



Hierarchical Survivable Network Design Problems

Inmaculada Rodríguez-Martín^{1,2}

Juan-José Salazar-González³

*DMEIO
University of La Laguna
Tenerife, Spain*

Hande Yaman⁴

*Department of Industrial Engineering
Bilkent University
Ankara, Turkey*

Abstract

We address the problem of designing two-level networks protected against single edge failures. A set of nodes must be partitioned into terminals and hubs, hubs must be connected through a backbone network, and terminals must be assigned to hubs and connected to them through access networks, being the objective to minimize the total cost. We consider two survivable structures, two-edge connected (2EC) networks and rings, in both levels of the network. We present an integer programming formulation for these problems, solve them using a branch-and-cut algorithm, and show some computational results.

Keywords: Network design, survivability, branch-and-cut.

1 Introduction

We study several two level network design problems with survivability requirements in both levels. In a typical two level network, the upper level is called the backbone network and connects the hubs (concentrators, switches, multiplexers) among themselves, and the lower level networks are called access networks and they connect the users to hubs. Klincewicz [12] uses the notation “backbone structure/access structure” to specify the structure of a two level network. We are interested in designing two level networks that have protection against a single edge failure, i.e., we assume that at most one edge can fail at a time. We consider two survivable network structures, namely, 2-edge connected (2EC) networks and rings, in both levels of the network. As a result, we study the design problems associated with four different networks: 2EC/2EC, 2EC/ring, ring/2EC and ring/ring networks.

The literature on the design of survivable networks has grown over the last years. However, most studies on survivable network design problems consider a single layer of the network (see the reviews by Grötschel et al. [9] and Kerivin and Mahjoub [11]). There are few studies that consider the design of two level networks with survivability requirements in both levels. The majority of such studies are on designing ring/ring networks (Thomadsen and Stidsen [19], Carroll and Mc Garraghy [3]), and most of the approaches proposed are heuristic approaches (Shi and Fonseca [17], Balakrishnan et al. [1]). The contribution of the present paper is to propose formulations and exact solution methods for the two level survivable network design problem where both rings and 2-edge connected networks are used to ensure survivability.

We can find many related problems in the field of network design. Fortz and Labbé [5] and Fortz et al. [6,7,8] study the design of networks with bounded rings. Magnanti and Raghavan [14] and Balakrishnan et al. [2] consider different variants of two-edge connected networks. Soriano et al. [18] and Caserta et al. [4] treat the design of survivable telecommunications networks based on ring structures. Finally, as examples of other types of two-level network design problems, we mention the ring/chain problem studied by Lee and Kon [13] and the capacitated ring/tree problem studied by Hill and Voß [10].

¹ This work has been supported by “Ministerio de Educación y Ciencia”, Spain (research project MTM2012-36163-C06-01). The research of the third author is supported by the Turkish Academy of Sciences.

² Email: irguez@ull.es

³ Email: jjsalaza@ull.es

⁴ Email: hyaman@bilkent.edu.tr

Download English Version:

<https://daneshyari.com/en/article/4651595>

Download Persian Version:

<https://daneshyari.com/article/4651595>

[Daneshyari.com](https://daneshyari.com)