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## Internship subject proposal

*Title:* Routing reconfiguration in WDM networks

*Intern level:* Master's thesis / Engineering school

*Duration:* 3 to 6 months with possible continuation in PhD

To perform a maintenance operation on a link of a WDM backbone network, it is necessary to change first the routing of all connections using that link on available resources. But, this may force to change the routing of other connections (as well as their protection plan). In this context, the routing reconfiguration problem is to schedule the order in which connections are rerouted, but due to cyclic dependencies between connections, it might be necessary to interrupt temporarily some connections during this phase. This problem has recently been modeled as a cops-and-robber like game in the digraph modeling the dependencies between connections [1], thus allowing to use powerful graph theoretic and algorithmic tools (treewidth, pathwidth, dynamic programming,...). The objective is either to optimize the number of simultaneous disruptions, or the overall number of disruptions, or trade-offs[3]. The problem is NP-complete in general and difficult to approximate, but can be solved in polynomial time for particular classes of (di)graphs [2]. Other objectives have now to be investigated, including:

- Consideration of physical constraints: when using a new wavelength in a fiber, it is necessary to adapt the tuning of already used wavelengths. Also, the cost of switching a connection from one path to another depends on the current usage of target fibers, and so of previous actions. New algorithms must be designed to handle these constraints.
- Scheduling of maintenance operations: it is possible to pool some route changes between consecutive maintenance operations in order to reduce the overall number of traffic disruptions. The goal is thus to determine the best scheduling of the maintenance operations.
- Trade-off between the number of disruptions and the number of intermediate routes: instead of disrupting a connection during a reconfiguration phase, it is possible to use an intermediate route if enough resources are available in the network.

**Prerequisites:** Algorithmics, graph theory, and programming languages (C or java). Integer programming would be a plus.

## Bibliography

- [1] D. Coudert, F. Huc, D. Mazaurec, N. Nisse, and J-S. Sereni. Routing Reconfiguration/Process Number: Coping with Two Classes of Services. In 13th Conference on Optical Network Design and Modeling (ONDM), Braunschweig, Germany, February 2009. IEEE.  
<http://hal.inria.fr/inria-00331807>
- [2] N. Cohen, D. Coudert, D. Mazaurec, N. Nepomuceno, and N. Nisse. Tradeoffs when optimizing Lightpaths Reconfiguration in WDM networks. Technical report RR-7047, INRIA, Sept. 2009.  
<http://hal.archives-ouvertes.fr/inria-00421140/>
- [3] D. Coudert and J-S. Sereni. Characterization of graphs and digraphs with small process number. Research Report 6285, INRIA, Sept. 2007. <http://hal.inria.fr/inria-00171083/>