A primal heuristic for the routing and spectrum assignment problem

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Abstract

Flexgrid optical networks are an emerging technology in the field of optical networks. In these networks, the frequency spectrum is divided into narrow frequency *slots*, and a sequence of consecutive slots forms a *channel* that can be switched in the network nodes to create a *lightpath* between two nodes. The *routing and spectrum allocation problem* (RSA) [2] consists in establishing the lightpaths for a set of end-to-end traffic demands that are expressed in terms of the number of required slots.

Formally, we are given a digraph $G = (V, E)$ representing the optical fiber network, a fixed number $\bar{s} \in \mathbb{Z}_+$ of available slots, and a set of *demands* $D = \{d_i = (s_i, t_i, v_i)\}_{i=1}^{k}$, where each demand d_i, $i = 1, \ldots, k$, is composed by a source $s_i \in V$, a target $t_i \in V$, and a volume $v_i \in \mathbb{Z}_+$. We define a *lightpath* for a demand $d_i = (s_i, t_i, v_i)$ to be a tuple (l, r, p), where $1 \leq l \leq l + v_i - 1 \leq r \leq \bar{s}$ and p is a (directed) path in G from s_i to t_i. In this setting, RSA consists in establishing a lightpath associated to each demand, in such a way that lightpaths do not overlap. Deciding if RSA is feasible for a particular graph G, a set of demands D, and an amount of slots $\bar{s}$ is NP-complete [2], so calculating the minimum $\bar{s}$ such that RSA is feasible is NP-hard. Furthermore, these problems turn out to be quite difficult to solve in practice.

In this work we propose a primal heuristic to improve the branch-and-cut algorithm presented in [2] for one of the ILP formulations of the RSA problem proposed in [1], namely, the model DSL-BF.

Keywords: flexgrid optical network; routing and spectrum allocation; integer programming.

References

[1] Bertero, F., M. Bianchetti, and J. Marenco, *Integer programming models for the routing and spectrum allocation problem*, TOP **26** (2018), 465–488.

[2] Bianchetti M. and J. Marenco, *Valid inequalities and a branch-and-cut algorithm for the Routing and Spectrum Allocation problem*, Electronic Notes in Theoretical Computer Science (in press)".