Techno-Economic Study of Optical Networks

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***Abstract*— Techno-economic research focusing on optical access networks traditionally looks at the upfront network installation costs. This paper additionally indicates where techno-economic research is heading and which questions it aims to answer.**

Keywords- techno-economic; next generation optical access; total cost of ownership; optical access; business modelling,

I. INTRODUCTION

Telecommunication networks are dominated by very rapid technology evolution, rendering existing equipment quickly outdated, increasingly closing gaps between formerly incompatible fields (e.g. broadcast and broadband). Additionally there seems to be no limit yet to the bandwidth the customer could consume (due to the ever newer and more bandwidth thirsty services) and would be willing to pay for when given the opportunity. Given the broad variety of projects to invest in as well as the competitive setting, it is for the operator not straightforward to estimate which project will have highest chance of getting the highest return. Especially for those projects which involve large network infrastructure rollouts, and unknown returns, a thorough and methodologically sound investment and risk assessment is required. The deployment of an FTTH network, which is currently under question in different regions across the world, is a typical example.

This paper gives a condensed overview of the field of techno-economic research and the current existing knowledge base considering optical access networks. Additionally this paper also indicates in which directions this techno-economic research is extended to cope with future challenges for Next Generation Optical Access (NGOA) networks.

II. ECONOMICS OF OPTICAL ACCESS

Techno-economic research takes a closer look at the economic value of (e.g. telecom) technology, infrastructure and services. Evaluating a telecom deployment project is much more than just summing up all costs and revenues, as network technology is very complex and infrastructure costs are huge and cover large geographical areas. The installation and operation of new equipment and deployment of new services is spread over many years and the different services have very different and uncertain uptake. Moreover, the related costs are varying over time and so is the competitive setting.

Optical access networks have been the focus of a lot of techno-economic research since they are associated to a limited number of users (i.e. low cost sharing factor and low bandwidth compared with aggregation and core networks). The main concern of most of this research has been on the investment in the new network infrastructure, as an FTTH network involves the deployment of a whole new network and the replacement of all the equipment at the customer side and in the central office. This is the highest cost and as such has been considered in most detail (e.g. contrast point-to-point and point-to-multipoint network in fiber).

Existing studies indicate how the cost of installation of the all optical access network infrastructure has a cost of at least 400-500$ per connection in dense urban areas and quickly reaching a cost higher than 1000$ per connection for more rural areas [1],[2],[3]. Additionally, customers are split between different operators within the same regional area, and as such only part of the connections are customers increasing therefore the cost quickly over 1000$ per customer. The 70% of this cost is associated to the outside plant [1]. The difference in cost between technologies – active optical networks vs. passive optical networks – is typically somewhere around 10% [1],[4]. Operational processes and revenues are typically not modeled in detail in the existing studies.

III. ECONOMIC CHALLENGES FOR NEXT GENERATION OPTICAL ACCESS

While the focus of the existing studies was on the upfront investment cost of the optical access network, many operators still struggle with the options beyond this point and look for answers to questions such as how to get the lowest long term operational expenditures, how to lower the energy consumption, or what technology will give market advantages and best upgrade possibilities. Regular investment analysis is not incapable of giving answers to these questions nor can it give sufficient information on the outcome of any new service deployment, estimation of risk profile, optimal long term upgrade strategies, etc.

A first step in this direction is seen in different projects, including OASE [5], in which the techno-economic research is looking at the full cost of ownership for an optical access network, completing the infrastructure costs with operational expenditures and taking all stages of the complete lifecycle of the project into account and finally also covering the full access area from the customer up to the central office. As such the research gives a better view on all components of the costs and will be able to give a more balanced toolbox for optimizing the choices in all stages, areas and technologies.

Especially when looking at different future technologies and architectures for an FTTH network, it is important to make sure that the total cost of ownership is used as a basis for the comparison (Figure 1). In the case of migrations between technologies, operational processes and comparison of different scenarios will become more important. The total cost of ownership evaluation should combine technical research on the NGOA technologies, system concepts and architectures with the techno-economic methodology. As such it will give indications for each particular scenario on the most cost efficient technology upgrade paths and migration strategies in these. It will also assess technology and evolution thereof on a long term basis.

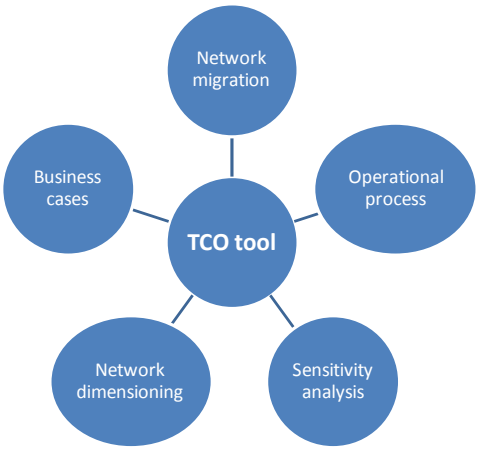

Figure 1: TCO tool structure as used within OASE

Finally, as the replacement of the full telecom access network is very costly, it could well not be considered profitable in many areas, typically the more rural areas, when only considering subscription revenues. Such large infrastructure rollouts involve many actors each with their own agenda, gains and goals. Business modeling complements the total cost of ownership view on the infrastructure or service. It indicates the interplay between the different actors and allows to allocate the overall costs and revenues calculated for the entire system to the different individual actors. Business models [6] indicate for which parts of the network competition is possible, e.g. there will most probably be only one physical infrastructure provider, on this of which there can be several competing network and service providers. Especially in those areas where there the TCO situation is favorable, competition aspects might be have a lot of impact. A operator who can attract only half of the market share can only count of half of the revenues to cope with his costs.

Next to that it is also necessary to take a closer look at possibilities and gains in cooperation, especially in those situations where an NGOA network would not naturally be installed by operators alone. Synergies between different utilities (telecom, electricity, gas, water) can be expected, both in deployment and in operations [7]. As the vast majority of outside plant deployment cost relates to trenching, this can be significantly reduced by installing different utility networks jointly in case of green field situation. In the operational phase, physical cable cuts will in a lot of cases effect multiple of these networks, some joint failure notification and localization process will therefore be beneficial for both of them. Although joint deployment and operation of different utility networks will definitely increase the coordination cost, this will by no means outweigh the overall gains in TCO.

The outcome of both the detailed view on the influence of competition and cooperation are the main inputs for discovering a feasible Europe wide NGOA rollout.

IV. Conclusions

Techno-economic research complements technological evolution and products with an economic analysis with the aim of indicating different tradeoffs and giving recommendations. It is essential for building a valid business model for a new technical advance and optical access networks have been given a lot of attention in this field of research. Traditionally this focused on the upfront network deployment costs using traditional investment analysis. These indicated that under current market structure the rollout of such network is only feasible in the dense urban areas. In the OASE project, this techno-economic research is extended with more detailed analysis of NGOA, including future technologies, upgrades and migration paths and looking at the total cost of ownership for the full lifecycle. The decision of an operator strongly depends on the business model and the comparison of alternative business models from the impact of the NGOA deployment is investigated. Finally the OASE project aims to give recommendations for operators, vendors and regulatory on how to deploy and evolve the optical technology.

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