Delivering Improved Multiple Services to IP Traffic in DiffServ Networks

Tamrat Bayle
Graduate School of Engineering
Hiroshima University
Hiroshima, 739-8527, Japan
tamrat@hiroshima-u.ac.jp

Reiji Aibara
Information Media Center
Hiroshima University
Hiroshima, 739-8511, Japan
ray@hiroshima-u.ac.jp

Kouji Nishimura
Information Media Center
Hiroshima University
Hiroshima, 739-8511, Japan
kouji@hiroshima-u.ac.jp

Abstract

This short paper presents the results of a research on the design, implementation and analysis of a packet scheduling mechanism for multi-traffic classes in the context of DiffServ networks. Our studies aimed at providing QoS assurances to real-time applications over IP networks. We began by identifying that QoS performance guarantees per-class of traffic aggregate are inherently required in the core of the Internet. We assume that traffic classification based on the application QoS requirements is an indispensable feature for providing QoS guarantees to a wide variety of real-time applications like voice over IP (VoIP) and video conferencing due to the scalability issues.

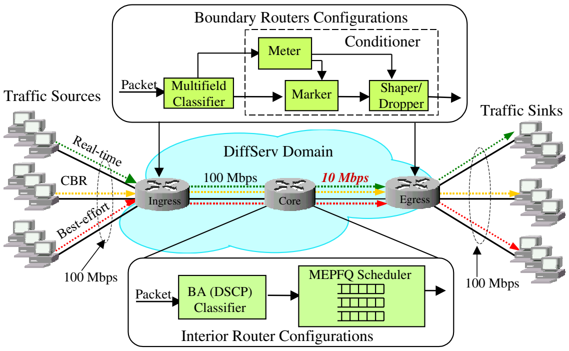

Figure 1. DiffServ Model for Simulations

1. Introduction

IP networks, such as the Internet and corporate Intranet, provide only best-effort service. However, best-effort delivery of data in the Internet cannot be used for the new emerging real-time applications, such as voice over IP (VoIP), and multimedia conferencing. New approaches are necessary to offer Quality of Service (QoS) guarantees for these real-time applications. In recent years, considerable research has been done to empower the Internet with effective and scalable QoS capabilities. The emerging *Differentiated Services* (DiffServ) architecture [1] is a promising approach to provide scalable and efficient framework for *classifying* and *prioritizing* different types of IP traffic (see Figure 1).

Providing QoS guarantees in IP networks requires the use of traffic *scheduling algorithms* in the routers. In this short paper, we outline that multi-traffic class scheduling mechanisms in the context of DiffServ architecture has an important role in enhancing service differentiation and protection of real-time, and mission-critical applications from other misbehaving applications. Consequently, we propose a new traffic scheduling algorithm, called Multiclass Efficient Packet Fair Queueing (MEPFQ) that provides tight end-to-end delay bound, and bandwidth guarantees with an ease of implementation. It is based on the work in [2] and incorporates the best characteristics of some existing approaches, notably the well known weighted fair queueing (WFQ) [3] and worst-case fair weighted fair queueing plus (WF^{2}Q+) [4].

MEPFQ, like [3, 4], allows to determine tight upper bounds on the end-to-end delay, and the minimum bandwidth requirements of different applications. However, the proposed scheme delivers these guaranteed multiple services to different traffic classes in DiffServ networks at a lower computational cost, with greater flexibility and ease of implementation.

2. Simulation Scenarios and Results

This section briefly describes the simulation model and presents few results obtained using the DiffServ network scenario depicted in Figure 1. We use the Network Simulator *ns-2* [5] to implement and evaluate the effectiveness the proposed algorithm. Moreover, Table 1 shows the summary of the traffic mixes for the simulations, as well as the mapping of these traffic mixes into their respective service

Table 1. Classifying traffic into classes

Traffic Types	Mapped Classes	No. Flows per Class	Service (PHBs)	Relative Weights
VoIP	Class 1	200	EF	$\phi_1 = 65\%$
CBR (data)	Class 2	10	AF	$\phi_2 = 25\%$
Self-Similar	Class 3	100	BE	$\phi_3 = 10\%$

classes, along with the per-hop behavior (PHB) treatments for the same scenario. We consider voice traffic to be treated with DiffServ first-class expedited forwarding (EF) PHB. It consists of 200 flows; each characterized by a packet size of 84 bytes, burst time 350 ms, idle time 650 ms, and peak rate of 64 kbps during on period. To represent the second traffic class, we consider constant-bit-rate (CBR) data. The CBR traffic consists of 10 sessions, which can be treated with assured forwarding (AF), and for the third class, used as a background best-effort traffic, we use 100 Pareto On/Off sources, each with an average rate of 100 kbps to generate an aggregate traffic rate of 10 Mbps. Traffic characterization according to a Pareto ON/OFF distribution is widely considered to describe the selfsimilarity (burstiness) nature of both the Internet and Ethernet traffic.

Figure 2 and Figure 3 present the end-to-end delay, and throughput results, respectively, using MEPFQ scheme. The results in both Figures show clearly how voice packets are served with the highest assurance of delay bounds, and bandwidth guarantees regardless of the sending rates of AF and BE traffic classes. For other classes, the delay is correlated largely with the increment of their average queue sizes during congestion, and their corresponding weights, as well. This is mainly due to the 65% of the service time of the scheduler is spent for serving the voice class. As a result, the more the queue is in congestion, the more the delay for packets to reach the destination is increased. The delay problem will be more aggravated if the queue size is getting large. On the other hand, the queue size should be set large enough to avoid packet loss. So, one has to face a tradeoff between packet loss and delay for medium and low classes during times of congestion.

3. Conclusions

We propose an effective technique to achieve QoS by enabling the network to control traffic on a per-aggregate traffic basis. Simulation results presented in this paper show that the proposed MEPFQ algorithm is effective in providing enhanced service to voice traffic class over other non-real-time traffic classes while providing the additional benefits of fair bandwidth sharing among the classes, along with scalability and ease of implementation. Our possible future work is to provide both mathematical analysis and extensive simulations on the end-to-end delay bound of the algorithm in comparison with other approaches.

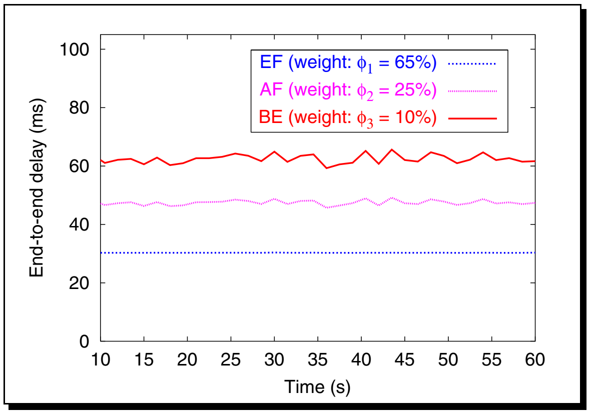

Figure 2. Average end-to-end delay

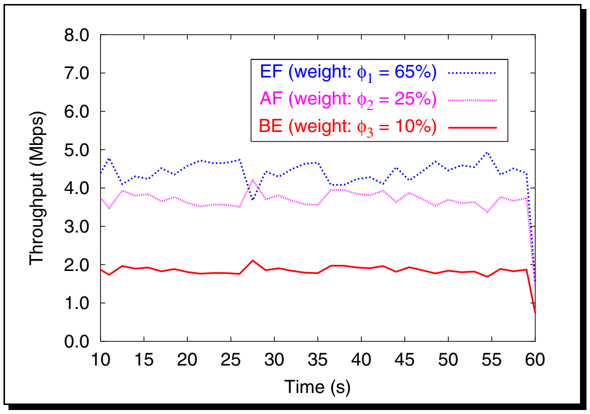

Figure 3. bottleneck link bandwidth

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