

Van Ooteghem, Jan et al.

**Conference Paper**

## Municipal driven fiber access network rollout

19th Biennial Conference of the International Telecommunications Society (ITS): "Moving Forward with Future Technologies: Opening a Platform for All", Bangkok, Thailand, 18th-21th November 2012

**Provided in Cooperation with:**

International Telecommunications Society (ITS)

*Suggested Citation:* Van Ooteghem, Jan et al. (2012) : Municipal driven fiber access network rollout, 19th Biennial Conference of the International Telecommunications Society (ITS): "Moving Forward with Future Technologies: Opening a Platform for All", Bangkok, Thailand, 18th-21th November 2012, International Telecommunications Society (ITS), Calgary

This Version is available at:

<https://hdl.handle.net/10419/72501>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

**Proceedings of the 19th ITS Biennial Conference 2012  
Bangkok, Thailand**

**Municipal driven fiber access network rollout**

**By**

**Jan Van Ooteghem, Koen Casier, Sofie Verbrugge,**

**Didier Colle, Mario Pickavet, Luc De Heyn,**

**Raf Meersman and Bart Rosseau**

## **Municipal driven fiber access network rollout**

**Jan Van Ooteghem, Koen Casier, Sofie Verbrugge, Didier Colle, Mario Pickavet**

**Ghent University – IBBT**

**Research Group Broadband**

**Communication Networks (IBCN)**

**Gaston Crommenlaan 8 bus 201, B-9050 Gent, Belgium**

**Email: jan.vanooteghem@intec.ugent.be**

**Luc De Heyn, Raf Meersman**

**Comsof N.V.**

**Gaston Crommenlaan, 10 bus 101, B-9050 Gent, Belgium**

**Bart Rosseau**

**Stad Gent, Department Strategie en**

**Coördinatie, Cel E-Strategie**

**Botermarkt 1, B-9000 Gent, Belgium**

### **Abstract**

A citywide fiber to the home network would certainly bring about a lot of advantages for the municipality. Still the operators tend to hold off, partly because of the very high deployment costs and often also because there is a medium high bandwidth network available. This is also the case for the city of Ghent in which an FTTH network is not available and does not seem to be planned in the near future. In this paper we investigate to which degree the municipality can play a role in triggering the rollout of FTTH or less extensive a fiber to the business rollout by initiating the first steps in the deployment. If a city plans to connect its own public buildings first, such as governmental offices and city services and in extension hospitals, schools, museums and other public care or recreational centers, it could already open up some of the advantages of an FTTH network to its citizens. One step further, the city could take a more foresighted deployment scenario into account, in which more ducts and feeders are deployed and some detours are allowed, to enable a faster and cheaper rollout towards businesses and/or residential customers. In this paper we investigate three rollout scenarios with varying focus and amount of foresight: sequential (noncoupled) rollouts; optimized for municipal, public and business areas; fully optimized network for all buildings in the city. The final scenario targets thus a future proof network topology for the whole city. The results of this study shows a much lower final cost when considering a full optimal rollout plan from the start for all buildings in your city. The potential value will also be higher, as the cost for furthermore rolling out towards a business and full FTTH network for inhabitants will be much lower. In addition a geomarketing methodology should be used selecting the most optimal areas focusing first on connecting municipal and other public buildings.

**Keywords:** Techno-economics, network dimensioning, municipal network, geomarketing

# 1 Introduction

For telecom operators, migrating to an all fiber access network is often a bridge to far. As none of the current European telco operators are taking the lead, a network rollout initiated by municipalities might be the solution.

Cities would certainly be interested in a rollout of a fiber network, as the direct and indirect benefits for the municipality itself can be large. A lot of savings can be made by reducing telecommunication leasing costs by connecting own and other public buildings such as schools, hospitals, social service offices or museums with own fiber. Currently a new digital divide is emerging here, as a lot of publicly owned instances do not have the money to invest in telecom, or do not even see the benefit of moving towards fiber. If the municipalities take as their focal point connecting their own departments and services and other public services, the network deployed in such could form a mazed backbone network for rolling out furthermore towards their inhabitants. Geomarketing can be used in order to select the “best” area or buildings to start rolling out fiber. This method is based upon selecting first the customers (both businesses and residential) with highest potential (e.g. ARPU driven by telecom operators, public buildings or black areas with high level of digital divide for municipalities). The second section will take a closer look at the context in which a municipal network is rolled out and the European legislation on telecom investments.

Based upon interviews with the city, we have listed buildings in four consecutive rollout phases: municipal buildings, other interesting public buildings, business areas and finally residential dwellings. Three optimization rollout scenarios are analyzed: sequential (non-coupled) rollouts; optimized for municipal, public and business areas; fully optimized network for all buildings in the city. The final scenario targets thus a future proof network topology for the whole city. The third section will describe in more detail the rollout phases, scenarios and the manner in which the dimensioning is calculated.

As this study is conducted together with the city of Ghent, the city center has been selected for this analysis. Section four and five present the case study and results of the GIS based network dimensioning, and calculations and analysis of the costs and revenues expected in the different cases. A network dimensioning tool developed within the TERRAIN project is used for this analysis [1]. Finally section six concludes this paper with a small overview of the methodology, the most important findings of the calculations and gives a more thorough explanation of the relevance of this in the TERRAIN project and more in general for municipal network deployments.

## 2 The legislative context of rolling out a municipal network

We focus in this paper and within the project on municipal fiber networks. Different options can be considered when rolling out these networks, and will depend on the actor that will take the initiative. When existing or new telecom infrastructure providers take the initiative, only the residential customers will be targeted, as they are the final customers of these providers. Taking a look at the broader picture, a lot of opportunities are missed in this approach. Municipal buildings, local neighborhood centrums, schools, hospitals, other care centrums, social services, etc. are most of the time not considered by these residential focused operators. Most of the time, these public customers will be connected upon the residential focused network. On the other hand when the physical infrastructure provider is more public/socially focused

(either initiative by the municipality or other large infrastructure provider such as utility companies), a broader perspective might be considered.

Still a public actor cannot just roll out a new municipal network using public money. There are several legislative rules to follow in order not to distort the market and/or go in competition with existing telecom providers [2]. A summary of the regulatory framework is provided in the following paragraphs.

There are in general two laws relevant to the deployment of NGA: (i) EU state aid rules, and (ii) telecom regulation.

First, the EU state aid rules prohibit in principle any financial resources made by the government, e.g. the city of Ghent, that confer selective economic advantages upon undertakings (regardless whether it is public or private), distort or threaten to distort competition, and affect the EU trade. The government's involvement in an NGA project is thus limited. In principle, the role of government can be found in the following situations.

1. Governments can play a coordinating role at the stage of infrastructure deployment, for example, demanding telecom operators to lay ducts when the road is opened by other companies.
2. Governments can make investments in broadband underdeveloped regions (certainly white zones, grey zones subject to further analysis) in order to promote services of general economic interest.
3. Governments can establish public private partnerships (PPP) with other undertakings if the project pursues genuine market interests. In this case, governments act as an investor, which does not qualify as state aid.

In other situations more active involvement of governments may possibly be blocked by the European Commission as infringing the EU state aid rules.

Secondly, telecom regulation concerns access and interconnection between telecom operators. There are two different approaches to regulate telecom operators: (i) symmetric regulation and (ii) the SMP regulation, or asymmetric regulation.

Symmetric regulation can be addressed to all telecom operators, regardless of their market power. It is nevertheless applicable only in limited situations. The one most relevant to the deployment of NGA is the obligation of co-location and the sharing of associated facilities. In other words, all NGA operators may be obliged to share facilities such as buildings, entries to buildings, building wiring, masts, antennae, towers and other supporting constructions, ducts, conduits, manholes and cabinets. However, there is no general obligation. Regulators must issue individual decisions when this obligation is necessary.

The most important approach is asymmetric regulation, or the SMP regulation. This regulation only concerns undertakings with significant market power (SMP). In most cases they are the incumbent operators. The incumbent operators are obliged to open their network at the infrastructure stream, at the connection stream and also at the application stream. In addition, they should also inform access-seekers of their migration towards NGA no less than 5 years in advance.

In the following sections we focus on the rollout of an optimally dimensioned municipal fiber network for all stakeholders in the city (municipal itself, public buildings and services, business areas and finally the inhabitants), considering that the public actors take the lead, and possibly finance at least their own internal network.

### 3 Constructing an optimal topology for a PPP with phased rollout

Geomarketing can be used in order to select the “best” area or buildings to start rolling out fiber. This method is based upon selecting the best customers first to connect to the new network, thus determining the rollout sequence for a predefined area [3]. This selection can be based upon different parameters: customers (both businesses and residential) with highest potential ARPU (mostly driven by telco operators), greenfield and brownfield areas where large (utility) infrastructure works must take place, shortest distance to the central office or other distribution point (thus lowest cost to connect), bridging the digital gap, etc. In case of a municipality the main focus should be on connecting their own and other public buildings first with more bandwidth, before considering other types of customers (such as businesses and residential dwellings).

#### 3.1 Rollout phases

We have defined four consecutive rollout phases, depending on the levels of importance from a municipal point of view:

1. *Municipal buildings*: these include all buildings for public administration, such as city hall, office buildings for municipal departments and tourist centra, but also local neighbourhood centra.
2. *Other public buildings*: locations of all other public services is included in this category such as hospitals or other public healthcare centra, schools (kindergarten, primary, secondary), university and museums, social service centers, etc.
3. *Business areas*: very important for the city are the local business areas as they (will) generate (additional) benefits for the city (taxes, employment, attraction of new inhabitants, etc).
4. *Residential dwellings*: homes of the local inhabitants (either single dwelling units or apartments within multi-dwelling units).

As mentioned in section 2 EU and national regulation decides that this network should only have the functionality of offering high bandwidth for public services, thus the level of municipal involvement is limited, but facilities could be foreseen from the start to have the option to furthermore rollout (towards business areas and residential dwellings) a future proof FTTH network in the end.

#### 3.2 Rollout scenarios

Based upon the different levels of importance of buildings based upon the geomarketing strategy of the municipality, we can define different rollout scenarios. The graphical representations can be found in [Figure 1](#).

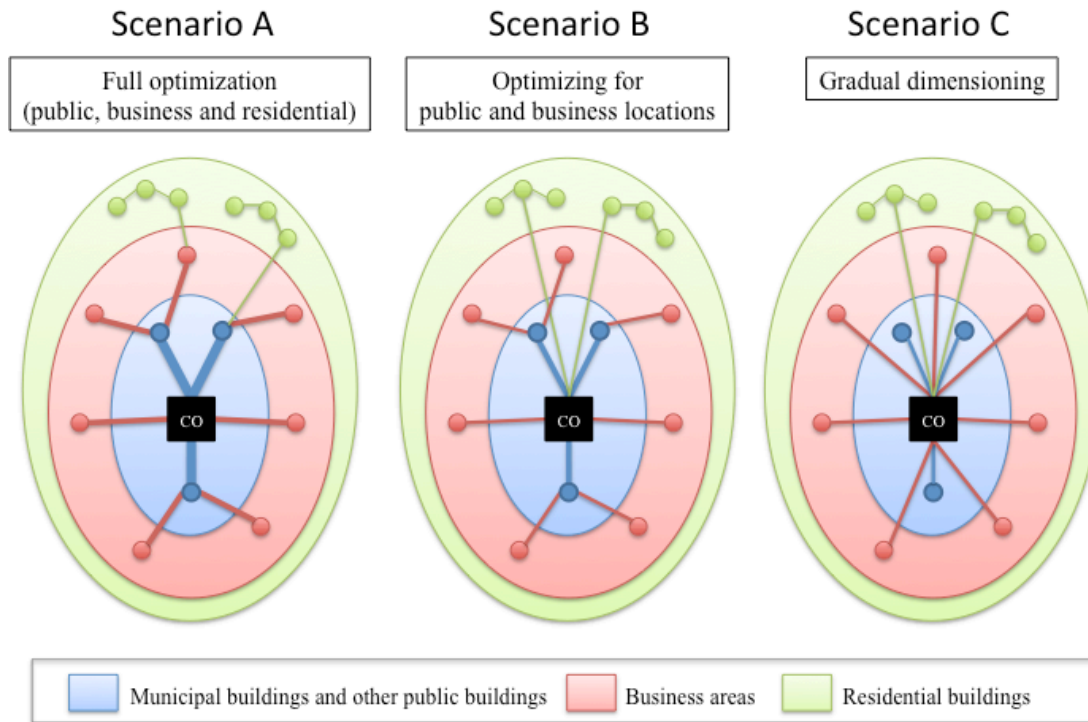


Figure 1: Rollout scenarios

### Gradual dimensioning (Scenario C)

There is no real preference or rollout sequence, thus no consideration of combining effort, reuse of trenching or ducts, or other processes for connecting the different buildings in the city. To connect municipal or other public buildings, the current (if available) infrastructure could be reused, thus extending the network infrastructure. When no infrastructure is available, for each building separately or group of buildings with the same level of importance, a network dimensioning and rollout plan will be made, not always taking into account other infrastructure rollouts, due to budget and/or timing issues or other parties involved. All networks can thus be considered separate. No or few costs will be saved from cooperation, combined use of infrastructure or equipment. This will thus be a suboptimal solution, leading to an increased overall cost and only limited optimized network architecture (just for the targeted area considered). This scenario will be used as benchmark for comparing the amount of optimization in the other scenarios.

### Optimizing for public and business locations (Scenario B)

A municipal initiative considering not only their own buildings but also other public locations and business areas would result in a more optimized solution. Several trenches could be reused, a better dimensioning of the required fibers will be proposed, optimization of network equipment, etc. will lead to a lower cost and faster rollout than the first scenario. As this network will comprise most of the city, and is optimized for business areas, it could be reused in the future as backhauling network for residential purpose (but only as passive optical network, as splitters must be placed to group several customers over the available fibers). On the other hand if a point-to-point network will be foreseen for the inhabitants of the city at a latter stage, additional (avoidable) trenching is required, leading to increased (and supplementary) costs.

### **Full optimization (public, business and residential building) (Scenario A)**

When considering all the buildings in a city with their own requirements (e.g. municipal buildings and business areas requiring more connected fibers than residents), a full optimal scenario could be worked out, optimizing trenching length, rollout time and overall cost. Even if the network would not be rolled out in one time, you have the option to continue at the point stopped, still knowing that your network architecture is still future proof. This case you could work towards a full point-to-point network for all buildings in the city.

### **3.3 Network topology**

Different types of network topology could be chosen for this municipal fiber network: ring or tree, or combination. We will consider a tree topology starting from the central office (CO). Between the different COs, a ring topology should be foreseen, but as we only consider one CO for this dimensioning, we will discard this in our solution.

A choice could also be made between a point-to-point (P2P) network, where every building or apartment will be connected directly to the central office with (a) dedicated fiber(s), and point-to-multi point (P2MP), where the fiber is split along the route and thus shared amongst several users. We consider in this paper a P2P topology for the dimensioning of the network, as this offers the best potential for the future in terms of choice of network equipment, bandwidth, upgradability, competition, etc. but is more expensive (more fibers required) [4]. This topology is mostly used in municipal fiber network rollouts, compared to a P2MP topology by most incumbent operators.

We discard also the discussion concerning a CO based passive optical network (thus splitters placed in the CO before the OLT (optical line termination) equipment) and an active optical network, where each customer is directly connected to the OLT. We consider in this analysis the latter (more expensive and future proof in terms of competition) technology in this study.

## **4 Case description**

The city of Ghent is located in the Flemish part of Belgium. It is Belgium's third largest city by number of inhabitants, as it counts 247,262 inhabitants [5]. Apart from its fixed residents, Ghent hosts about 65,000 students in its university and other higher education institutions, of which many reside during the week in the city (although not taken up in the statistics).

The municipality of Ghent (i.e. the city itself and 11 surrounding communities) covers a surface of 157.69 km<sup>2</sup>. [Figure 2](#) gives an overview of the city area and the distribution in terms of number of households.



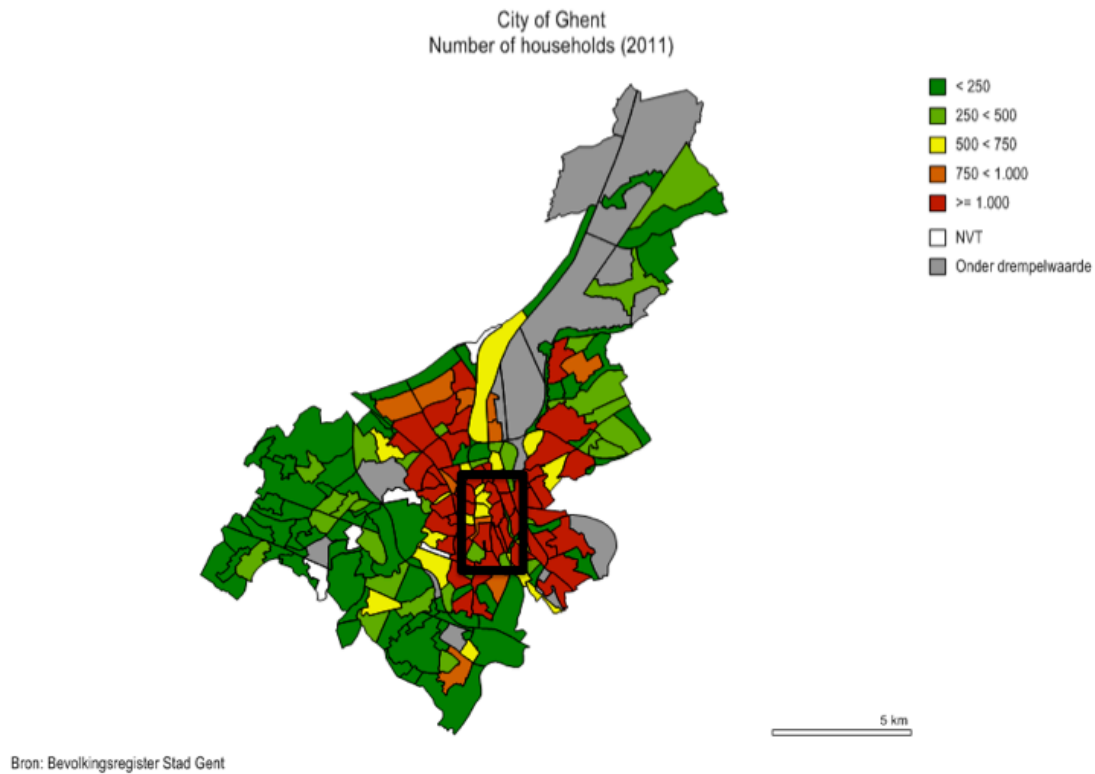


Figure 2: City of Ghent (in terms of inhabitants) [5]

For this analysis we will only focus on a specific area, right in the city center (black box in [Figure 2](#)). Following buildings with GIS based locations [6] in the selected area are considered, and thus taken into account for phase 1 till 4: municipal buildings (35), other public buildings (28), business areas (2,057) and residential dwellings (15,980). The distribution of locations can be seen in [Figure 3](#).

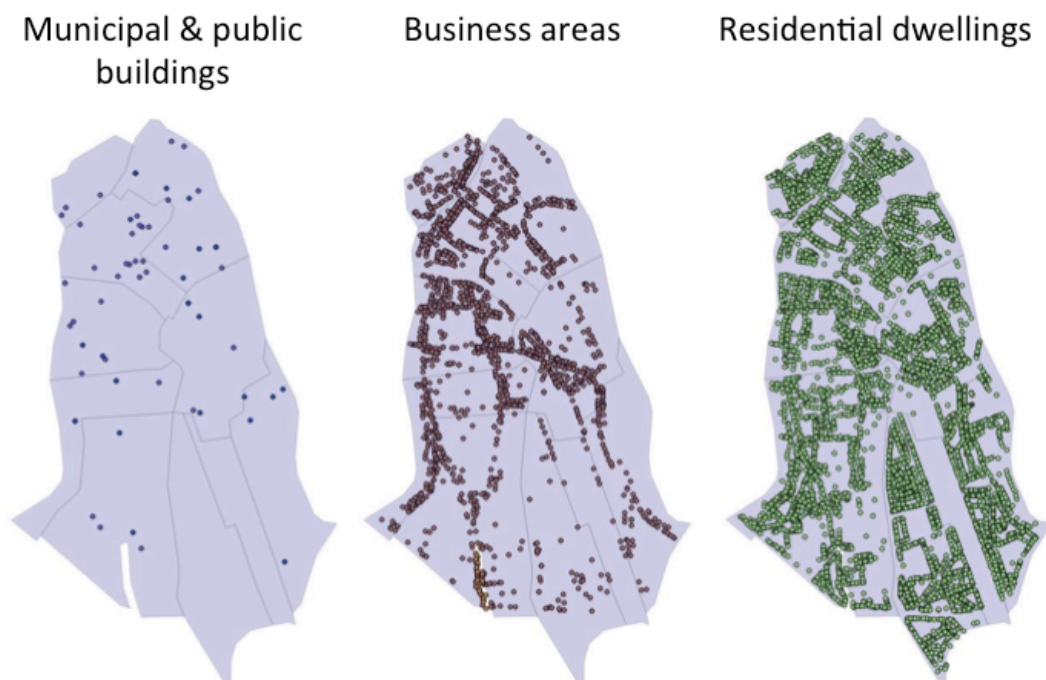


Figure 3: Selected area for network dimensioning in Ghent (Binnenstad) [6]

## 5 Results

We have calculated the optimal rollout topologies for the three scenarios described before. We calculated the full physical installation path including trenching, ducts, cables, flexibility and drop points, central office and the costs for lighting up the path from the customer locations to the central office. A view on the different topologies will already give some interesting insights in the focus and outcome of the alternative scenarios. The topologies are shown and analyzed in the first subsection.

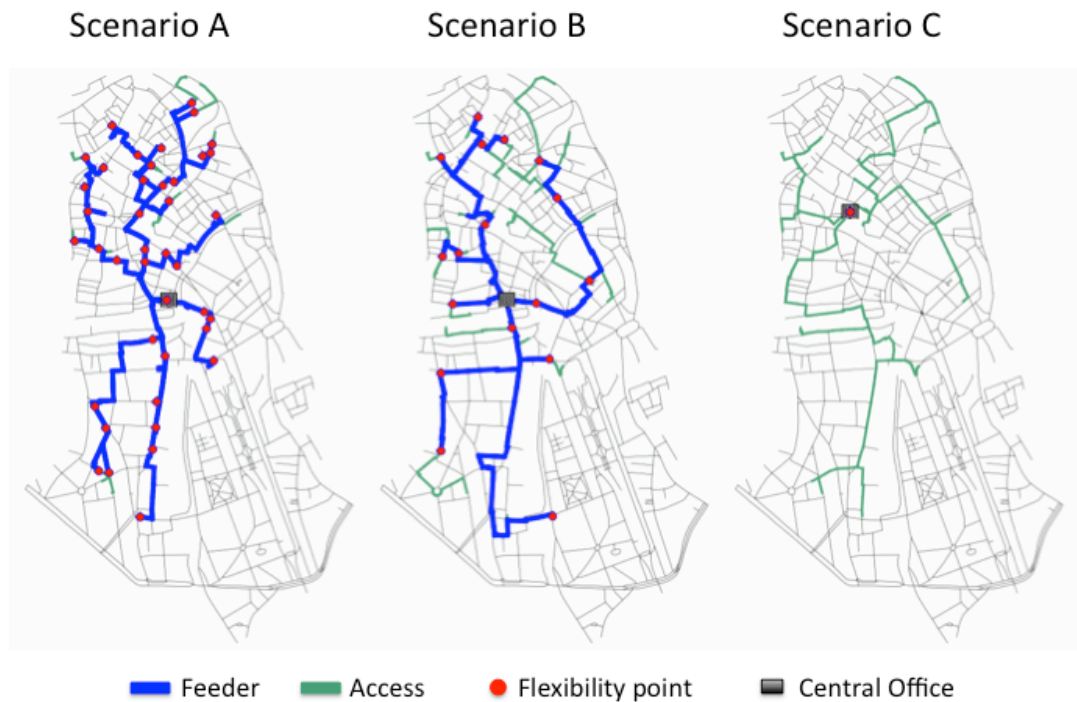
Comparing the topologies of the scenarios indicate differences in installation size in terms of trenching, ducts and cables. This shows a more detailed view on the rollout of the outside plant, typically considered to be the most cost intensive part of the network rollout. The second subsection will analyze in more detail the results of the different scenarios with a focus on this part of the network.

Finally the costs of the rollout will play an important role, and especially what this means for which actor in the FTTH ecosystem. Clearly a larger installation at the beginning of a network rollout in the city could help reducing the additional effort for an operator to rollout an overall citywide FTTH network at a latter stage. The third subsection shows the impact of the scenarios on the costs and rollout possibilities for the different scenarios.

### 5.1 Network Topology

| [Figure 4](#) till [Figure 7](#) show the topology of the network rolled out for the three scenarios in respectively phase 1 till 4. Clearly scenario A and B will install a large feeder network which is to be reused in the following phases. The more short term optimization in scenario C (sequential non-coupled rollouts) will lead to a smaller topology for connecting the public buildings, but additional trenching and parallel parts of the network, which could have been avoided, in the following phases. Scenario A contains the longest feeder and duct network, and most flexibility points. Clearly the most optimal end results (scenario A and B) will lead to a less optimal first phase topology as some detours have been taken for latter phases, and are visually notable, for providing a shorter rollout in the later phases.

It is important to note as well in the first phase the location of the CO, which is placed slightly more centralized in scenario A than in scenario B. Scenario C will have a CO placement centrally located for the municipal buildings, but clearly not central and thus not optimal for the full area, which will have implications on the following rollout phases ([Figure 4](#)).



**Figure 4: Rollout phase1: feeder, distribution and flexibility points**

The second phase (connection of other public buildings) will introduce small increments on the feeder topology and flexibility points in both scenario A and B. In scenario C, much more distribution ducts and cables will be installed ([Figure 5](#)).

The third phase (connecting business areas) shows an important difference between scenario A and B. While in scenario A the feeder network is extended to cope with future rollout of an FTTH network for full residential coverage, scenario B will focus on the optimal rollout of this phase and not look further. As such scenario B will rollout a lot of distribution cabling at this phase instead of extending the feeder part. As scenario C optimizes every step separately, a new network connecting 2000+ locations has to be rolled out at this phase. This will lead to extensive rollout of feeder and cabling in the city ([Figure 6](#)).

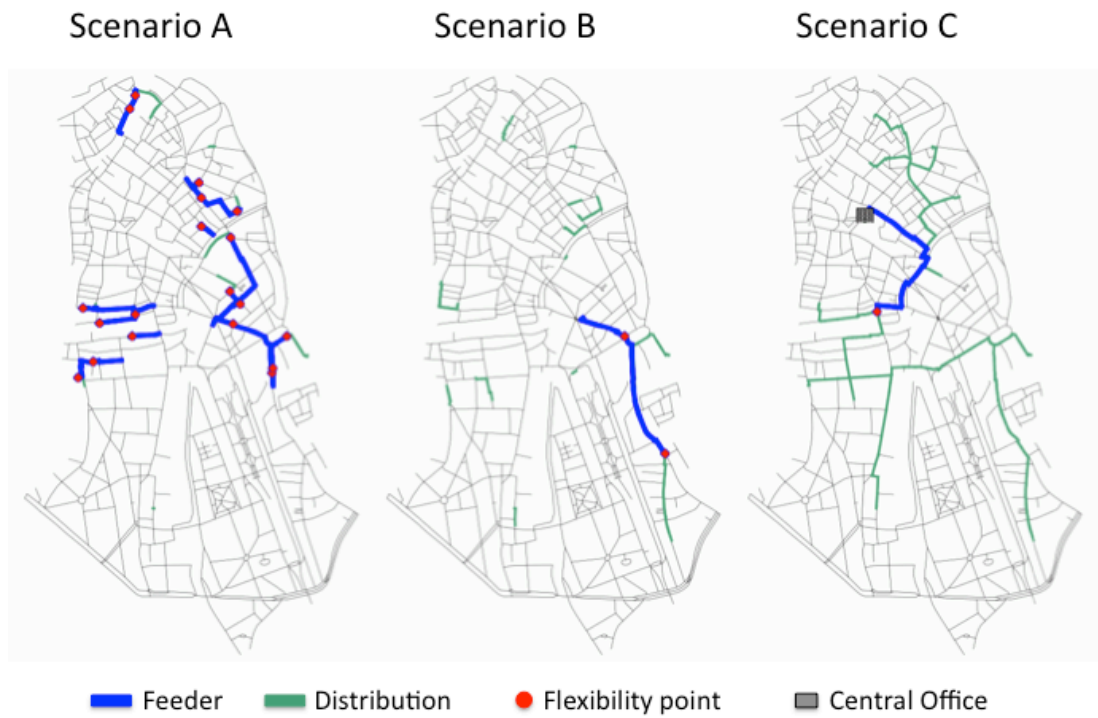


Figure 5: Rollout phase2: feeder, distribution and flexibility points

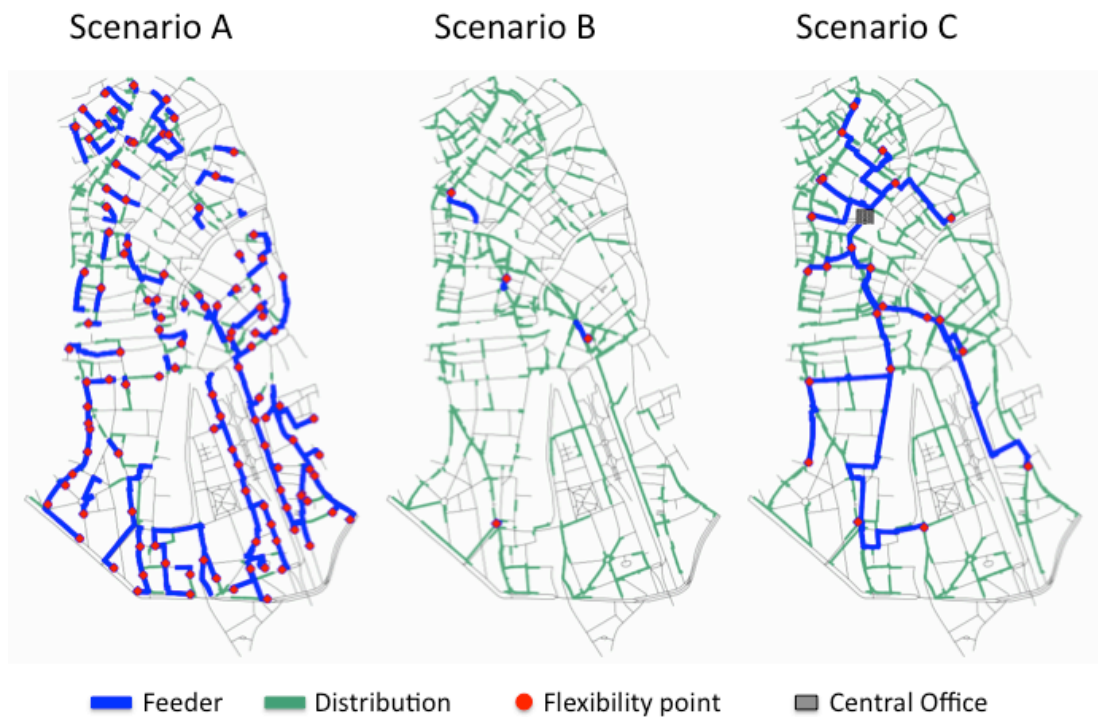
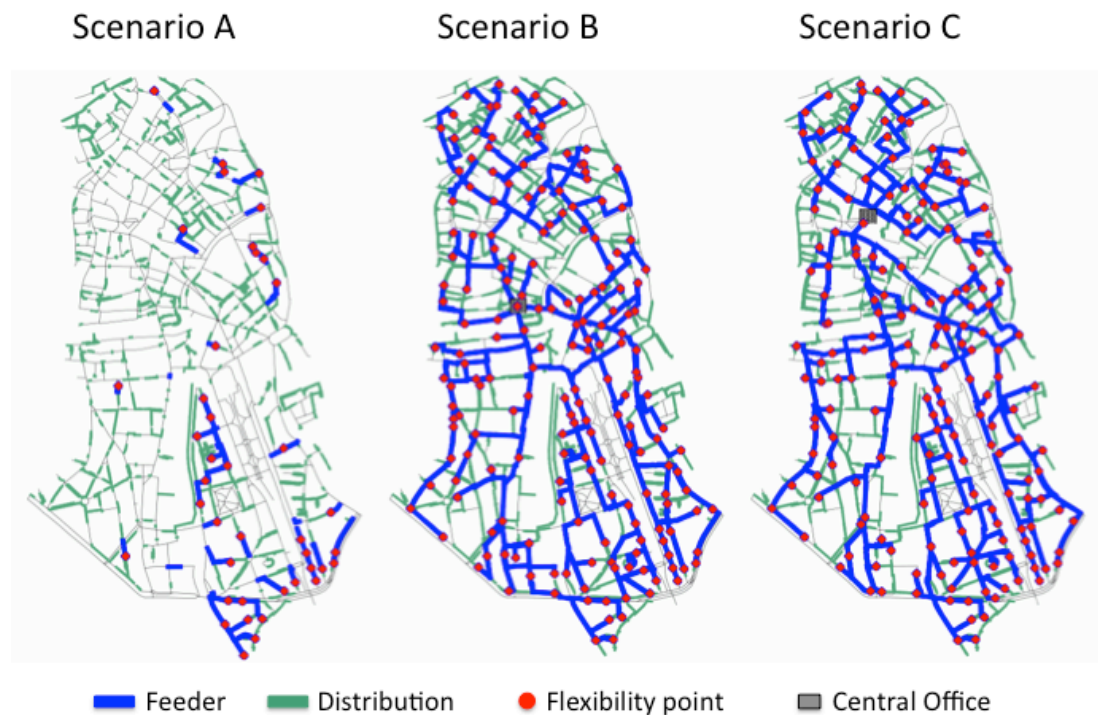


Figure 6: Rollout phase3: feeder, distribution and flexibility points

In the final step, a citywide FTTH network is deployed with full residential coverage. At this point the network will reach 18k end customers (both residential, business as public infrastructure) and connect this to one CO. Clearly at this point the placement of the CO will play an important role, and will especially in scenario C lead to large additional cabling. Both scenario B and C have a large deployment of both feeder and distribution. At this point, scenario A only shows minor increments of the feeder and distribution part, which will clearly lead to a much faster deployment than in the other scenarios ([Figure 7](#)).



**Figure 7: Rollout phase4: feeder, distribution and flexibility points**

The way an FTTH network is dimensioned will clearly have a large influence on the outcome of the topology. Clearly in scenario B and C a large parallel network will be deployed in the last phase (residential customers). Scenario A will deploy a very large and fiber rich feeder network very early, while only connecting a rather small amount of public buildings. These differences, which are readily observed, will of course have impact in the amount of work and installation of the equipment, timing of the deployment and the costs both for the municipality as for any following operator. These will be discussed in the subsequent chapters.



## 5.2 Network Dimensioning

Starting from the network topology and the location of the feeder ducts and fiber and the distribution fiber, we calculated the lengths of trenching, duct and cable to install in the different phases.

Trenching will be an important factor for optimizing the overall cost, as this comprises up to 60% of the total network installation cost [7]. In [Figure 8](#) we see a clear influence of the focus of each of the scenarios. Scenario A will have the lowest end cost, but a higher intermediate cost. Scenario B will have a higher starting cost as it focuses to have the lowest cost in phase 3. In phase 4 this scenario will again have a higher cost than scenario A. Scenario C finally will have the lowest cost early in the project, as it aims to minimize in each step, but the lack of overall optimization leads for this scenario to the highest cost from phase 3 on.

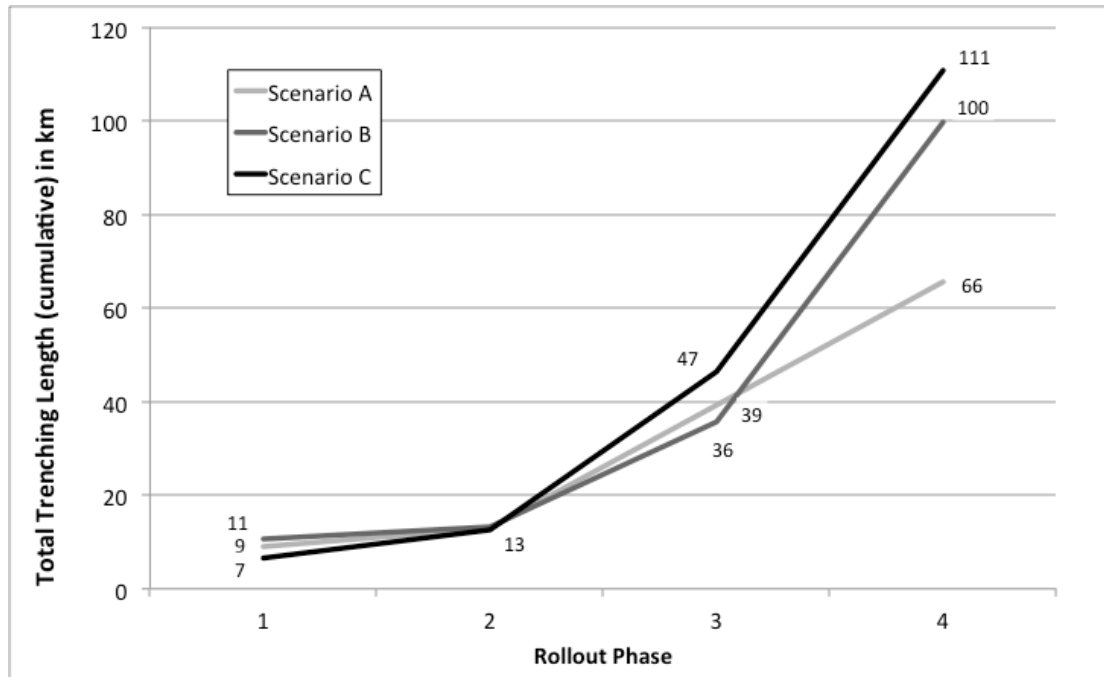


Figure 8: Total trenching length in km (cumulative)

Scenario A also invests heavily in the early phases in the rollout of feeder ducts and cables and less in distribution ducts and cables (see [Figure 9](#) and [Figure 10](#)). This extensive network of feeder ducts and cables, in combination with trenching, guarantees much more flexibility when upgrading this infrastructure to a full residential FTTH network in the last phases. Overall after all four phases this leads to much less distribution ducts and cables, and an equal amount of feeder ducts and cables compared to scenarios B and C.

How this will translate into costs is shown in the following subsection.

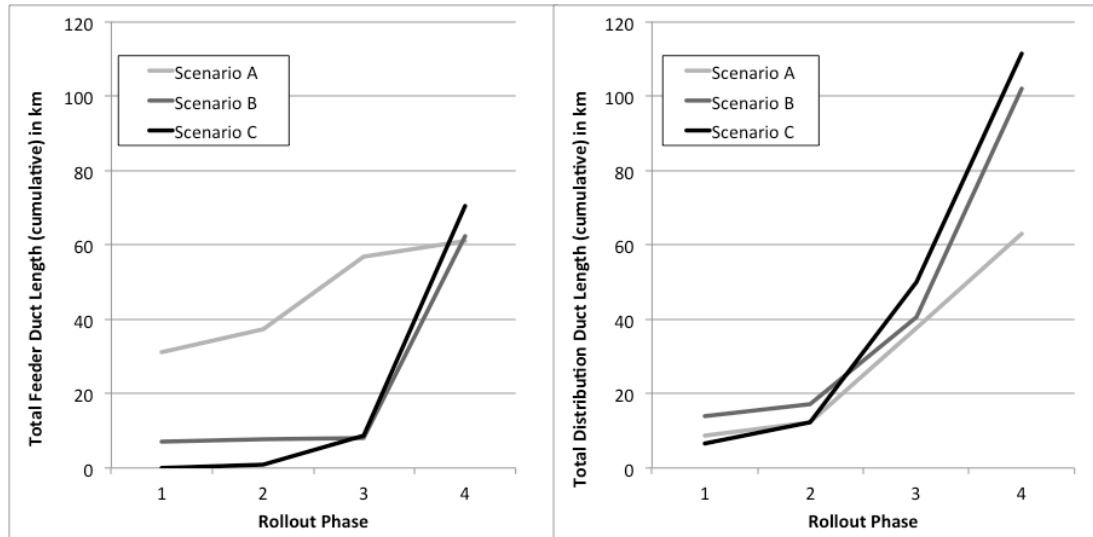


Figure 9: Total duct length in km (cumulative)

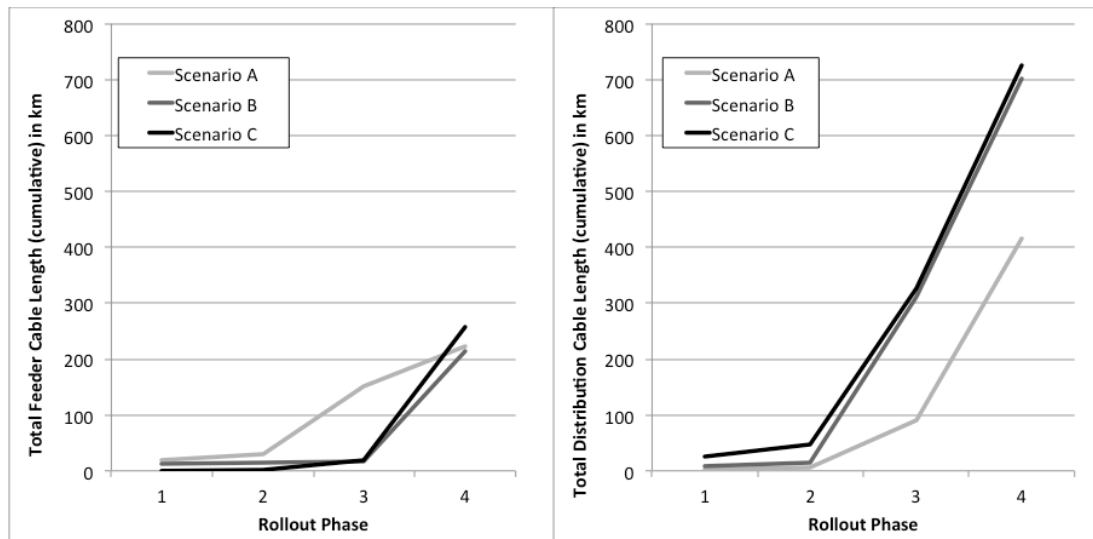


Figure 10: Total cable length in km (cumulative)

### 5.3 Network costs

Possibly the most important question in the deployment study is how this higher installation of feeder trenching, duct and cable early in the process will reflect in the costs for the municipality and for the costs in the last phase (possibly taken by a network operator). **Error! Reference source not found.** shows the total investment costs for the FTTH network growing with the consecutive phases. The first thing to notice is the much lower (-2.5 M€) investment for rolling out the city wide residential FTTH network when using scenario A. Important to note in this figure is also the even more reduced extra investment incurred between phase 3 and 4, which most probably would be left to the network operator. Clearly this lower investment cost at a latter point in the deployment comes at a cost, and scenario A will have a much higher cost for connecting phases 1 (+700k€), 2 (+740k€) and 3 (+1.5M€). Scenario B follows more closely the investments in scenario C and will lead to the lowest investments in phase 3 (-500k€), for which this scenario is optimized, and only a slightly higher investment in phase 2 (+11k€). The gain at the end is also much lower (-770k€).

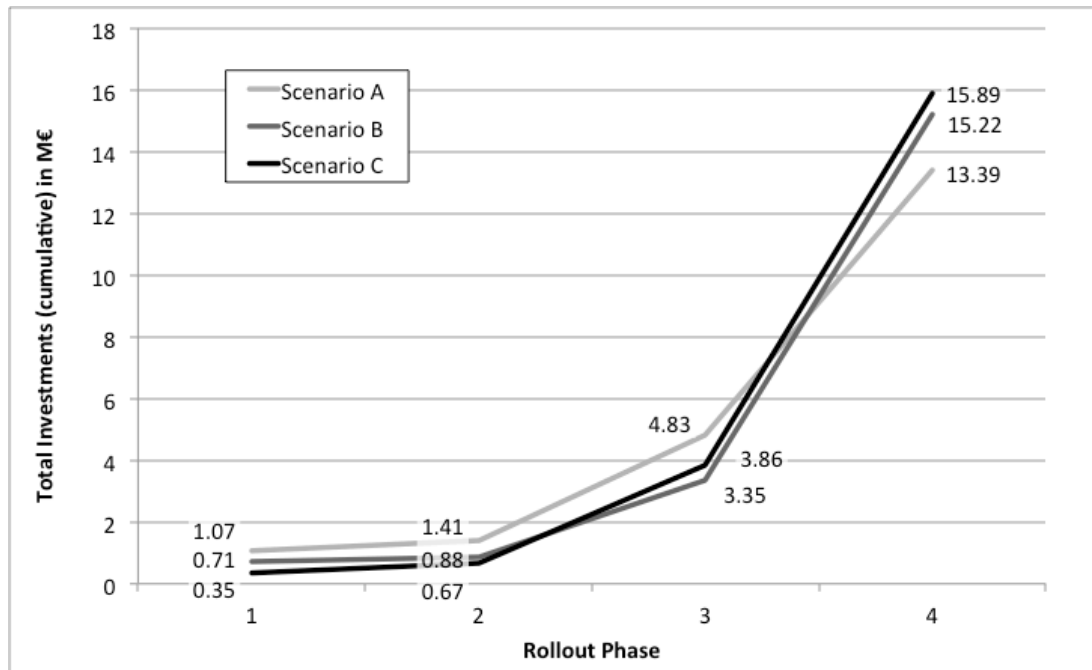


Figure 11: Total investment cost

These trends are also reflected in the costs per home passed as shown in [Table 1](#). It shows the incremental cost per home passed for each phase. Here the reduction in investment in phase 4 for scenario A is obvious as the incremental cost per home passed is lowered with over 30% to 536 €, making the rollout of this phase most probably a profitable business case. As such scenario A will clearly be a good stimuli for investments in a residential FTTH network in the municipality, although with a fairly high investment in the first phases. Further investigation should identify under which circumstances the municipality could be allowed to invest so heavily in the first phases if it would like to stimulate later residential FTTH deployment. Clearly the municipality will be the primary investor in the feeder network and could set open access charges for making use of this infrastructure in order to regain some of the early investments. As such a more valid business case could be constructed with an incremental investment per customer between 536 € and 739€ (the fully allocated cost for the residential FTTH network in scenario A when considering all four phases).

Scenario B has the lowest incremental investment cost for phases 2 and 3 making it a valid business case if the city would have a focus on public buildings of the second phase and business areas. Again more research should indicate under which circumstances the municipality can invest in such scenario.

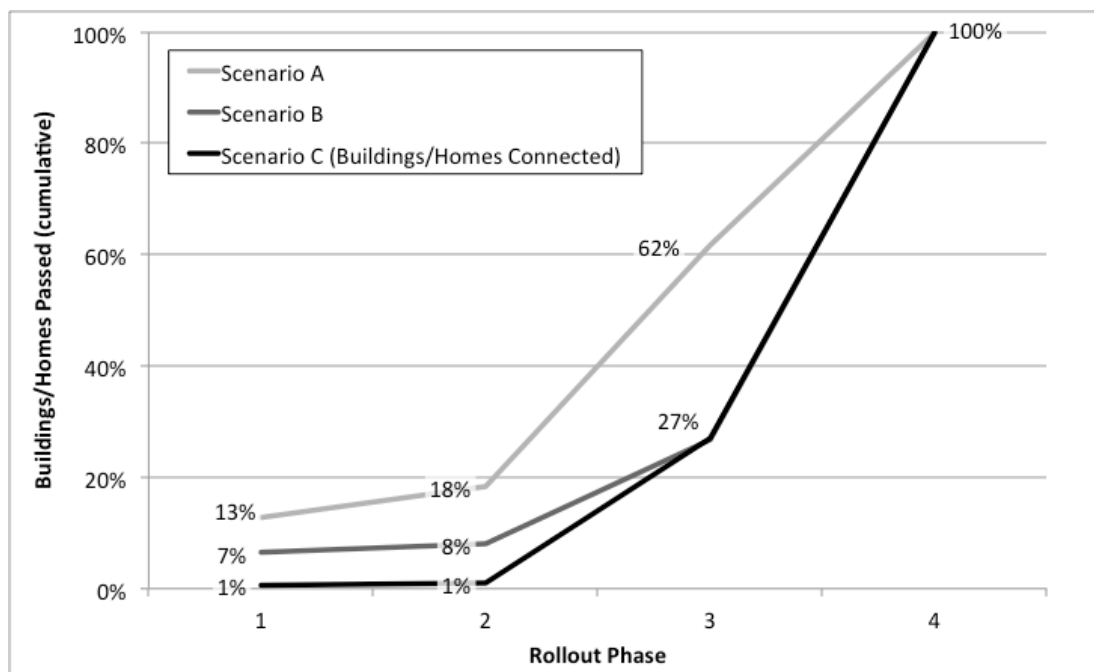
Clearly scenario C provides no stimulations of any kind for the later phases of the rollout. As such it is merely used as the benchmarking scenario and provides values for connecting all public buildings with a standalone fiber network.



**Table 1: Cost per Building/Home Connected per phase**

	Rollout Phase			
	1	2	3	4
Scenario A	30.608 €	12.253 €	1.660 €	536 €
Scenario B	20.183 €	6.024 €	1.201 €	743 €
Scenario C	10.059 €	11.434 €	1.548 €	753 €

Finally scenario A and B will have additional benefits in rollout period by shortening the road works disturbances. As such it could also provide the operators with a shorter time to market and a significant number of early connectable customers, as the feeder network already connects very early in the process all possible future users it passes. **Figure 12** shows how scenario A already enables the connection of 13% of all future customers at the end of the first phase, so when only 35 actual locations have been connected. At the point where 2000 business customers have been connected, already 62% of all houses in the area have been passed by the feeder and distribution network and can be connected. Scenario B can connect almost 1/3th (or more than 600) of the business customers at the end of the second phase, when merely 63 public locations have been connected. It is obvious that such early connections will lead to a much stronger word of mouth effect, which could lead to an increase in the demand for fiber. It will also lead to a better spread of connections in the process and as such to a better and more cost effective planning.



**Figure 12: Buildings/Homes Connected vs Passed**

## 6 Conclusions and future work

A citywide fiber to the home network would certainly bring about a lot of advantages for the municipality. Still the operators tend to hold off, partly because of the very high deployment costs and often also because there is a medium high bandwidth network available. This is also the case for the city of Ghent in which an FTTH network is not available and does not seem to be planned in the near future. In this paper we investigate to which degree the municipality can play a role in triggering the rollout of FTTH or less extensive a fiber to the business rollout by initiating the first step in the deployment. If a city plans to connect its own public buildings, such as governmental offices and city services and in extension hospitals, schools, museums and other public care or recreational centers, it could already open up some of the advantages of an FTTH network to its citizens. One step further, the city could take a more foresighted deployment scenario into account, in which more ducts and feeders are deployed and some detours are allowed, to enable a faster and cheaper rollout towards businesses and/or residential customers.

In this paper we investigate three rollout scenarios with varying focus and amount of foresight. Within the first scenario we focus on the optimal rollout of the city wide residential FTTH network and consider the costs of gradually dimensioning towards this fully optimal network. In this scenario the public buildings are grouped in different priorities and connected in sequential stages, and any operator (or the city) can later on connect business areas and the residential dwellings. In the second scenario we focus on the network rollout towards municipal and other public building locations and business areas. A full residential FTTH network would then be rolled out separately. In the third scenario, we consider the costs of the separated rollouts to connect (1) the locations for all municipal and (2) public buildings, (3) the locations of all business areas and finally (4) residential dwellings. This scenario serves as base case in which minimal reuse of planning and deployment is possible.

The results of this study shows that the overall cost in the second and third scenario can be significantly lower for connecting all public buildings as several routes can be shared and others dismissed based on the final optimal topology. Additionally many overhead costs in planning and connecting in the later stages can be decreased, compared to the scenario A. This scenario will have a much lower final cost and the potential value during and after network rollout towards municipal and other public buildings will be higher, as the cost for furthermore rolling out towards a business and full FTTH network for inhabitants will be much lower. In both first and second scenario, the infrastructure rolled out by the municipality can be seen as an open access network and can be used by each network and service providers in the area. As such, this constellation is not expected to cause any problems with EU competition law regulation as the initial network is built for the cities own purpose.

A phased rollout in which the city initiates (e.g. by means of tendering) the rollout of a public services fiber network could really improve the FTTH business case. Depending on the focus of the city, a business or fully residential FTTH network deployment could be stimulated by taking into account an optimal citywide planning early in the process. In addition a geomarketing methodology should then be used to select the most optimal areas focusing on connecting first municipal and other public buildings.

In future work, these steps could be furthermore extended by considering planned road and utility infrastructure works in the city in the upcoming years, furthermore decreasing the total rollout cost.

## Acknowledgement

This research was carried out as part of the IBBT TERRAIN project. This project is co-funded by IBBT, IWT and Acreo AB, Alcatel-Lucent, Comsof, Deutsche Telekom Laboratories, Digipolis, FTTH Council Europe, Geosparc, Stad Gent, TMVW, TE Connectivity, UNET and WCS Benelux BV. More information about the TERRAIN project can be found on <http://www.terrainproject.be/>.

## References

- [1] Comsof FiberPlanIT tool, <http://www.comsof.com/fiberplanit>
- [2] “Communication from the Commission - Community Guidelines for the application of State aid rules in relation to rapid deployment of broadband networks”, Official Journal of the European Union, OJ C 235/7, 30.9.2009
- [3] K. Casier, J. Van Ooteghem, M. Sikkema, S. Verbrugge, D. Colle, M. Pickavet, P. Demeester, “Influence of GeoMarketing on the roll-out of new network infrastructures”, Published in the proceedings of the CTTE 2011 conference, May 2011, Berlin
- [4] K. Casier, J. Vanhaverbeke, B. Lannoo, J. Van Ooteghem, S. Verbrugge, R. Meersman, D. Colle, M. Pickavet, P. Demeester, “FTTH deployment costs: a comparison of Pt2Pt and PON”, Published in the proceedings of the FITCE 2009 conference, Prague, Czech Republic, September 3-5, 2009
- [5] Gent in Cijfers, City of Ghent, <http://www.gent.be/gentincijfers/>
- [6] Open Data library, City of Ghent, <http://data.gent.be/>
- [7] 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.