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Techno-economic concepts and techniques used for strategic planning of optical telecommunication networks

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ABSTRACT
This talk will discuss research results on Strategic Planning obtained in the IWT GBOU-project "Optical Networks and Node Architectures".

The network planning problem is situated in a constantly changing environment. Nearly all important inputs for the network planning process vary over time. Changes are observed in the number of customers as well as in the type of the offered services. Data traffic has for instance known a tremendous growth and this greediness is not expected to stop. However, future traffic demands are not known in advance, therefore predictions have to be used. No expert can produce exact predictions and no methodology can completely eliminate the uncertainty. The traffic volume is expected to keep growing, but the growing rate is unknown. Apart from future demand, also future equipment cost is unknown. Strategic planning focuses on helping the network operator to expand his network in an economical way in this dynamic and uncertain environment.

Several parts of the strategic network planning problem have been studied in the project and will be discussed in this presentation. Different techniques to assess the uncertain situation and take this into account during planning calculations were described. The concept of anticipated network planning to take into account long-term evolutions is described. A lot of attention is also given to the use of economic investment decision techniques for the network planning problem. Network expansion can be considered as a long-term investment problem involving import cash flows for the network operator. Among those cash flows, revenues and costs can be distinguished. Costs for the operator include capital as well as operational costs. Special attention was given to the development of an OpEx cost model for a network operator. To describe long-term network expansion, the use of classical investment decision techniques like Net Present Value is compared to the recent approach of Real Options Valuation. All research topics were studied concerning realistic network planning examples. Finally, the presentation will also cover recent research results, obtained during the last phase of the project. In the light of the ongoing traffic growth in backbone networks, both the use of grooming and the introduction of Optical Cross-Connects (OXCs) are interesting solutions for a network operator to transport this traffic in an economical way. Grooming means optimizing the resource usage in a multi-layer transport network e.g. by efficiently packing low-capacity traffic streams into high-capacity optical channels in an IP-over-Optical network. The introduction of OXCs in backbone nodes allows to send transit traffic in the nodes directly on the optical layer, without going back to the IP layer in intermediate nodes, saving capacity on the IP layer. Since OXCs are still very expensive today, it is important for the operator to find the optimal introduction time. Starting from the trade-off between link-by-link and end-to-end grooming, we have studied the gradual migration from a network without OXCs (using link-by-link grooming) towards the introduction of OXCs in some nodes (and the use of end-to-end grooming). A migration path introducing OXCs in so-called end-to-end grooming islands is proposed. The impact of OXC introduction on the logical network layer, as well as some practical implications, is described. A case study for a pan-European network with growing traffic demand over the time interval of 10 years illustrates the practical application of the suggested migration technique. It is shown that OXCs get introduced gradually. To be able to spread the expenses and gradually adapt to the growing traffic demand, the island based grooming approach is a straightforward and effective approach. Starting from an entirely link-by-link grooming network in 2004, nearly all core nodes are equipped with OXCs by 2014. Simulations have shown that this island based grooming approach can lead to important savings in capital expenditures. Sensitivity analysis revealed that the main cost driver in case of link-by-link grooming is the SDH line card cost. A lower line card cost favours the use of link-by-link grooming, whereas a higher cost favours the introduction of OXCs and the use of end-to-end grooming.

Keywords: strategic planning, optical networks, investment decision techniques, migration

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