

Master thesis – Internship proposal

## Network topology and multipath routing

One of the challenges of networking is to control the flow of data to optimize the use of resources and ensure equitable service to users. Control of Quality of Service can be improved by using routing solutions. Among routing mechanisms, multipath routing allows to soundly balance the load on the network, thus improving overall resource utilization and fighting against congestions.

Mechanisms for load balancing are already in use in network cores. Studies [1] highlighted the use of ECMP [2], which allows data to be transmitted over multiple routes with equal costs. However, these multi-paths are often quite short, or merely apply to links between single pairs of routers.

The objective of this master thesis is to investigate the relationships linking the topology of the networks and the opportunity to efficiently implement a multipath routing. Examining the multipath algorithms and routing protocols in the literature [3,4,5], it is first necessary to define what is the *efficiency* of a multipath routing. This may rely on indicators such as the number of routes discovered, their length, the fact that they are totally or partially disjoint, etc. Questions about the metrics are substantial: is it easier to build metrics opportune to multipath routing, or to overcome metrics to just rely on topology? The answer to these questions may be different, using equal cost paths or not. We should also consider load sharing, because the routing can offer a large amount of poor routes that will eventually not be used by the sharing mechanism.

Is it possible to link indicators related to the topology (nodes degrees, distribution of these degrees, k-connectivity, etc.) to those that characterize the efficiency of multipath routing? Knowing the topological characteristics of a network, is it conceivable to say what multipath routing algorithm is most effective?

Considering the problem from a different angle, and given a routing algorithm, can we infer models of topology which could favor multipath efficiency? Are there topological patterns which hamper the establishment of multiple routes; on the contrary, are there patterns which tend to improve it? Is it possible to create realistic networks based solely on patterns that promote multipath routing? Can we create a set of simple topologies (case studies) facilitating the evaluation or comparison of the quality of a multipath routing algorithm?

### Supervisors

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### Bibliography

- [1] Brice Augustin, Timur Friedman, and Renata Teixeira, *Measuring multipath routing in the internet*, in IEEE/ACM Transactions on Networking (TON), vol. 19, issue 3, pp. 830–840, June 2011.
- [2] C.Hopps, *Analysis of an Equal-Cost Multi-Path Algorithm*, RFC 2992, November 2000.
- [3] S.Vutukury. *Multipath Routing Mechanisms for Traffic Engineering and Quality of Service in the Internet*. PhD thesis, University of California, Santa Cruz, 2001.
- [4] X.Yang and D.Wetherall, *Source selectable path diversity via routing deflections*, in SIGCOMM, volume 36, pages 159–170, october 2006.
- [5] Pascal Mérindol, *Routage multichemins par interface d'entrée*, PhD thesis, Université Louis Pasteur, Strasbourg, 2008.