fig. 4. Final output priority after priority-policy-process.

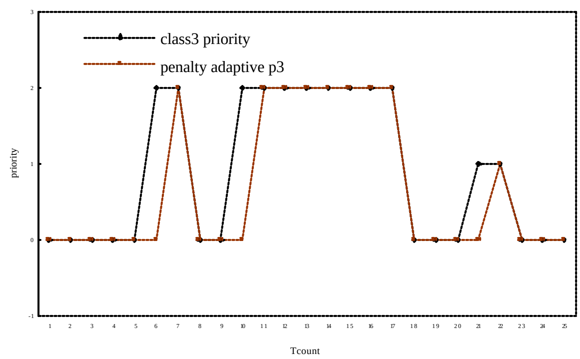
To verify to compare the effect of priority-policy-process, we compare two priorities that each class has, one is a priority before priority-policy-process and the other is a priority after priority-policy-process. This result says that the priority after priority-policy-process has more characteristic priority of each class than before priority-policy-process.



(a)



(b)



(c)

Fig. 5. Priority comparison between the priority before priority-policy-process and the priority after priority-policy-process in each class: (a) Class 1 priority comparison, (b) Class 2 priority comparison, and (c) Class 3 priority comparison

5 CONCLUSION

Many kinds of QoS algorithm already proposed and now applied in several systems focused on the method how it works efficiently to shape the traffic in fixed priority. It is difficult to adapt user's requirement. In order to admit user's requirement flexibly, we focus on the method that provides high QoS to the current traffic. Main concern of our algorithm is to ensure better QoS to the often-used service traffic. It doesn't matter that the QoS system provides good quality to the non-used service traffic, because the user decides whether the QoS System is good or bad by the quality of service that user is using currently.

In this paper, we propose the algorithm that is adapted to user traffic. It can provide high quality of service to user on time. However it has still complexity and we need more experimentation with more reliable input data.

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