A Genetic Algorithm for Joint Optimization of Spare Capacity and delay in Self-Healing Network

H W Chong

Department of Computer Science
City University of Hong Kong
83 Tatchee Avenue., Hong Kong

Sam Kwong

Department of Computer science
City University of Hong Kong
83 Tatchee Avenue., Hong Kong

Abstract

This paper presents the use of multi-objective Genetic Algorithms (mGA) to solve the capacity and routing assignment problem arising in the design of self-healing networks using the Virtual Path (VP) concept. The aims to minimize the sum of working and backup capacity usage and transmission delay often compete and contradict with each other. Multi-objective Genetic algorithm is a powerful method for this kind of multi-objective problems. In this paper, a multi-objective GA approach is proposed to achieve the above two objectives while a set of customer traffic demands can still be satisfied and the traffic is 100% restorable under a single point of failure. We carried out a few experiments and the results illustrate the trade-off between objectives.

1 INTRODUCTION

Reducing network protection costs while maintaining an acceptable level of survivability is one of the main objectives of the network planners. The transmission delay from a source node to a destination node depends very much on the paths chosen. Every customer likes to have a route with minimum delay, the TELCO operator cannot promise every customer that the route is the shortest. It becomes an interesting problem for one to choose routes that will compromise the interests of the TELCO operator and different customers.

The above problem can be regarded as the combination of two sub problems:
1. The objective to minimize capacity subject to a constraint on delay with given a network topology and assigned traffic requirements.
2. The objective to minimize delay subject to a constraint on the total capacity with a given network topology and assigned traffic requirements.

Obviously, these two sub-problems are dependent and cannot be easily solved without considering each other's existence. That is an issue that makes the above problem a relatively hard one, which is not easy to be solved using classical optimization methods.

To tackle the above problems, a GA-based multi-objective optimization approach is presented in this paper. We will see how the method obtains a Pareto set of solutions in that any single set of solution can be freely chosen according to the fulfillment of the system requirements. In this paper, we will also see that spare capacity and delay are jointed optimized and to provide a highly available service.

2 EXPERIMENTAL RESULTS

To validate the effectiveness of the proposed approach, we have performed experiment in network shown in figure 1. The experiment is based on customer traffic demands of 100 working virtual paths and the highest ranked chromosomes in the final generation are depicted in figure 2. A Pareto optimal set can be clearly obtained by applying the multi-objective GA-based approach.

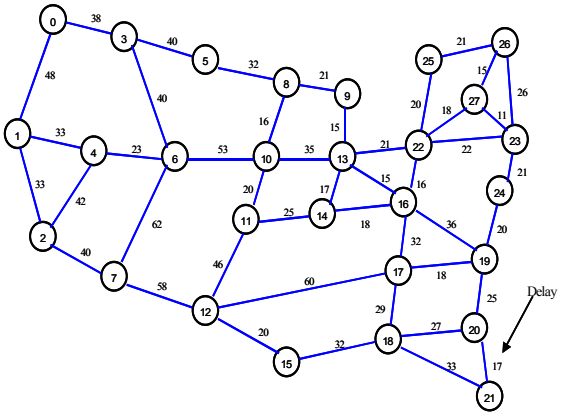

Figure 1. Network 1

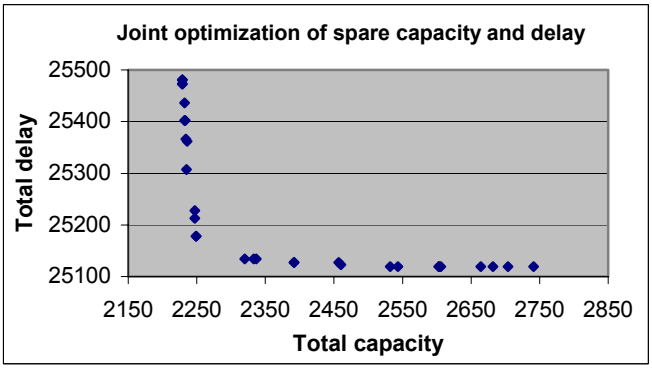

Figure 2. Final pareto front of Network 1