Capacity Reconfiguration in Logically Fully-Connected Networks

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Abstract

Loss networks have been commonly used to model telecommunication systems for decades. Their mathematical properties were explored by Kelly [2] and Whitt [3] in the mid-1980s. While it may seem that the essentially circuit-switched nature of these models would make them unsuitable for today's packet-switched data networks, there are still applications to IP networks with Label Switched Paths, ATM networks with Virtual Path Connections and optical networks.

In a loss network with complete sharing, a call is accepted if there are sufficiently many free circuits on all the links along its route to meet its capacity requirements. An alternative strategy for managing a network might be to partition the capacity on the physical links to create a logically fully-connected network which overlies the original network. Such a network could be expected to have a reduced level of performance because calls might be rejected when they could have been accommodated, but the trade-off could be worthwhile in terms of simplicity of management.

In a logically fully-connected network, it is essential that logical capacities be assigned to the links in the correct manner. Given a fixed underlying physical network and traffic loads, it is easy to formulate this as an optimisation problem which can be solved by a number of methods. One which works surprisingly well is a greedy algorithm called XFG, due to Berezner and Krzesinski [1]. Under realistic traffic loads, the performance of such a network is not far below that of a network with complete sharing.

A problem remains in that traffic loads are unlikely to remain fixed over medium to long-term timescales. To overcome this, we need a method for

reconfiguring capacity in response to changes in traffic loads. Such methods may also be able to respond to stochastic fluctuations even over short timescales. In this talk, I shall discuss a number of different methods for doing this. They are all distributed in nature and result in the network itself acting like an intelligent entity. I shall also describe some solved and unsolved mathematical problems that have arisen in the course of this work.

References

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[2] Kelly, F.P. (1986) Blocking probabilities in large circuit switched networks. *Advances in Applied Probability* **18** 473–505. 1986.

[3] Whitt, W. (1985) Blocking when service is required from several facilities simultaneously. *AT&T Technical Journal*, **64** 1807–1856.