Research Approach towards the Profitability of Future FTTH Business Models

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Abstract: In order to offer future higher bandwidth applications, the choice for a fiber to the home (FTTH) network seems to be the best candidate. Still, as the full deployment of a new FTTH network involves tremendous civil works and costs, only the highly profitable areas, e.g. city centers, are currently being installed. With the installation of such FTTH networks, all involved parties stay with many questions. What will the future bring on demands from services, upgrades of equipment and maintenance of the new network? What are the next best areas to install and where will an FTTH network require additional public stimulants to succeed? What are the best business models to get a sustainable long term countrywide FTTH installation? In this paper we present the OASE approaches for more in depth analysis of the FTTH total cost of ownership (TCO) and for comparing different possible business models both qualitatively and quantitatively. We show how building a complete TCO tool with a modular approach will help to compare different installation and migration scenarios and it will also form a sound basis for evaluating business models. Here we start with an overview of all actors involved and the roles they can take in the deployment and exploitation of the network.

Keywords: Techno-economic, Business Modelling, Optical Access, FTTH

1 The need for FTTH

Telecom is a fast evolving market, in which new applications can quickly take over, offer ever richer services, but also require more and more bandwidth. Many currently existing access network infrastructures based on DSL (Digital Subscriber Line) or HFC (Hybrid Fiber Coax) technology run increasingly in bandwidth shortage problems. To offer the currently high-end services as HDTV, 3D TV, online gaming, etc. and especially to be ready for the future even more demanding services (e.g. 4K TV, videophones, thin clients, etc.) an FTTH network offers the most cost-efficient solution. FTTH has already been rolled out in several areas worldwide, and an important question for a lot of operators today is where and when to deploy FTTH networks to new areas. With an FTTH network in place in the viable regions, new business issues will come up for the operators. Within the FP7 ICT-OASE project [1] – Optical Access Seamless Evolution – the focus is on the business issues that arise once FTTH is rolled out to the viable regions. Here the different actors on the market – operators, suppliers, public instances – are interested in the evolutions of applications, customer demands, prices, technologies and business models and the influence on their business models.

Considering the evolution of access bandwidth in the past, we might expect, if the trend holds, that the peak bandwidth being delivered to the customer in 2020 would be in the line of 1Gbps. In the scope of OASE we consider next-generation optical access (NGOA) networks with a dedicated and sustainable bandwidth up to 500Mbps (per customer) and a peak bandwidth of at least 1Gbps (shared) to be the goal of future evolutions. Additionally, in order to have more opportunities for reducing the costs, for instance by reduction of the amount of central offices (i.e. node consolidation), we also look at solutions which offer a transmission distance up to 100km with only amplification nodes in between, and a passive split ratio allowing up to 1000 customers per fiber feed. This last point of focus could also allow for important operational savings, as maintenance costs for the outside plant will be highly depending on the amount of fibers in the network. Clearly these three requirements will pose enormous constraints on the NGOA network and equipment and are unreachable with current equipment. In the future, solutions will come up to increase bandwidth per customer, split ratio and transmission distance. Comparing the different future solutions on their costs for installation is not straightforward. In future scenarios, up to 2020, we will first have to take into account that the network is most probably already installed in some regions and the choices made at the point of deployment will pose constraints on the solutions possible and influence the migration costs. Secondly, planning up to 2020 (and beyond) will most probably also have to take into account more than one migration as equipment is often replaced after 5 years (or less). Thirdly in 2020 the telecom marketplace might look substantially different than today. Business models from the different telecom actors might have shifted considerably and new currently non-existing business models might have arisen. Finally, estimating the costs of installation within 5 or 10 years will introduce important uncertainties, e.g. costs will evolve a lot in time, and the evaluation will give a broad range of outcomes instead of one single expected outcome. Clearly the evaluation should take into account constraints, migration scenarios, business models and input uncertainties. The outcome of the OASE techno-economic evaluation will as such not be one path and its viability, but rather general recommendations on current and future installations and a description of the options for telecom actors on the evolution of FTTH leading to NGOA networks.

In order to be able to evaluate many different scenarios and business cases, we develop in OASE both a TCO tool able to calculate migration scenarios with special focus on operational processes, and detailed business modeling approaches aimed at evaluating possible business models in 2020 on their viability, achievability, constraints, etc. In the following sections, both topics will be discussed in more detail. After this we conclude the paper with the main messages and a view on the techno-economic research path of OASE.

2 Calculating the Total Cost of Ownership of FTTH

The first step in evaluating the economics of an FTTH network for possible future scenarios is clearly to make a good estimation of all costs incurred. In typical upfront planning of an FTTH network, the deployment costs are very high and should be calculated in detail [2][3]. In more future oriented scenarios, especially in those projects in which an optical access network already exists, the migration of the network from one generation of the optical technology to the next generation, customer management and network operations will become more important drivers for the costs. Typically calculating costs is a complex task, much more complex than calculating revenues when the customer base is known. Estimating the customer base is part of a dedicated task within OASE and is not part of the focus within this paper. The combination of TCO and revenues is the necessary input to perform more detailed investment analysis.

A first techno-economic goal of the OASE project is to implement a total cost of ownership (TCO) calculation tool capable of calculating long term migration scenarios. In the remainder of this section, we show how to find all required models to come up with a complete TCO tool, how to couple this TCO tool to the main influencing parameters (e.g. prices, customers, etc.), and to what building blocks and tool selection this has lead as a conclusion.

2.1 Calculating all costs

When calculating the costs, it is important to make sure that all costs are represented in the model. In order to do this, we start from a project lifecycle – planning, deployment, migration, operational and teardown – as shown in Figure 1 and combine this with a zooming approach in which we increase the detail of the largest or most risky/unknown cost components first. Clearly the figure already gives an indication of the importance of the different cost components, by means of stronger and darker text and lines, in the total cost of the exploitation and upgrade of an FTTH network.

As mentioned with the zooming approach, we delve into more detail in the largest subcomponents (or influences) of the final cost. An example of this is shown in the migration phase, where it will be important to make a distinction between pre-connection of the customer in new areas vs. later connection of the customers especially from a cost point of view. We further split this cost to come up with detailed cost components for which both input and calculation are easier to make. An example of this is energy costs which are part of the continuous costs of infrastructure, and in their turn part of the operational phase. It is more straightforward to link this cost to specific inputs and calculations which will also be shown in the following section.

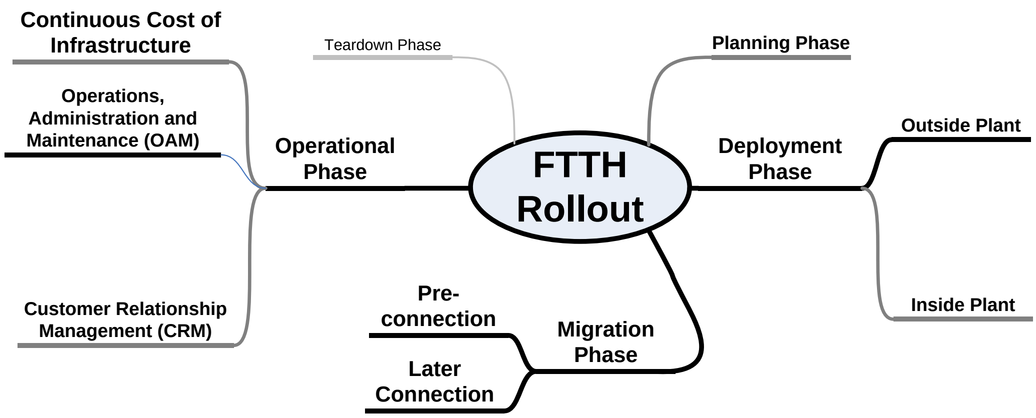


Figure 1: Project lifecycle and zooming approach

2.2 Finding the sources of the costs

In order to find the sources for all costs, we started by identifying the parameters (including also cost factors) that should be considered in the TCO evaluation. They have been classified in 4 categories and each parameter can easily be linked to at least one phase of the proposed cost breakdown: Network related parameters contain any parameter related with the network and its offered services. For example, the times to set-up, tear-down or change any running service can be included in the operational phase of the network as well as the component failure rate and energy consumption, whereas the component cost and space can be included in the planning phase. Area related parameters include area size, user distribution, ground cost, and existing infrastructure. Most of them can be included in the

planning phase. Financial related parameters such as inflation, learning curves, depreciation can be included in the planning, deployment and operational phases.
Operator related parameters include parameters related to human resources (e.g. salaries for each type of employee, working shifts, etc.), billing and accounting can be linked to the operational phase.

By combining the cost breakdown shown in the previous section with the full scan of cost sources shown in this section, we will be able to build a full TCO tool with a dedicated level of detail for each cost. As mentioned before, for instance energy cost, which is one of the finest grained cost components in the previous section will require as input a list of the different network components and for each of them their energy consumption.

2.3 A plan for building the OASE TCO tool

From both approaches and the scan of existing tools, we constructed a building blocks model for the TCO tool as shown inFigure 2. As a lot of the proposed functionality has already been incorporated within the FP6 IST-TONIC tool [8] – TechnO-ecoNomICs of IP optimised networks and services – we will start from this tool and adapt it to reflect the focus on migration scenarios and the outcome of the cost breakdown and source detection as mentioned before. On top of this TONIC tool, we will implement missing functionality (for instance to reflect business models) and interface with more detailed tools at disposal of the project partners. As such we break down the complexity of the implementation. Additionally all calculations still hold a valid look at the total cost even while investigating very specific sub-scenarios.

The extensions and interfaces to the TONIC tool are:

- Business model – as further explained in the next section – indicates the business roles and actors associated to the business scenario that should be evaluated. This input will indicate which costs should be included in the TCO evaluation.
- Operational model describes the operational costs associated to the network and offered services. One example could be the lifecycle based operational model, which could be applied to the network (shown in Figure 1) and to the services [4][5].
- Cost model indicates the considered cost parameters as well as their dependence with other factors such as time, inflation, competition, etc. This model includes for example the learning curve for the costs of each component.
- Dimensioning tool gives the required equipment and infrastructure to cope with the given demand, network and topology. The output of this tool will depend on the technology, the required protection, the targeted bandwidth, etc.

Based on these inputs, the TCO tool will evaluate the TCO assigned to a particular case study and the cost migration evaluation of different migration paths from a defined scenario [6][7]. Some post-processing could be done by the TCO tool or by a separate tool (e.g. sensitivity analysis, real option evaluation, etc.).

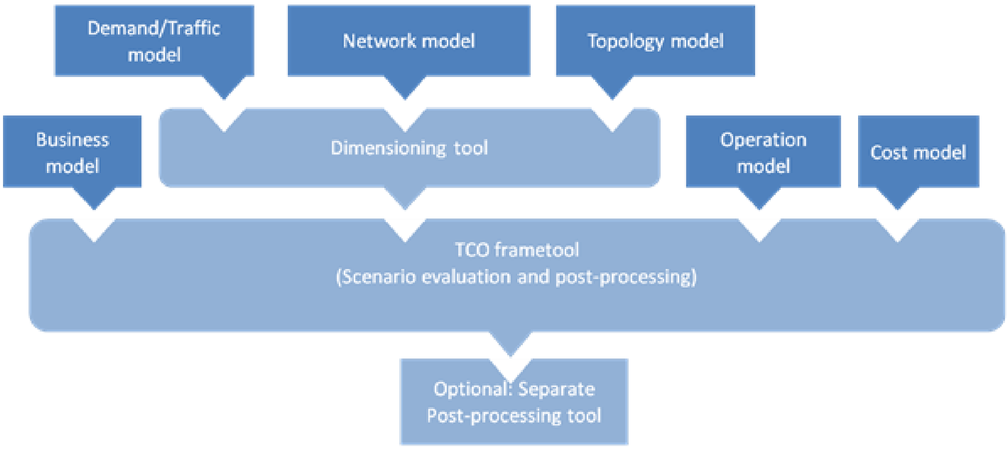


Figure 2: Different building blocks for TCO tool

3 A view on the business models for FTTH

Of course, calculating the costs only gives you a part of the picture. The business model and the market will also have an important impact on the outcome of the project. In the OASE project we will have a closer look at the impact of multiple actors on each other and on the outcome of an FTTH project. In order to do this we first look for the different business roles (e.g. fiber deployment, physical customer connection, network repair, etc.) that need to be taken care of in exploitation of the FTTH project. Next we will look for actual actors in the marketplace (e.g. housing company, telco, municipal network provider, etc.). The combination of roles and actors will form the actual value network for FTTH. Within OASE a limited set of interesting business cases will be quantitatively analyzed making use of the TCO tool as described in the previous section.

3.1 Business Roles

The responsibilities in the network can be segmented based on the considered network lifecycle phases like deployment, customer provisioning and operations. Alternatively we can also distinguish the different network parts like backbone, access, building and home. Furthermore, we can use a layered view on the network distinguishing the following 6 layers: right-of-way/trenching, duct/fiber, WDM/MAC, IP, service and content. These are indicated on later visualisations as 6 layered rectangles with trench+RoW at the bottom and content on top.

This finest granularity combination of network layer, lifecycle phase and network part will unambiguously define the elementary business roles (Figure 3). As the service and content layer are not relevant in the backbone network, they are omitted there. Similarly, the RoW/trench layer is omitted in the home part of the network. For example the role indicated by the black box indicates the physical operations in the fiber layer of the access network, meaning repairing all fibers in case a cable or duct breaks.

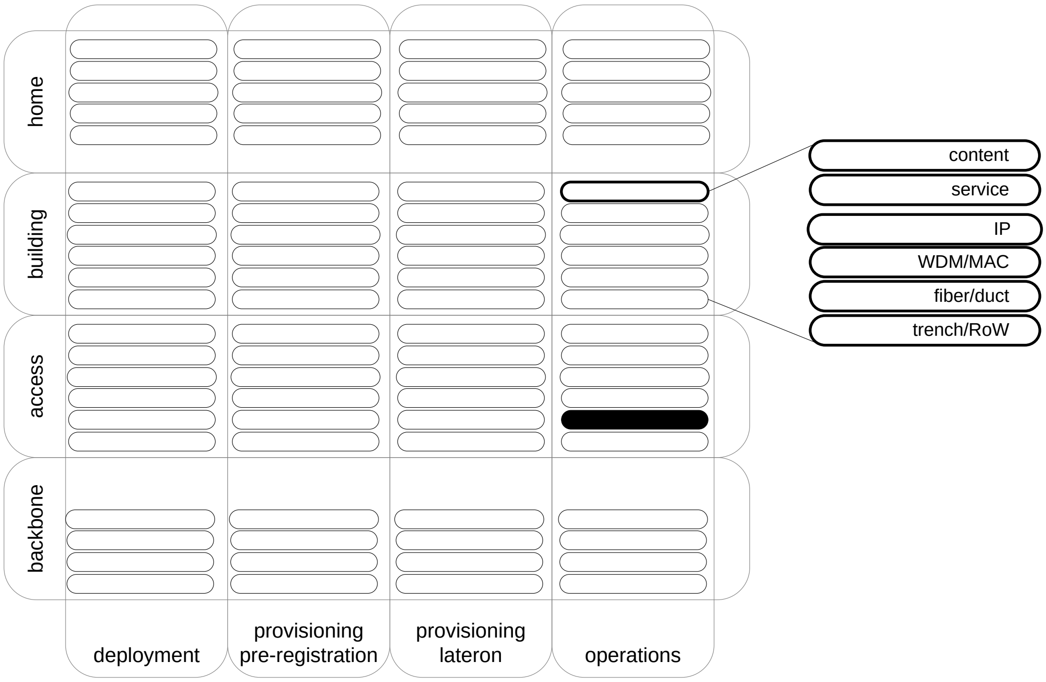


Figure 3: Elementary business roles define responsibilities on different network layers in grid of network lifecycle phases and network parts

3.2 Business Actors

The actual players in the FTTH field are the business actors. Within the OASE project, we identified the following network oriented actors. They are unambiguously defined by specifying the roles they take responsibility for (Figure 4 (a)).

- A Telecommunication Operator (telco) operates the networks necessary for data, voice and IP-based video transportation. This group includes the incumbents in telecommunications and mobile network operators (MNO), e.g. BT, Deutsche Telekom, France Telecom, etc. He basically takes the roles in backbone and access networks for all lifecycle phases and all network layers. All roles indicated by vertically striped boxes in Figure 4 (a) are under the responsibility of the telco.
- A Cable Operator maintains and operates cable TV and Internet access. He takes similar roles as the telco.
- A Public Municipal Infrastructure Provider constructs, manages and exploits optical fiber to the home networks (or to the building) within cities and intends to provide every dwelling with a connection, acts in public interest and therefore takes the dark grey roles in Figure 4 (a). A Private Municipal Infrastructure Provider acts in private and also takes the light grey roles in Figure 4 (a).
- A Municipal Infrastructure and Network Provider constructs, manages, exploits optical fiber to the home (or to the building) networks within cities and operates these networks with own active equipment.
- Housing Companies construct, manages and exploits optical fiber to the home networks restricted to the in-house area, and acts in public interest. He takes the diagonally striped roles in Figure 4 (a).

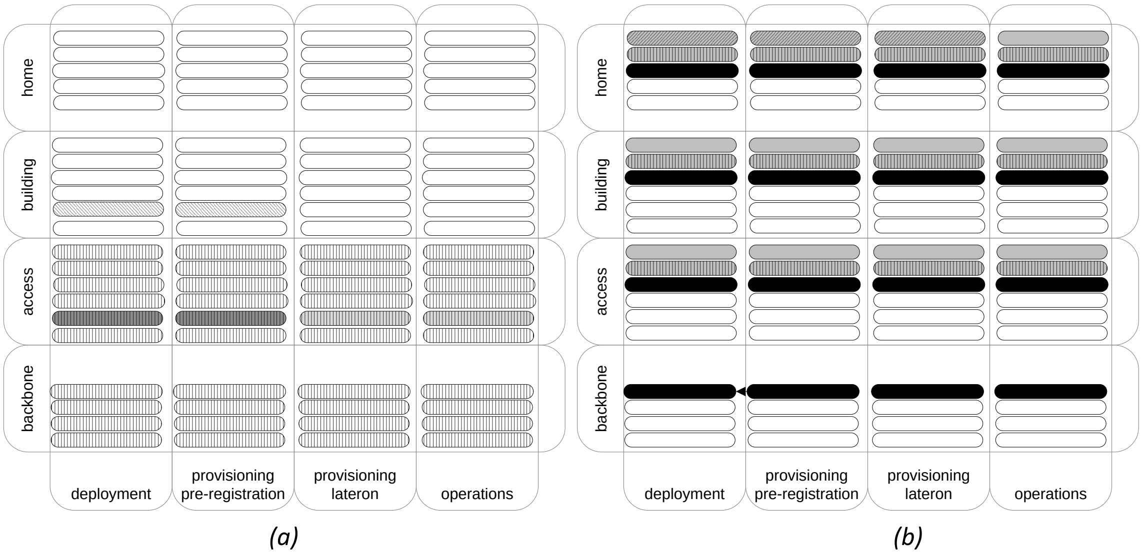


Figure 4: network oriented actors (a) and application service oriented actors (b) mapped to elementary business roles

Furthermore, also the application service oriented actors have been identified [9]. Again, they are defined by specifying their responsibilities in terms of elementary business roles (Figure 4 (b)).

- An Internet Service Provider offers his customers access to the Internet, keeps the customer data and provide AAA functionality; however, these companies do not necessarily operate their own network (e.g. United Internet, Virgin, Level Free, etc.). He takes the roles indicated by the black boxes inFigure 4 (b).
- An Application Service Provider develops and offers internet services. He takes the vertically striped roles in Figure 4 (b) (e.g. NetFlix, Apple, OnLive, Google, etc.)
- A Content Service Provider produces, owns, aggregates and resells content and often has own service platforms (e.g. Warner Music Group, EMI, Sony BMG, etc.). He takes the grey roles in Figure 4 (b). The diagonally striped roles indicate that the set-top box deployment and connection may be under the responsibility of the customer (do-it-yourself).

3.3 Business model scenarios

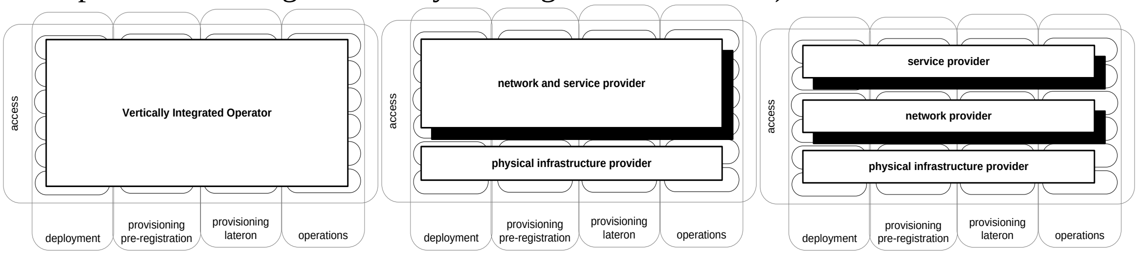
Once actors are mapped to roles, value streams can be added between the different roles in order to fully define the value network. Value streams indicate relations between roles, which can be anything like money, knowledge, goods, bandwidth, etc.

Within these value networks, we can select specific situations (combinations of roles). For the business studies concerning NGOA networks, we are most interested in the different levels of openness in the access network, indicating where competition is possible. Therefore, we identify the following relevant business models in the access network below: vertically integrated operator, co-opetition above the physical layer and a fully open access network. These are in line with three of the business models described in [11]. Of course, they need to be related in more detail to the actors and business roles in the other parts of the network (backbone, building and home), which will be studied within the OASE project. For the sake of readability, the figures in this section only focus on the access network.

- *Vertically integrated operator*. This scenario considers the original business case of an operator who is active on all layers and will take up most (if not all) roles within the

FTTH network (Figure 5(a)). Clearly this situation is possible in the so-called black areas [10], in which more than one FTTH deployment can be viable at the same time and as such infrastructure competition is also probable on the technology level (VDSL, HFC or Mobile Broadband). This will be a kind of a business reference case in order to identify the impacts of other scenarios related to. In some areas, the business case of a vertically integrated operator could remain also for the future. Of course, in practice, all kinds of resale based on wholesale offers within higher layers are in place as well. The vertically integrated operator (telco, cable operator) takes up all roles over the different network layers and network life cycle phases. Furthermore, it can take up both the backbone and access part, building and home are generally not under this responsibility.

- *Co-opetition above the physical layer*. Here we will look into the scenario in which the FTTH physical infrastructure (up to the fiber) has been deployed and operated by one actor who opens up this infrastructure for all network and service operators on top (Figure 5(b)). This is a valid scenario in areas, where there are not enough incentives to roll out an FTTH network for more than one (grey area) and even not for one (white area) private operator (nomenclature defined by the EU [10]). In this situation a cooperative deployment of the FTTH infrastructure, in white areas in cooperation with public funding, could prove to be the single business case allowing FTTH to be deployed in a shorter term in these areas and with a more competitive service provisioning on top of it. Both the cooperation and competition on top of it could lead to a higher customer surplus.
- *Fully open access network.* One step further than the business case mentioned above, is a fully open access network in which the network is opened up to different actors at different levels [11]. To enable that, a split is introduced between the physical infrastructure (provided and owned by one – typically but not necessarily public – actor), the network connectivity equipment such as Ethernet and IP layers (provided by possibly several actors) and the service layers (provided by a multitude of actors (Figure 5(c)). The promises of this scenario are an increase in customer surplus. The first reason is the fact that the sunk costs are taken by bodies which can support long-term return-on-investment (even taking into account indirect revenues), and which are compatible with the role of natural monopoly closely associated with infrastructure. The second reason is that by splitting the network connectivity and services, the customers could get a higher number of services provided by smaller firms with possibly limited access to capital but with high flexibility and degree of innovation).



(a) *(b)* *(c)*

Figure 5: business model scenarios considered within OASE

The business model scenarios described here will be evaluated using the TCO tool described above. A clear description of the different actors in terms of the business roles they take responsibility for, will allow to define interfaces in the network cost model unambiguously. Using these interfaces for communication between the TCO tool and the business scenarios allow to retrieve cost values for the different business roles. Those will be combined with expected revenues from the demand and market model in order to lead to a full investment analysis evaluation for all business actors involved.

4 Research Path of OASE

The current paper focuses on describing a useful framework for techno-economic and business oriented evaluation of FTTH network deployments. This goes beyong the typical capex-based, single player evaluation and is essential in a realistic assessment of the viability of an FTTH network. Note that actual numerical results based on the framework will be presented in follow-up work.

When installing an FTTH network, the upfront costs of deployment are very important. When glazing into the crystal ball of the future optical technology evolution, migration scenarios become much more important cost-wise.

Within OASE the first techno-economic focus is to develop a total cost of ownership (TCO) tool which goes further than the current existing tools, as we focus on longer term evaluation including future technologies and migration scenarios. In this paper we have shown how we make sure that we consider all relevant costs in the right amount of detail and how we link this to the driving parameters. Finally we have indicated that in OASE we will build an integrated tool based on the existing TONIC tool, which will interface with more dedicated tools (e.g. for operational modeling). In combination with dedicated revenue models, which will be developed in a later stage within OASE, this will lead to a reliable investment analysis toolkit for future FTTH upgrades.

Clearly when looking at the future and taking into account that FTTH will most probably not be deployed in all areas (so-called white areas) without public funding, the business model will also have an important impact on the outcome of future FTTH evolutions. In this paper we have shown how we detect the different business roles to be performed in the FTTH project and can link them to the existing (and new) actors in the marketplace. From the full value network of all possible actors, roles and their interactions, we selected tree business cases on which we will focus. In those business cases we will perform more dedicated evaluations using the aforementioned TCO tool.

The use of an integrated and fully cost covering TCO tool and the possibility to extend this through the means of interfaces, in combination with a detailed multi-actor view and selection of realistic business cases, will allow OASE to come up with meaningful longer term techno-economic predictions for FTTH technology.

References

[1] http://www.ict-oase.eu/

[2] A. Mitcsenkov, G. Paksy, T. Cinkler, "Topology Design and Capex Estimation for Passive Optical Networks", 6th International ICST Conference on Broadband Communications, Networks, and Systems (BroadNets 2009), Madrid, Spain, Sep. 14-16, 2009.

[3] K. Casier, S. Verbrugge, R. Meersman, D. Colle, M Pickavet, P. Demeester, *A clear and balanced view on FTTH deployment costs*, The journal of the Institute of Telecommunications Professionals (ITP), Vol 2, Part 3, 2008, pp. 27-30.

[4] K. Casier, S. Verbrugge, R. Meersman, D. Colle, P. Demeester, "On the costs of operating a next-generation access network", 7th Conference of Telecommunication, Media and Internet Techno-Economics (CTTE 2008), Paris, France, June 18, 2008.

[5] C. Mas Machuca, O. Moe, J. Eberspächer, M. Jäger, A. Gladisch, "Service cost model and cost comparative studies", INFO Journal, Vol 11, No 3, May 2009.

[6] M. Jaeger, R. Huelsermann, "Network migration cost study", 14th International Conference on Optical Network Design and Modeling (ONDM 2010), Kyoto, Japan, Feb. 1-3, 2010.

[7] R. Zhao, L. Zhou, C. Mas Machuca, "Dynamic Migration Planning towards FTTH", Networks 2010, Warsaw, Poland, Sep. 27-30, 2010.

[8] T. Monath; N. Kristian; P. Cadro, D. Katsianis, D Varoutas, "Economics of fixed broadband access network strategies", IEEE Communications Magazine, vol. 41, issue 9, Sept. 2003.

[9] T. Monath, M. Kind, T. Heger, M. Schlesinger, J. I. Aznar, "Economical analysis of experience-optimized service delivery", 9th Conference of Telecommunication, Media and Internet Techno-Economics (CTTE 2010), Ghent, Belgium, June 7-9, 2010.

[10] EU, "Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks", Official Journal of the European Union, (2009/C 235/04), section 40.

[11] M. Forzati, C. P. Larsen, C. Mattsson, "Open access networks, the Swedish experience", 12th International Conference on Transparent Optical Networks, ICTON 2010, Munich, Germany, June 27 - July 1, 2010.