Chapter 1

Introduction

Many approaches have been proposed for the fair resource allocation problem where QoS (Quality of Service) routing in communication networks offering multiple services for users. Fair resource allocation problems are concerned with the allocation of limited bandwidth among competing activities so as to achieve the best overall performances of the system but providing fair treatment of all classes of competitors [7]. The objective of these optimization problems is to determine the amount of bandwidth for each class to maximize the sum of the users' satisfaction. The optimal solution could satisfy users' preferences with respect to throughput and fairness (see [4], [3], [9], [10]).

Wang and Luh [15] proposed a precomputation-based maximizing model for the network dimensioning problem. Assume there are m classes in different QoS requirements. The formulation and analysis is carried out in a general utility-maximizing framework. It precomputes bandwidth allocation (rate vector) and end-to-end paths with QoS guarantees, in terms of utility functions. They presented a routing database, identifying an optimal path upon each connection request. The purpose of their paper was to choose the optimal solutions in order to provide a set of solutions satisfying user' preferences with fairness. Numerical results showed sensitivity of utility functions by changing several values of parameters, including the weight of utility function for each class. But it is wondering that if the weight for each class is taken as a free variable, instead of a fixed number. This is because the decision maker is always interested in obtaining the optimal weights in this kind of problem. Hence, trying to get the optimal solution with optimal weights in the model is our objective of this thesis.

Consider a directed network topology $G = (V, E)$, (as shown in Figure 1.1) where V and E denote the set of nodes and the set of links in the network respectively. Suppose we are given the maximal possible capacity (U_e) of each link e. Given the purchasing cost of bandwidth (κ_e) and the cost taking account of delay (ℓ_e) for each link e. In this network, there are m different classes of connections which have their own QoS minimal requirement (b_i) and maximal end-to-end delay (D_i). Denote the total number of connections, for each class i, by J_i. Let $\mathcal{K}_i$, for each class i, be an index set consisting of J_i connections, that is, $\mathcal{K}_i = \{1, \ldots, J_i\}$. Every connection, in each class, is allocated with the same bandwidth q_i and must satisfies the same QoS minimal requirement. All connections are delivered between the same source and destination nodes in this network. Under a limited available budget (B), we want to allocate the bandwidth in order to provide each class with maximal possible QoS. The purpose of this work is to maximize the weighted sum of utility functions of the bandwidth for each class.

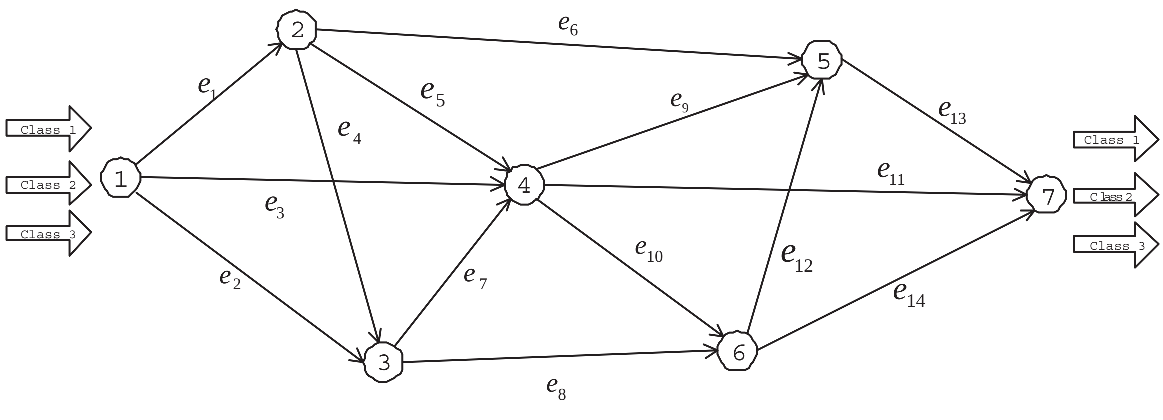

Figure 1.1: Network Topology for an Illustrative Example

Because the complexity of this problem is known as NP (Non-determined Problem) hard, we will adopt solver BARON of software GAMS (see [11] and [12]) to compute the optimal weighted sum of utility functions for each class i, $i = 1, \ldots, m$. This study is carried out by the models, named Model I and II, which are to be defined in Chapter 3. When it yields the first result, we carry on changing the parameter J_i to observe the variations of q_i, w_i and total utilization value. Subsequently, we keep on changing the parameter B and other parameters to observe their variations. By the numerical results in Model I, it shows that w_k is equal to 1 for some k, the others are equal to zero whatever parameters change. In Model II, the form of optimal weights is a vector $(w_1, w_2, \ldots, w_m)$ with $w_i = \frac{1}{m}$, for each $i = 1, 2, \ldots, m$.

This thesis is organized in the following. In Chapter 2, we introduce the network optimization model proposed in [15]. Chapter 3 introduces two models: Model I and Model II. Model I contains an objective function which is a weighted sum of logarithms of the bandwidth for each class and constraints. One of the constraints is that the sum of weights for each class is equal to 1, while Model II is considered with Ordered Weighted Averaging Method [9]. In Chapter 4, We investigate the difference between Model I and Model II. We draw the conclusion in Chapter 5. The listing file of GAMS are included in Appendices.