An Integer Programming Approach to Two-Layer Telecommunication Network Design

P. Belotti[1] **and S. Orlowski**[2]

Abstract: Most telecommunication networks consist of several subnetworks: A *virtual* layer in which the routing decisions are taken, and an underlying *physical* transport layer in which the communication demands are actually routed. A link in the virtual layer can be seen as a capacitated pipe (subpath) in the physical layer. Every routing path for a communication demand is composed of such pipes, and their total flow must not exceed the capacity of these pipes. The two-layer network planning problem consists of finding a set of capacitated pipes together with a routing of demands through these pipes, minimizing total link and node cost and possibly satisfying further practical side constraints.

The mathematical challenge is that capacity has to be installed not on physical links, but on subpaths in the network in integer multiples of a base capacity, which is usually large compared to the units in which the demands are given (typical values are 16 or 63).

We have developed an integer programming model using a path-flow formulation for a basic version of this network planning problem which occurs in different contexts. The model can easily be extended by several practical side constraints depending on the specific technology. Since generating new columns in the flow formulation also creates new rows, we try to obtain feasible upper and lower bounds by running a branch-and-cut-and-price algorithm on a relaxation of this model in combination with heuristics. In the talk, we will report on our experiences with this approach.

[1] Operations Research Group,
DEI, Politecnico di Milano,
P.za L. da Vinci 32, Milano, Italy,
belotti@elet.polimi.it

[2] Zuse-Institute Berlin,
Optimization Department,
Takustr. 7, 14195 Berlin, Germany,
orlowski@zib.de