SOUTENANCE DE THÈSE

M^me Marinela Shehaj

Soutiendra sa thèse de **Doctorat** sur le sujet :

Robust dimensioning of wireless optical networks with multiple partial link failures

Dans l'Unité de Recherche :

HEUDIASYC UMR CNRS 7253

Lundi 3 février 2020 à 10h

à l'UTC, bâtiment Blaise Plascal, salle GI42

devant le jury composé de :

M^me Ghada Jaber maître de conférences, université de technologie de Compiègne, laboratoire Heudiasyc
M. Jacek Rak, associate professor, Gdansk University of Technology, Pologne
M. Walid Ben-Ameur, professeur, Telecom SudParis, UMR CNRS 5157
M^me Corinne Lucet-Vasseur, maître de conférences, université Picardie Jules Verne, MIS
M. Dritan Nace, professeur, université de technologie de Compiègne, laboratoire Heudiasyc
M. Michal Pioro, professor, Warsaw University of Technology, Pologne

Invité :
M. Michael Poss, chargé de recherche, université de Montpellier, UMR CNRS 5506, LIRMM

Robust dimensioning of wireless optical networks with multiple partial link failure.

This thesis summaries the work done in optimization of wireless optical networks. More specifically, the main goal of this work is to propose appropriate network dimensioning algorithms for managing the demand and ensuring traffic satisfaction in a network under partial link failures (i.e. when some links and/or nodes are operational with reduced capacity) caused mostly by weather conditions. The primary criterion in deciding the efficiency of the proposed algorithms for the network is the dimensioning cost of the network while keeping the traffic satisfaction at high reasonable levels.

The main application area of this thesis are the networks that apply Free Space Optics (FSO) - a well-established broadband wireless optical transmission technology where the communication links are provided by means of a laser beam sent from the transmitter to the receiver placed in the line of sight. FSO networks exhibit several important advantages but the biggest disadvantage is vulnerability of the FSO links to weather conditions, causing substantial loss of the transmission power over optical channel. This makes the problem of network dimensioning important, and, as a matter of fact, difficult. Therefore, a proper approach to FSO network dimensioning should take such losses into account so that the level of carried traffic is satisfactory under all observed weather conditions.

In this thesis, we firstly describe such an approach. It starts with introducing a relevant dimensioning problem and presents a robust optimization algorithm for such enhanced dimensioning. To construct our approach we start with building a reference failure set which uses a set of weather data records for a given time period against which the network must be protected. Next, a mathematical model formulation of the robust network dimensioning problem uses the above failure set. Yet, such obtained reference set will most likely contain an excessive number of states and at the same time will not contain all the states that will appear in the reality. Hence, we propose to approximate the reference failure set with a special kind of virtual failure set called K-set parameterized by an integer value K, where K is less than or equal to the number of all links in the network. For a given K, the K-set contains all states corresponding to all combinations of K, or less, simultaneously affected links. Sometimes, there are situations where the weather is extremely bad and what we propose is to build a hybrid network model composed of FSO and fiber links. Furthermore this idea is extended by considering simultaneous degradations of K nodes (meaning degradation of all adjacent links). Finally, inspired by the hitting set problem a new idea was to find a large number of subsets of two or three affected links and to use all possible combinations (composed of 2 or at most 3 of this subsets) to build a new virtual failure set that covers as much as possible the reference failure set that we got from the study of real weather data records. Next, this new failure set will serve as input for our cut-generation algorithm so that we can dimension the network at a minimum cost and for a satisfactory demand realization.

A substantial part of the work is devoted to present numerical study for different network instances that illustrates the effectiveness of the proposed approach.

Keywords: Resilient and survivable networks, operational research, free space optics, variable link capacity, linear and mixed-integer programming, and robust optimization.