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Success factors for FTTH deployment in Europe: Learning from the Leaders

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Whereas broadband coverage with speeds of up to 30 Mbit/s is quite high, Europe is generally lagging behind in the roll-out of high-performance, future-proof fibre networks (Fibre-To-The-Home/ Fibre-To-The-Building). Yet, some European countries have been quite successful in their efforts to make FTTB/H connections available to their populations. This observation suggests the question, what strategies were applied and whether or not they could be applied in other countries as well.[1] In order to find out about success strategies in selected FTTH leader countries we use a case study approach in which different factors like market structure, competition, regulation, policy intervention and demand are analysed. In the case studies, specific strategies which are of central importance for the selected countries are highlighted: In Estonia, we find that building a countrywide middle-mile-network as a public-private-partnership was a decisive move. In Sweden, municipality-owned city networks which have deployed fibre networks as Open Access Networks play an important role. In Spain it was hard regulation combined with a surge in demand which has lead to the "fibre-miracle". And in Switzerland, the countrywide roll-out of fibre networks is coordinated in a multi-stakeholder approach which was initiated by the national regulator. In the analysis part, six success strategies are derived from the empirical part, four of them originating directly from the respective countries and two being relevant in all selected countries. In the final part of the contribution, the recommendations are tested by applying them to the situation in Germany where FTTH coverage remains low.

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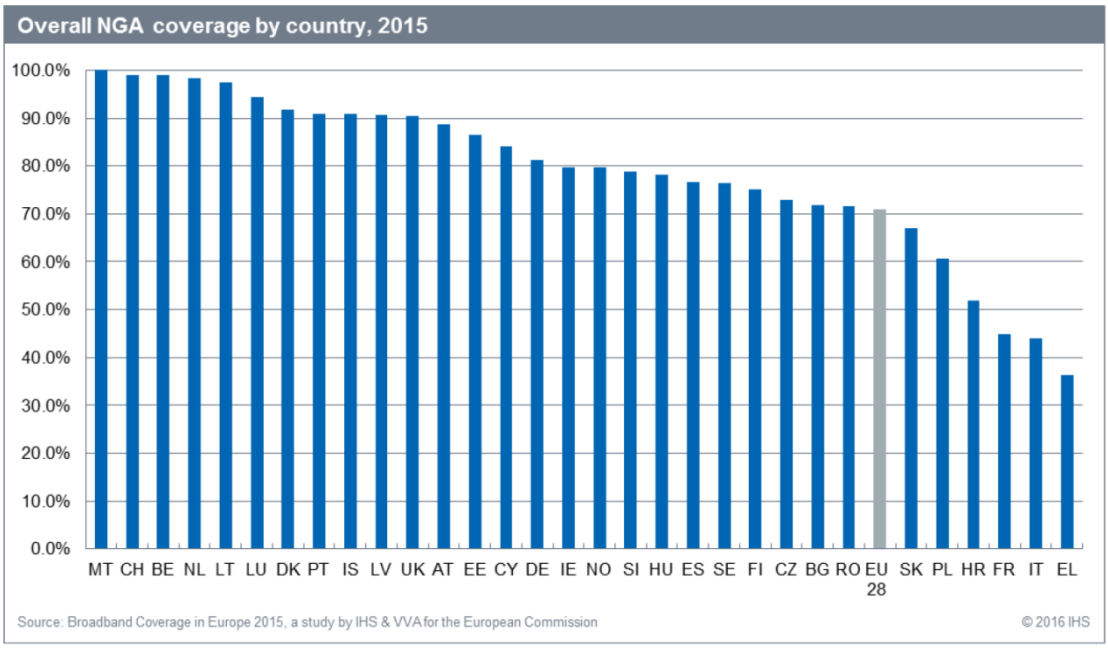
1 Introduction and research question

The availability of broadband Internet connections in Europe has grown significantly during the last years. Today, broadband Internet connections with at least 30 bits/s via fixed network connections (VDSL, cable-TV-networks and fibre-based networks) are available for over 70 percent of the population in all countries of the European Union (see EU28 average in figure 1). European statistics calls this kind of mid-range Internet connectivity "Next Generation Access (NGA) coverage". Mobile broadband Internet connections like HSPA or LTE are not included in this category. However, figures on mobile coverage usually reflect fixed network availability as mobile connections usually require fixed network components for the backbone infrastructure.

Figure 1: NGA coverage in Europe 2015

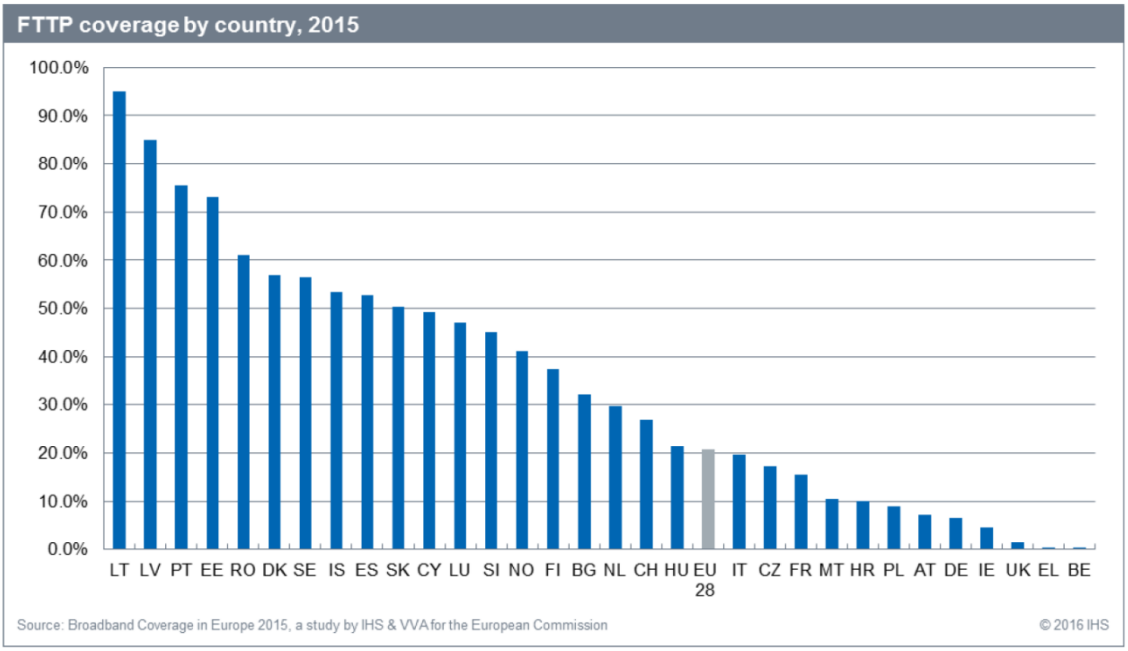


Source: European Commission 2016, p. 27.

In contrast to the NGA coverage, the availability of fiber-based Internet connections is relatively low in Europe (see figure 2). Fiber-based Internet connections are considered superior in all technical areas like bandwidth, symmetry of down- and upload speeds, latency, jitter, stability, etc. compared to traditional access technologies based on copper like VDSL or cablemodems. FTTH/B is considered to be the long-term development path of Internet access. The EU28 average for Fibre-To-The-Premises (FTTP) coverage - which is the EU expression for FTTH/B – today is about 20 percent. Here, the distribution is very uneven: Whereas some countries already have relatively high percentages of FTTP-coverage, some

countries, including large industrialized countries like Germany, the UK or France, are way below the average.

Figure 2: Fibre-To-The-Home/ -To-The-Building in Europe 2015



Source: European Commission 2016, p. 29.

If some countries are way ahead in their development path towards fully fibre-based networks, the question is, how did they achieve the high availability? What are the factors which are responsible for their successful roll-out of fiber-based networks and what could possibly be learned from the leaders? Thus, the research question in this contribution is: What are the reasons for the successful FTTH/B-rollouts in the leading countries in Europe and which strategies can be generalized in order to help other countries in their attempt to catch up?

2 Method

To answer these questions, a case-study approach was chosen, examining four European countries defined as "leaders": Estonia, Spain, Sweden and Switzerland. The case studies are based on desk research and interviews with experts. The reason for choosing a case-study approach and not a hypothesis-testing approach is that we look at a very complex situation where many different factors are correlated and where causality is often difficult to prove. The variety of points of departure in the different countries, and the different approaches and

strategies followed suggest to analyse each country in its own right. In the case studies we will look at the following factors shaping the development in the respective countries: market structure, competition, regulation, policy activities and demand.

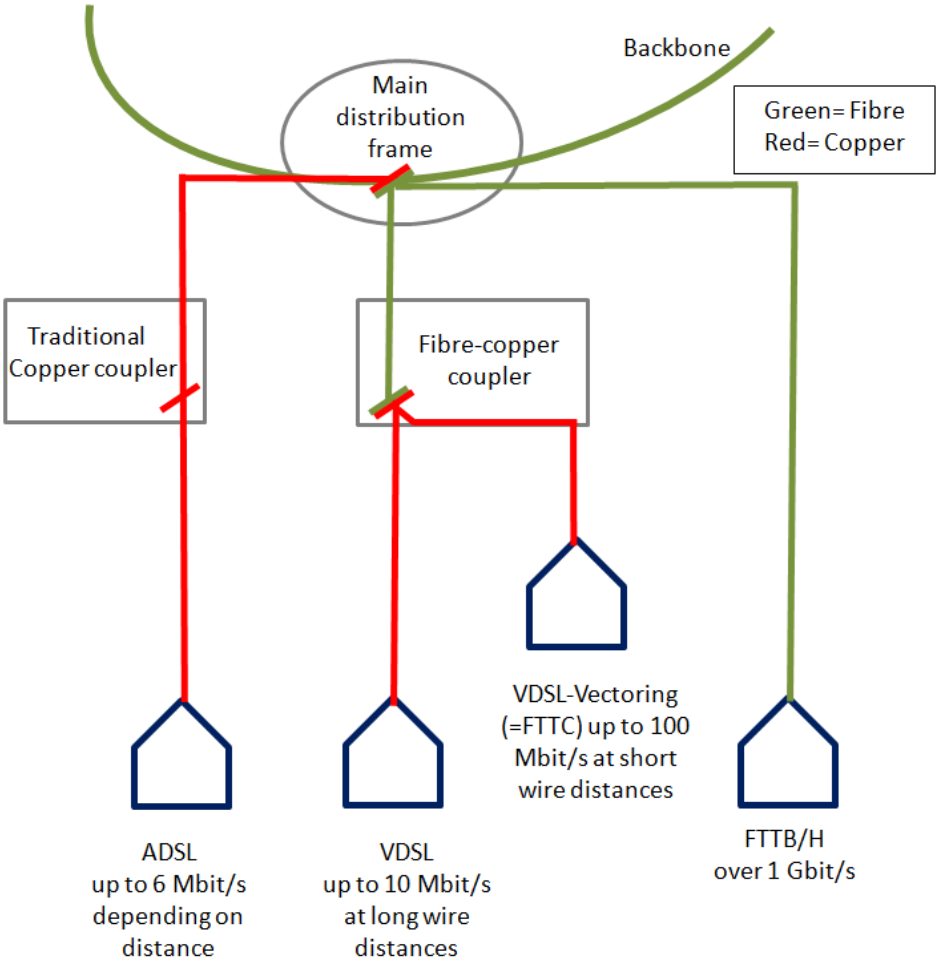
Whereas other authors using similar methodological approaches merely concluded that there is wide variety of influencing factors for the broadband rollout (Lemstra and Melody, 2015), in this contribution we will go one step further and try to identify the single most important factor or strategy in each country for the successful FTTH/B rollout. From a conceptual point-of-view the isolation of a single one factor to determine success is delicate. However, in the country cases we attempt not to isolate but to suggest the single most important factor which is being put into the context of other factors which are relevant as well (a similiar approach is being followed by Domingo, Van der Wee, Verbrugge and Oliver 2014).

3 Why FTTH/B? Definition of broadband

Fibre-To-The-Home or Fibre-To-The Building allow for transmission speeds from 100 Mbit/s reaching into the Gbit/s range. The capacity of fibre-based Internet connections has been increased constantly in the past years by using multiple spectrum splits. Fibre technology is considered to be the future proof broadband technology which will replace copper-based access technologies in the long run. Fibre technology is already used in backbone networks which connect traditional access networks and they are used to connect mobile transmission stations, as such being a prerequisite for the future 5G mobile broadband roll-out. As demands for bandwidth and quality of service increase, fibre seems to be the only technology capable of meeting the requirements concerning bandwidth, stability, low latency and jitter as well as symmetrical download and upload speeds. Whereas in the past it was questioned whether users would actually need such high throughput connections, today it is clear that the demand will be rising extraordinarily in the coming years and that infrastructures will have to be modernized accordingly (Gries; Plückebaum; Martins 2016, p. 34ff, Godlovitch; Henseler-Unger; Stumpf 2015, Emmendorfer 2015). In the meantime, transition technologies like VDSL-vectoring, G.fast or DOCSIS 3.x will try to meet the rising demand. However, in the long term, fibre connections directly to the home or to the building (“real” fibre connections) are inevitable. Thus, this contribution will focus on “real” fibre connections.

To better understand the situation in the countries analysed, figures 3 and 4 show the architectures and capacities of the different access technologies using the telephone network and the cable-TV network respectively. Fibre routes are marked in green while copper is drawn in red.

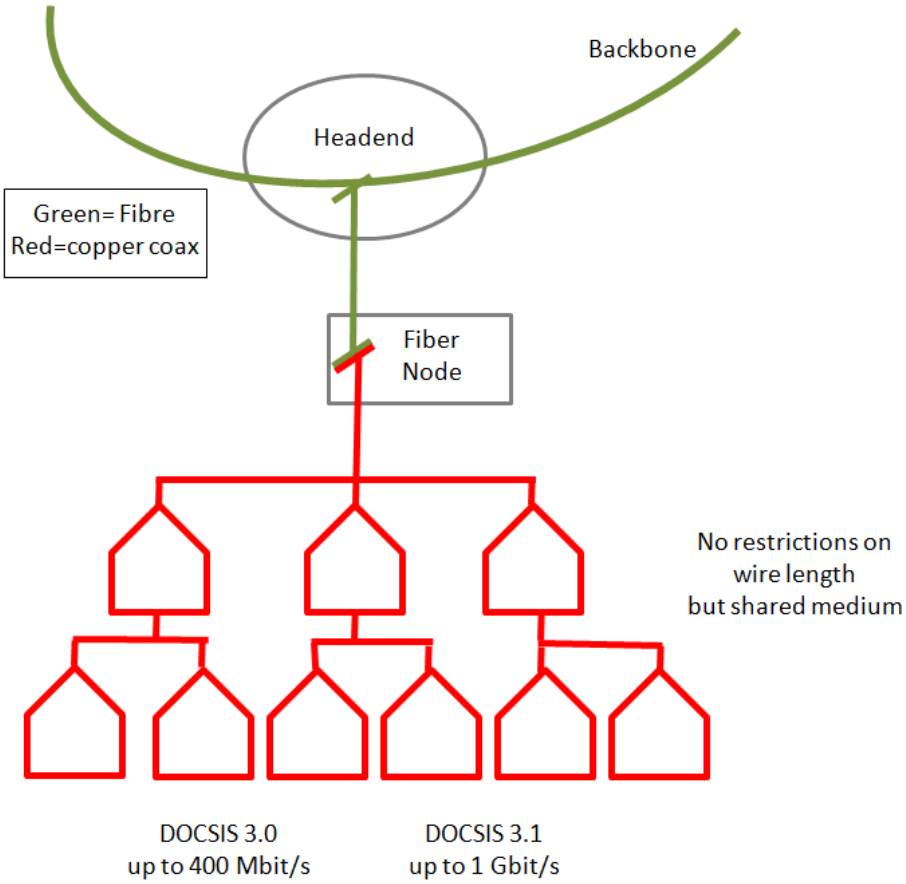
Figure 3: Broadband architectures based on the telephone network



Source: Own figure

Broadband connections which are based on the telephone network face wire distance restrictions: The longer the wire distance the lower the transmission speed. Broadband connections which are based on cable-TV network face the shared-medium-restriction, which means that fewer bandwidth is available for the individual user if many users are online at the same time. With FTTH or FTTB these restrictions do not apply.

Figure 4: Broadband architecture based on the cable-TV network



Source: Own figure

In the next section, four selected countries will be analysed according to their coverage of fibre-based networks, their market and competition structure, their regulatory activities, their policy activities supporting broadband deployment and demand. For each country, one specific factor will be identified as being responsible for the high FTTH/B coverage.

4 Cases

Table 1 shows the NGA and FTTP broadband coverage in the selected countries ranging from 73,1 percent overall coverage of FTTP in Estonia to 27 percent in Switzerland. Not being a leader in fibre-based networks, Germany is listed with a 6,6 percent overall FTTP coverage.

Table 1: Current broadband coverage in the selected countries

Country	Overall NGA coverage	NGA coverage in rural areas	Overall FTTP coverage	FTTP coverage in rural areas
Estonia	86,4	60,7	73,1	50,7
Sweden	76,4	13,9	56,4	13,7
Spain	76,6	23,9	52,8	5,6
Switzerland	99	89,5	27	6,6
Germany	81,4	36,4	6,6	1,4

Figures are of June 2015, source: European Commission 2016

It has to be noted that these figures are merely rough indications on where these countries stand in their attempt to roll out fibre-based broadband infrastructures. Several restrictions concerning the way these figures are calculated apply. However, European Commission figures are currently the best figures available for broadband coverage in Europe.

4.1 Estonia

Estonia has the highest FTTP coverage in our country sample with 73,1 percent of the population being able to directly connect to the fibre network (see table 1). And even in rural areas still half of the population has access to FTTP.

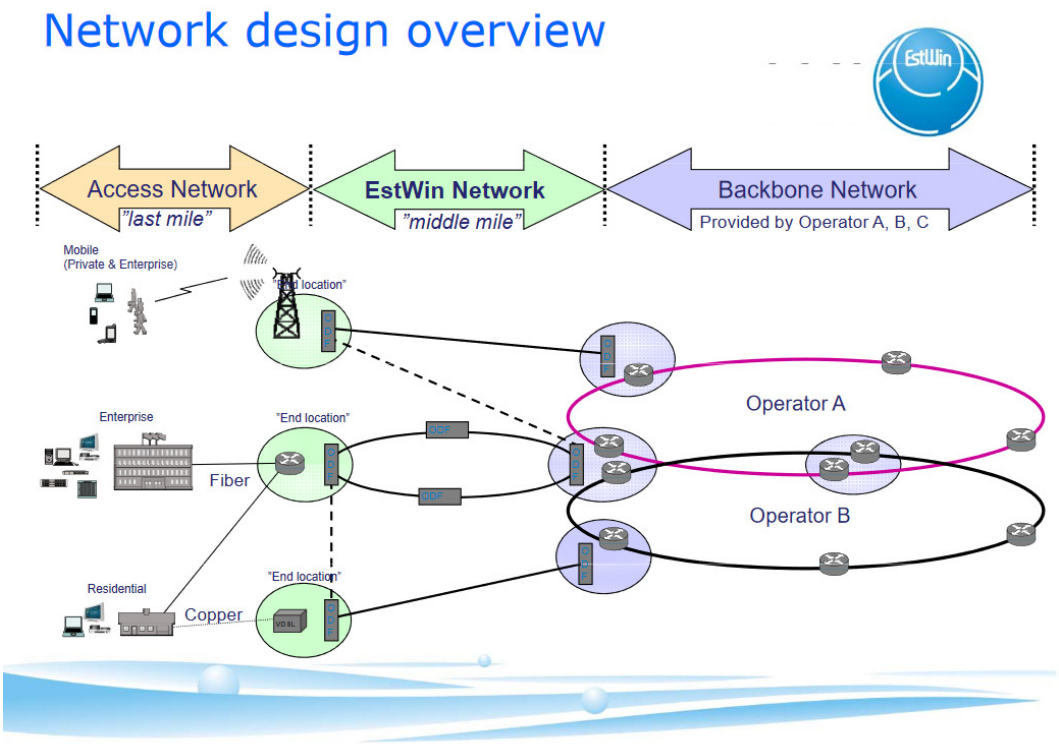
The Estonian broadband access market is characterized by a functioning competition between VDSL, cabelmodem, Wifi and mobile broadband offers. A strong player is the former incumbent Telia Eesti which is now owned by Swedish TeliaSonera. Telia Eesti has a market share of almost 100% of VDSL-connections, offers mobile broadband services via HSPA and LTE and also runs one of the national fibre backbone networks. In the fixed network area, cable-TV operators Starman and STV are major competitors. Both companies have upgraded their networks with DOCSIS 3.1 and are now migrating their network to real FTTH/B. Estonia´s telecommunications network is considered to be one of the most advanced in Europe. The country has successfully modernized its telecommunications infrastructure after the declaration of independence from the Soviet Union in 1991. Resembling a greenfield situation, outdated components and networks were replaced by modern ones. Today, high-speed fixed, wireless and mobile Internet connections are available in Estonia like in only few other countries in the world.

The Estonian government follows the strategy of eEstonia, making the country a living lab for all kinds of advanced Internet services. The broadband rollout is part of its "Digital Society Strategy 2020", with its most recent update from 2014. Concerning broadband goals, the strategy aims at the use of FTTH/B in 60 percent of the households by 2020. As a consequence, real fibre connections must be available almost nationwide by this date, as not all households being able to connect automatically decide to subscribe. The way the goal is formulated indicates that in Estonia, supporting demand and migrating users to fibre is currently one of the top priorities of the country. As Estonians have a special affinity with mobile services, Fixed-Mobile Convergence seems especially important in the country which means that providers have to offer bundled services including fixed, wireless and mobile connections.

A public-private-partnership for building a countrywide middle-mile-network bringing fibre access points closer to rural households

The most important activity which resulted in the current high availability of fibre connections in Estonia is the EstWin-project, a public-private-partnership of national telecommunications providers and the Estonian state which was founded in 2009.

Figure 5: The EstWin-project in Estonia to build a middle-mile network



Source: EstWin 2009, p. 5

The approach was to build a middle-mile-network which connects the existing national fibre backbones with local points of access (termed "End location" in figure 5).

Thus, high-speed Internet was made available in all parts of the country, especially in rural areas, where public buildings like town halls, schools or libraries were used to install points of access. From these points of access, the last-mile-network was to be built by private companies which were granted exclusivity in the respective areas. The built-up is almost complete today, most of the planned 1.400 access-points are already installed. The costs for building the middle-mile-network were about 300 Mio Euro, 75% of which was financed by the European Commission and the State of Estonia.

4.2 Sweden

With 56,4 percent availability of fibre connections, Sweden has the second highest FTTP coverage of the selected countries. The high coverage currently is limited mostly to large and midsized cities. In the rural areas of Sweden, FTTP coverage is only at 13,7 percent. However, where fibre connections are available they are more popular than VDSL or cablemodem offers. FTTH reaches a market share of 17,5 percent of the broadband market, while xDSL has 11,4 and cablemodems 6,6 percent of the market share (source: OECD 2015, www.oecd.org/sti/broadband/1.8-TotalBBSubs-2015-12.xls). In addition, mobile broadband is very popular in Sweden.

Apart from Telia Sonera, the telco incumbent in which the Swedish state still has a share of 37,3 percent, Telenor, the Norwegian incumbent active as a competitor in fixed and mobile services Sweden, and the cable-TV-network company Com Hem, the city networks owned by the municipalities play an important role in the Swedish broadband market. All over the country, there are currently about 180 municipalities active in the deployment of fibre networks. Their combined share of the fibre market is about 60 percent, the remaining 40 percent are provided by Telia Sonera, Telenor or the Com Hem.

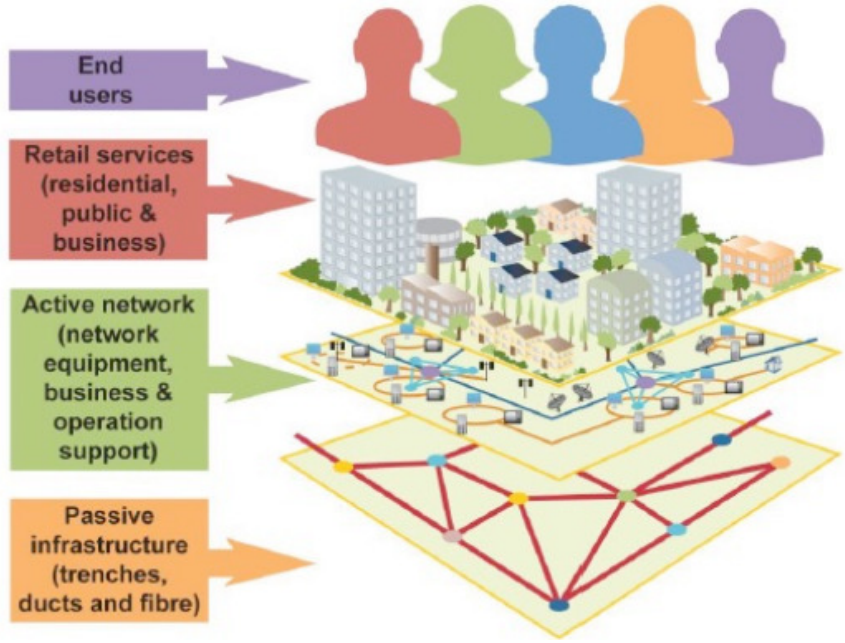
The Swedish Government has set out the goal of providing direct fibre access to 90 percent of households and enterprises in Sweden by the year 2020. This goal was formulated in the broadband strategy of 2009 which is still valid today. As a interim target, the strategy did

foresee a 40-percent coverage until the year 2015, which was easily achieved because of large FTTH/B rollouts of the city networks in the big cities and urban areas. Currently, the focus is on providing fibre access to the rural areas. Considering that the country is in parts extremely sparsely populated, the 90 percent goal is a very ambitious goal.

Municipality-owned city networks roll out FTTB/H as Open Access Networks

Two crucial factors for achieving the high coverage of FTTH/B in Sweden are the activities of the municipality-owned city networks ("Stadsnäts" in Swedish) in the fibre rollout and the successful organisation of a functioning competition among the service providers (Internet, telephony, TV, other IP.services). The city networks use the Open Access Network approach in which the municipality finances the deployment of the (passive) fiber network and then leases the network to interested service providers (see figure 6).

Figure 6: Architecture of Open Access Networks separating the network from the services



Source: FTTH Council Europe 2016, p. 15

Concerning the "Active network" layer in figure 6, there are different approaches possible. In some cases, the active network is managed by the city networks as well, in other cases it is left to the service providers as part of the network lease. The main issue is that infrastructure provision and service provision are seperated. Unlike investments of commercial companies, investments by public bodies like municipalities, utilities or city networks allow for longer

time-frames. Whereas enterprises need the prospect of 3 to 5 years for refinancing their investments in order to get allowance by their stakeholders, municipalities can plan for refinancing time-frames of 10 years and more. In Sweden, municipalities have transferred the concept of "services for the public" to broadband Internet: As with water or electricity, the provision of broadband Internet is considered to be a public responsibility in Sweden (Mölleryd 2015).

Interestingly, at the beginning of the activities of the city networks, this was planned otherwise: In the year 2000, the Swedish government, together with Swedish telecommunication and Internet firms intended to build a nationwide fibre network. The plan, which was put forward in the action plan "An information society for all", assigned the leading role in the nationwide rollout to private companies. State activities were only foreseen in remote areas. The respective law was passed in the spring of 2000. At the end of the same year, the so called dotcom bubble had collapsed and the situation for telecommunications and Internet companies had changed completely. They could not hold their promise to finance the network, so the state stepped in. Almost one billion Euros were invested for a national backbone and city networks got involved to lay out fibre from the access points to the households and enterprise sites (Vitale 2014; Troulos and Maglaris 2011).

4.3 Spain

Spain has the third-highest percentage of FTTP coverage of our selected countries. According to the latest figures from the European Commission, describing the situation in mid 2015, 52,8 percent of the population in Spain could be reached directly by fibre Internet. In rural areas, this number decreases to 5,6 percent, which indicates the current broadband challenge of the country (see table 1). Only four years earlier, at the end of 2011, the percentage of overall FTTP coverage amounted to 9,7 percent (see Broadband Coverage in Europe report of 2012). This means that fibre coverage in Spain has increased extraordinarily over the past years, a development observers termed the "fibre miracle" of Spain (Herrera-González 2014).

Whereas most of the broadband connections in the Spanish countryside today are DSL connections, in the cities and urban areas, fibre connections are becoming an alternative for users as telecommunications providers continue their deployments. Former telecommunications

monopolist Telefonica which offers its services in Spain under the brand name "Movistar" has the largest fibre access network. Telefonica was privatized in 1997 and the state does not own shares of the company anymore. Competitors are Vodafone Spain and Orange Spain. Both companies have invested large sums in the built-up of their own fibre access networks in Spanish cities in recent years. Also, they have recently acquired cable-TV network providers Ono and Jazztel respectively. All three telecommunications (and cable-TV) providers also offer mobile broadband services.

In 2012, Spanish telecommunications companies have announced to leapfrog VDSL-Vectoring and other hybrid fibre-copper technologies and to invest directly in FTTH/B wherever possible (European Commission 2016, p. 180). The resulting roll-outs lead to a situation in which today Telefonica can serve 14 Mio households with real fibre connections, Vodafone Spain 9 Mio households, and Orange Spain 7,4 Mio households (including connections via acquired providers, see Boyle 2016). In fact, all three network providers have deployed their own fibre networks, often connecting households to their network which were already being served by competitor´s lines. This massive network overbuild was the result of a heated fibre deployment phase between 2012 and 2016. Today, Telefonica has to offer unbundled access to its fibre networks and competitors have negotiated network-sharing agreements so that competition can also take place on existing infrastructures.

The digital agenda of the Spanish government of 2013 was accompanied by a separate broadband plan ("Plan de telecomunicaciones y redes ultrarrápidas") in which different phases for a nationwide roll-out were defined and different goals concerning coverage were set. The most important instrument to achieve the coverage goals was considered to be the regulation of the telecommunications sector. In addition, for the rural areas, a national funds with money from the European structural and investment funds was foreseen. With 277 Mio. Euros, many deployment projects in the rural areas in Spain were co-financed.

Regulation enables “fibre-miracle” in cities; in rural areas, municipalities take the initiative

Applying the "ladder of investment" approach (see for example Bourreau, Doan and Manant 2010), the Spanish regulator CNMC (Comision Nacional de los Mercados y la Competencia) granted regulatory holidays for incumbent Telefonica for FTTH/B connections in 2009. Telefonica used the following years to massively deploy fibre networks in Madrid and Barcelona

and several other big cities. However, the Spanish fibre boom only started in 2012 when Telefonica introduced a quadruple-play service called "Fusion Fiber Movistar" which included flatrate telephony, mobile telephony, a 100 Mbit/s-Internet access and an IPTV-package. The service was so popular that it reached a high market share in a very short time, motivating competitors to imitate the offer. For that matter, competitors had to deploy their own fibre networks (Herrera-González 2014). The overbuild of fibre networks, which was the consequence of this strategy, was promoted by the fact that telecommunication lines in Spain are often deployed above ground (see figure 7).

Figure 7: Over ground deployment of broadband access technologies in Spain

Source: www.adslzone.net/2016/09/05/espana-la-red-fibra-hogar-ftth-mas-grande-europa/

Regulatory holidays for Telefonica formally ended in 2016 which means that the company had to open its fibre networks to competitors allowing for competition at the service level. In return, competitors Vodafone Spain and Orange Spain had to open their networks for Telefonica´s services as well. Excluded from this arrangement are 66 Spanish cities, among them Madrid and Barcelona, in which competitors have deployed their own networks.

In rural areas, there are many fibre deployment projects, most of them are initiated and coordinated by the rural municipalities and financed by the European structural and investment fonds. Local utilities, mainly responsible for water and sewage water, play an important role in Spain. Some municipalities have also agreed on partnerships with telecommunications

companies and support their deployment activities in return for connecting public buildings and offering computer training courses for their population.

4.4 Switzerland

With an overall coverage of FTTH/B of 27 percent, Switzerland is ranked fourth in our country sample. However, fibre deployment currently is in a hot phase in Switzerland so that figures may rise substantially over the next years. As in other countries, coverage in rural areas in Switzerland is significantly lower with 6,6 percent in 2015 (see table 1).

The broadband situation in Switzerland is characterized by a distinct infrastructure competition between telecommunication service providers and cable-TV network providers. Cable-TV is available in almost all Swiss households (98,1 percent homes passed) which means that even in rural areas, broadband Internet can be used via cablemodems. The biggest cable TV company is UPC Switzerland (formerly Cablecom) which has upgraded its networks to the DOCSIS 3.0 standard in recent years so that most of its 1,4 Mio customers can subscribe to Internet services with up to 500 Mbit/s. On the telecommunications side it is Swisscom, the former monopolist which leads the market with a 60 percent share of the broadband market. Swisscom offers VDSL, VDSL-Vectoring as well as FTTH/B connections to its customers.

Since 2008, Swisscom has invested three times as much compared to the average of European incumbents for the deployment of fibre networks (European Commission 2016, p. 192). The major reason for this is the strong position of a third player in the Swiss broadband market: the municipalities, respectively the municipally-owned utilities which have invested massively in the fibre deployment in large and mid-sized cities from 2008 onwards. The activities of municipally-owned utilities (“Stadtwerke”) and cable TV networks have put Swisscom under pressure to either invest in fibre as well or to lose customers.

In 2016 there were over 50 areas in Switzerland where municipalities deployed their own fibre networks, often with technical support and in cooperation with Swisscom. Both parties use a unique cost-sharing model in which they divide the deployment costs and in which not one fibre is being deployed but four of them at the same time (4-fibres per home-approach).

The four-fibres-per-home-solution was the result of a series of roundtable meetings with stakeholders from the broadband market which was initiated and moderated by Swiss regulator ComCom (Federal Communications Commission) between 2008 and 2012 (see below). The current action plan for digitalisation and broadband deployment ("Digitale Schweiz") has the aim of providing countrywide ultra high-speed broadband to every citizen by 2020. "Ultra high-speed broadband" ("Hochbreitband") in Switzerland includes FTTH/B, DOCSIS 3.0, and LTE. In contrast to other countries where digital action plans are initiated by ministries, the in Switzerland telecommunications regulator is responsible.

Multi-stakeholder approach to coordinate the countrywide roll-out of fibre networks

As mentioned above, between 2009 and 2012 the regulator ComCom called in a series of roundtable meetings with stakeholders to coordinate the broadband rollout in Switzerland. The aim of the meetings was to avoid parallel or triple deployments of fibre networks by the different network companies (as in Spain for example). In attempt to balance interests and at the same time to keep up the speed of individual deployment activities, ComCom organised the meetings which took place in the castle of Waldegg nearby Soloturn (see "figure" 8).

Figure 8: Castle of Waldegg near the city of Solothurn, where the roundtables took place

Source: www.solothurnservices.ch/locations/schloss-waldegg/

The meetings were held secretly, only CEOs of telecommunications, cable TV, city network providers and other stakeholders were allowed to attend. Prepared for and moderated by ComCom, the result of the nine roundtable meetings was the four-fibres-per-home-approach which was to be applied in all areas where municipally-owned fibre providers are active.

The four-fibres-per-home-approach is similar to the Open Access Network approach discussed in the Swedish case. The difference is that municipality-owned network providers can also offer their own services using by using their own fibre line to the homes. In fact, city networks in Switzerland have recently joined forces and founded the Swiss Fibre Net AG in order to improve their marketing expertise and to put together attractive services to their fibre customers. So far, mainly Swisscom has profited from the four-fibres-per-home-approach because customers mainly subscribe to Swisscom services with they know from the VDSL worlds. The third of the four fibres are reserved for the services of cable-TV providers which are only slowly beginning to use the new lines as they have their own lines into most homes already. The fourth fibre is optional for new entrants and for excess capacities.

Apart from the competition from city networks and cable-TV providers, another reason why the dominant player Swisscom agreed to take part in the roundtables and to support the four-fibres-per-home-approach is the high authority of national regulator ComCom. In fact, ComCom could also have chosen to force Swisscom to unbundle their fibre networks in case the company would not cooperate.

5 Overview of success factors

In the analysis of the situation in the four selected countries, several factors were considered. In addition, in each country one decisive factor was identified which can be held responsible for the overall success of the fibre deployment in that specific country. Thus, we found four success factors directly related to the countries analysed:

1. Build up a middle-range network to bring fibre access points closer to rural households (Estonia)
2. Enable municipal utilities or city networks to become active in the rollout of fibre networks (Sweden)

3. Allow for regulatory holidays for FTTH connections to the incumbent (Spain)
4. Use a multi-stakeholder approach to coordinate the fibre deployment and avoid overbuilds (Switzerland)

In addition, the analysis of the development in the different countries shows that there are two factors of general importance:

6. Define ambitious coverage goals.
7. Support Open Access Networks in order to enable competition at the service level.

As these success factors are derived from the analysed countries - thus having their relevance and importance within a specific setting -, it is difficult to generalize the results of this study. Instead of attempting a compelling generalization, we suggest to use the results found for a stimulation of discussions on fibre deployment strategies in countries which are trying to catch up. In the next section, such an approach is followed as we will discuss some of the suggested success factors in the context of the situation in Germany where FTTH/B coverage is still low.

6 Applying the success factors to Germany

With only 6,6 percent overall coverage, Fiber-To-The-Home/Building is still in its infancy in Germany. And although manifold broadband projects in rural areas are under way - being co-financed by the federal government, the federal states ("Bundesländer") and the European Commission via its structural funds - many of the supported projects deploy VDSL, VDSL-Vetoring or DOCSIS 3.0 networks. Accordingly, the current coverage of fibre access in rural areas in Germany is 1,4 percent. One of the reasons for these low figures is the so called "evolutionary" strategy of dominant market player Deutsche Telekom. This means that the company, in which the German state still owns 32 percent, uses existing cables and wires rather than laying new fibre cables to the homes at any deployments. On the other hand, the company has spent many Mio. Euros in the past years to upgrade its network to VDSL and vectoring technologies in order offer Internet connections with up to 50 Mbit/s.

Interestingly, during 2011 and 2014, the incumbent followed a different strategy when it deployed FTTH in 12 midsized German cities. The plan was to reach at least 10 percent of

German households with FTTH after the initial phase. However, the strategy changed fundamentally in 2014 when Deutsche Telekom announced that there is not enough demand for FTTH and stopped its FTTH-activities.

In the broadband market, Deutsche Telekom mainly competes with telecom and cable-TV company Vodafone Germany as well as several regional big cable TV companies. Cable-Internet is being offered to around 63 percent of the population in Germany. Other competitors are city networks like NetCologne, Wilhelm.tel or EWE TEL.

In the following we will discuss the success factors found in the country analysis with respect to their suitability to increase fibre availability in Germany.

Define ambitious coverage goals

The current broadband goal of the German federal government is to provide 100 percent of the population with 50 Mbit/s Internet connections by the end of 2018. Compared to the goals set by the governments in the countries analysed here, this goal is the least ambitious. Yet, more ambitious goals like for example 100 Mbit/s for 90 percent of the population by 2020 as in Sweden would not go without controversy in Germany. In fact this would require a major strategic change for Deutsche Telekom because its current VDSL and VDSL-Vectoring deployments are mostly not able to reach 100 Mbit/s. More ambitious goals thus would require to switch to FTTB/H, at least in regions where broadband projects are co-financed with public money.

Build up a middle-range network to bring fibre access points closer to rural households

This strategy, which was highlighted in the analysis of the Estonia, could be feasible in Germany as well. As soon as local access points are available, the further deployment of FTTH/B networks is much easier and cheaper. Local points of access could be installed in public buildings like town halls, schools or libraries. In a second step, commercial roll-outs or roll-outs financed by the municipalities could be tackled. In fact, the state of Schleswig-Holstein is currently checking the feasibility of building such a middle-range network. Especially law restrictions for subsidies in the telecommunication area need to be checked which seems to require extra time.

Enable municipal utilities or city networks to become active in the rollout of fibre networks

The activities of municipally owned utilities or city networks have proved a decisive factor for successful fibre deployments in Sweden, Spain and Switzerland. Local or regional public bodies are able to plan in longer time horizons. For example, the Swiss electricity utility ewz which deploys fibre in the city of Zurich, calculates 20 years for refinancing the current deployment costs (ewz 2016) - a calculation no commercial actor would be able to make. In Germany, city networks are also active in the broadband rollout. However, their activities are still rather limited, which is due to specific law restrictions and a lack of expertise in local decision making processes. Also, the transfer of the concept of "services for the public" ("Daseinsvorsorge") to broadband Internet access seems to be difficult in Germany as long as the strong consensus exists that private companies and not the state shall be responsible for the deployment of high-speed Internet. In this context, another success factor is of relevance:

Support Open Access Networks in order to enable competition at the service level

Open Access Networks are networks built up by municipally owned utilities or city networks which are being leased to commercial providers of Internet and TV services. The fact that the infrastructure is being built with public money does not mean that the competition principle is abolished. To the contrary, Open Access Networks enable competition on the service level in areas where previously no competition was possible because there were no networks available. In Germany there are some broadband projects utilizing the Open Access Network-approach. The impression is, however, that Open Access Networks are only being built in areas where the population and decision makers are extremely frustrated with existing providers and see no other possibility as to build up the network by themselvs. The possibilities and advantages of Open Access Networks thus should be better communicated in Germany so that more municipalities may choose this approach.

Allow for regulatory holidays for FTTH connections to the incumbent

As we have seen in Spain, regulatory holidays could initiate a fibre boom especially if demand increases and competitors follow with deploying their own fibre networks. In Germany, this option is rather difficult, firstly because there have already been attempts by Deutsche Telekom to get regulatory holidays in the past, which were finally declined by the European

Commission. And secondly unintended effects would be massive overbuilds in cities where demand is bigger than in rural areas. A rather smart allocation of resources could come from applying the last success factor which is a coordinated fibre deployment with consultations among all involved players:

Use a multi-stakeholder approach to coordinate the fibre deployment and to avoid overbuilds

The Swiss case has shown that a roundtable-approach could be used to effectively coordinate nationwide fibre roll-outs and to avoid overbuilds. Especially because different strategies are followed by the different commercial actors as well as by ministries on the federal and state level, a better coordination of activities seems to be necessary in Germany. In fact, the German Federal Ministry for Economic Affairs, which is responsible for the broadband deployment - together with the Federal Ministry of Transport and Digital Infrastructure - has suggested in its recently published white book on digital platforms to call in a national roundtable in the future (BMWi 2017, p. 84). Thus, the challenge of a better coordination may be addressed after national elections in the autumn of 2017.

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