

# 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  $d_i$ ,  $i = 1, \dots, k$ , 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. Marengo, *Integer programming models for the routing and spectrum allocation problem*, TOP **26** (2018), 465–488.
- [2] Bianchetti M. and J. Marengo, *Valid inequalities and a branch-and-cut algorithm for the Routing and Spectrum Allocation problem*, Electronic Notes in Theoretical Computer Science (in press)".