SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

Action number: CA15127
STSM title: Optimization Model for Designing FSO Networks Resilient to Weather Conditions
STSM start and end date: 18/08/2018 to 24/08/2018
Grantee name: Michael Poss

PURPOSE OF THE STSM/

(max.500 words)

In [1] M. Pióro et al. proposed a protection strategy called Flow Thinning (FT). The purpose of the STSM was to extend the FSO network optimization model involving FT to the set of states (where each state corresponds to restricted availability of link capacities) described as polytopes. The advantage of using the later is that they are capable to efficiently describe the varying weather conditions. As FSO networks are vulnerable to weather conditions, their transmission quality can be easily degraded if special measures are not taken. A key property of the FT strategy is that it can handle effectively the end-to-end transmission continuity in FSO networks under fluctuating channel capacity due to changing weather conditions. In the STSM, we have added the uncertainty polytope state characterization to the existing mixed-integer programming optimization models.

[1] Michal Pióro, Yoann Fouquet, Dritan Nace, Michael Poss: Optimizing Flow Thinning Protection in Multicommodity Networks with Variable Link Capacity. Operations Research 64(2): 273-289 (2016)

DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS

(max.500 words)

During the STSM, we have pursued our work on an optimization model for resilient network dimensioning for an implementable version of FT, called quadratic flow thinning (QFT). With QFT, the capacity of each tunnel is adjusted according to an optimized, tunnel-specific quadratic flow thinning function, whose arguments are the fractions of currently available link capacities (in relation to the maximum link capacities) on a pre-specified, tunnel-dependent subset of links. The main novelty of the extended model is characterization of the link availability states by means of the so called state polytope instead of a limited list of preselected states. This feature makes it possible to dimension QFT networks for representative sets of states that can be met during network operation.

Dimensioning of FT networks is not an easy task because of non-compactness of the related linear (or mixed-integer) programming formulations. Roughly speaking, one must generate the scenarios that pertain to the uncertainty set on the fly, in the course of decomposition algorithms. This is somewhat related to the Benders cutting-plane generation algorithm, with the main difference that the separation problem is not based on linear programming duality. Instead, the later amounts to maximize the quadratic function defining the constraint on the uncertainty set. That problem can be cast as a QP (Quadratic Program) or MIQP (Mixed-

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Integer Quadratic Program), depending on whether fractional failure states are considered or not. While both problem types are strongly NP-hard to solve exactly, heuristic and opimal solutions can be obtained with the CPLEX solver.

During the STSM, a further extension of the resilient network dimensioning model was initially elaborated in order to cover the so called quadratic flow thinning (QFT) – an improved version of AFT.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

(max. 500 words)

The major result of the STSM consists in replacing traditional finite scenario sets by uncertainty polytope given by a compact number of linear inequalities. This required row-generation algorithms to generate s subset of the scenarios on the fly in the course of iterative algorithms.

The results achieved during the STSM will form the basis for a section in Chapter 3.11, on optimization of FSO mesh networks resilient to weather conditions, in the RECODIS final book "Guide to Disaster-resilient Communication Networks".

FUTURE COLLABORATIONS (if applicable)

(max.500 words)

The collaboration of Dr. Michael Poss (the STSM applicant) with Warsaw University of Technology will continue, with further visits planned for later this year.