# Abstract

We present an approach for the fair resource allocation problem and QoS routing in All-IP networks that offer multiple services to users. The objective of the optimization problem is to determine the amount of required bandwidth for each link and each class to maximize the sum of the users' utility. In this work, we focus on approaches that, while allocating bandwidth, attempt to provide a proportionally fair treatment of all the competing classes. First, we will show that an achievement function can map different criteria subject to various utility onto a normalized scale. It may be interpreted as a measure of QoS (Quality of Service) on All-IP networks. Using the bandwidth allocation model, we can find a Pareto optimal allocation of bandwidth on the network under a limited available budget. This allocation can provide the so-called proportional fairness to every class, that is, this allocation can provide the similar satisfaction to each user. Next, we present a routing scheme under consideration of the delay. Such an optimal path provides the end-to-end QoS guarantees to each user. Finally, a numerical example is given to illustrate how to solve the fair resource allocation problem and how to modify the nonlinear parts.

Keywords: multiple-objective problems, achievement function, proportional fairness, Pareto optimal, ordered weighted averaging method, routing, delay, fair bandwidth allocation