ATM Switch Capacity Allocation Problem

Youngho Lee* · Jeonghee Han* · Seong-in Kim*

* Dept. of Industrial Engineering, Korea University

Abstract

In this paper, we consider a switch capacity allocation problem arising from the deployment of asynchronous transfer mode (ATM). ATM is a standard of switching technology for broadband integrated service digital networks (BISDN). The most important feature ATM provides is that it guarantees successful transport of any service regardless of its characteristics, i.e., bit rate, quality requirement, or the bursty nature of traffic, thus making it possible to deploy ATM technology to any transport network. Moreover, ATM provides efficiency in the use of its resources through dynamic bandwidth allocation. Due to these attractive features ATM provides, most telecommunication companies are considering the evolution of their networks to broadband ATM networks.

Accordingly, network planners of telecommunication companies are facing some ATM network design problems, i.e., demand forecasting, virtual path (VP) routing, network sizing, etc. Customary, ATM network sizing refers to both switch and transport network sizing in an ATM environment. Among these two ATM network sizing problems, we deal with ATM switch sizing problem, where we determine the number of ATM switches along with their capacities necessary to satisfy customer demands such that total switch cost consisting of fixed cost and variable cost is minimized for each ATM switch site. Although transport network sizing problem is as important as switch sizing problem, in this paper, we focus on switch sizing problem due to the following two practical reasons : i) ATM is a switching technology which can be embedded to any transport of the existing networks, ii) thus, most telecommunication companies are considering the upgrade of their existing non-ATM switches to ATM switches first, and then the upgrade of transport networks in order to fully utilize their existing transport networks.

In order to describe the ATM switch capacity allocation problem more precisely, let us consider a set N of demands d_i for $i \in N = \{1, \dots, n\}$, and a set M of switch types, indexed by $k \in M = \{1, \dots, m\}$, each having its fixed cost c_k. And, let h_k be the (variable) cost of a single module of switch of type $k \in M$ having its unit capacity bk. Furthermore, let rk be the maximum number of modules that can be installed at switch of type $k \in M$. Then, the problem is to determine which switch types to use, and how many modules to install for the switches to use in order to minimize the total cost while satisfying all demands without splitting any demand over more than one switch.

We have developed two mixed-integer programming formulations and a column generation formulation of the problem. Also, we have prescribed a tabu search heuristic procedure that exploits the special structure inherent in the problem. Computational results show that the proposed tabu search heuristic procedure performs better than the column generation approach for almost problem instances.