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**Broadband developments in Europe:
A retrospective review of the
determinants of supply and demand**

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Purpose of this document

This document captures and extends the learnings from the research-annex-book project on the dynamics of broadband markets in Europe. This research project is undertaken as part of the visiting research fellowship at the Institut Barcelona d'Estudis Internacionals – Catedra Telefonica.

Abstract

This contribution provides insights into the dynamics of broadband markets in Europe. While there are many studies capturing the dynamics from an econometric perspective, qualitative studies are much smaller in number and typically provide a top-down perspective. This contribution takes a broad view as it looks from the 'bottom-up' at broadband developments. In terms of the market dynamics, it first of all focuses on the ability to pay and willingness to invest and the interplay between the supply side actors. This concerns not only the telecom incumbents, but in particular the non-telco actors, such as municipalities, housing corporations, citizens cooperatives, etc. Secondly, it concerns the development of the technologies deployed. Thirdly, the roles of policy and regulation are considered. The most important outcomes reviewed are broadband coverage and uptake, next to the data rates provided and consumed. Overall, the contribution provides insights into the industrial organisation of the sector. The determinants of wired broadband market dynamics are discussed in their perceived order of importance.

Keywords

Telecommunication networks; demand; supply; competition; investment; policy; regulation; European Union.

1. INTRODUCTION

This contribution is aimed at providing insights into the dynamics of broadband markets in Europe. While there are many studies capturing the dynamics from an econometric perspective, qualitative studies are much smaller in number. Moreover, the qualitative contributions typically focus on what in terms of policy and regulation is expected from the telecom operators and other actors, thereby providing a top-down perspective. This contribution takes a broader view as it looks from the ‘bottom-up’ at broadband developments. In terms of the market dynamics, it first of all focuses on the ability to pay and willingness to invest and the interplay between the supply side actors. This concerns not only the telecom incumbents, but in particular the non-telco actors, such as municipalities, housing corporations, citizens’ cooperatives, etc. Secondly, it concerns the development of the technologies deployed. Thirdly, the roles of policy and regulation are considered. The most important outcomes reviewed are broadband coverage and uptake, next to the data rates provided and consumed. Overall, the contribution provides insights into the industrial organisation of the sector.¹

The past and the present are captured in this contribution under the heading ‘retrospective review’. This review covers the period 2000-2015. This contribution focusses on the dynamics of the wired broadband markets. Under each heading the determinants in terms of actors or drivers of broadband market dynamics are discussed in relation to their perceived level of importance in broadband development. In this retrospective review a total of twelve determinants are discussed for wired broadband.²

While this overview is based on developments in Europe, it may inform research efforts into broadband developments in other regions of the world.

The retrospective review builds upon the research that has led to the twelve country cases studies as included in the book “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda” (Lemstra & Melody, 2015), which – for the purpose of this research – have been updated for recent developments. For an appreciation of the methodology applied in the original research and the interpretation of the research findings reported here, a summary of the research approach is provided in the following chapter – Chapter 2. Chapter 3 then captures the research outcomes, in terms of the determinants of supply and demand.

¹ The focus is on the network operator side of the industry, in relation to the equipment supply side and to the end-users. The way the equipment supply side has evolved and, in Europe, became consolidated and challenged by new entrants from China, falls outside the scope of this contribution.

² The determinants can be considered the attributes of a multi-criteria analysis of the broadband market.

2. RESEARCH APPROACH

The broadband developments and market dynamics in twelve EU Member States have been captured in twelve longitudinal³ case studies. The case study period starts with the introduction of broadband, around the year 2000, and runs until the year 2013.

2.1 The country case study design

The scope of the research includes both fixed and mobile/wireless broadband. The realization of the high-end data rate target of the Digital Agenda is to a large extent dependent on the deployment of fibre in the access network (fibre to the curb and to the last amplifier, as well as fibre to the business and to the home). As this transition to fibre is a major economic, regulatory and political challenge, the focus in the country case studies is on the developments in the market for fixed broadband.

Our hypothesis is that the broadband market dynamics are determined by a combination of factors, which have been assessed in terms of their importance through the case study research, including:

Geography and demography; historical infrastructure developments; institutional arrangements; time of joining the EU; market structure; distribution of market power; firm ownership; position and role of the regulator; political priorities and preferences; and the industrial setting.

The units of analysis were the actions of the key actors operating in the broadband market and their outcomes. The key actors identified upfront were:

The operators providing broadband services; the government, policy makers and legislators affecting the operating conditions in the broadband market; and regulators, enforcing the laws and regulations applicable to broadband.

The case studies revealed which ‘third actors’ have influenced the market dynamics to a significant extent, and hence were included in the explanation of the broadband market outcomes. These actors included local and regional governments; housing corporations; citizen collectives; market entrants from outside the sector, etc.

The cause-and-effect logic the authors of the case studies applied to explain the market outcomes were largely based on the logic of strategizing which firms apply in competitive markets. This included reviewing the external and internal environment, and comparing the market

³ A longitudinal study is defined as a correlational research study that involves repeated observations of the same variables over long periods of time, often many decades. It is a type of observational study. In our context, the term longitudinal case study is used to denote the developments over time of the same variables in qualitative terms.

opportunities and threats against the company's strength and weaknesses, as advised by a range of authors, from Porter (1980) to De Wit and Meyer (2010).

In their analyses of the market dynamics and their explanations of the market outcomes the case study researchers have addressed the following issues: (1) the market structure and its evolution, covering the infrastructure and services dimension and capturing the degree of entry and exit; (2) the type of competition, e.g. price or functionality based, and the intensity of competition; (3) the role of regulation, e.g. through local loop unbundling; (4) the role of fixed versus mobile broadband; (5) the investment pattern, privately or publicly driven; (6) the role of innovation.

The market outcomes considered as the dependent variables were the uptake of broadband, the data rates and the prices. The criteria for the interpretation of the case findings, e.g. in terms of intensity and degree, have been a judgment call by the case researchers, leveraging their extensive experience in the field.

A recurring issue in interpreting the different approaches and outcomes in historical research is the lack of the counterfactual. In our research, the broad set of twelve comparable country-level case studies, capturing very diverse developments and market outcomes, has compensated for the lack of a counterfactual in each case. A critical analysis of the similarities and differences in the settings of the cases allowed for meaningful comparisons to be made and relevant patterns to be discerned (Diesing, 1971; Wilber & Harrison, 1978).

A further methodological difficulty is that the strategies of private actors are not necessarily part of the public domain and hence can often only be inferred in hindsight or established once the outcomes have become apparent; an issue that applies to a far lesser degree to public policy making. Hence, the capturing of motivations and the strategic analysis applied by these actors had to come from interactions of the case authors with these actors and from their insights into the (typical) strategic behaviour of these actors. These interactions have necessarily been limited in number, but are considered sufficient for an appropriate interpretation of the case study materials, as the developments of broadband markets are (mostly) determined by only a few major actors.

In the design and the execution of the research, the researchers have paid due attention to assuring construct validity by using, to the extent possible, multiple sources of evidence, establishing chains of evidence and making these explicit. Where possible, local experts (e.g. fellow academics, regulators) have reviewed the case study data, the analysis and the conclusions. As the cases have been largely built from literature and only a selective use of interviews, the reliability of the case studies is strengthened through detailed referencing.

In this multi-case study research assuring the internal and external validity have gone hand-in-hand through the application of pattern recognition and pattern matching, the cross-validation of

explanation building, the testing of rival explanations, and the validation of the replication logic across the multiple cases.

2.2 Methodology

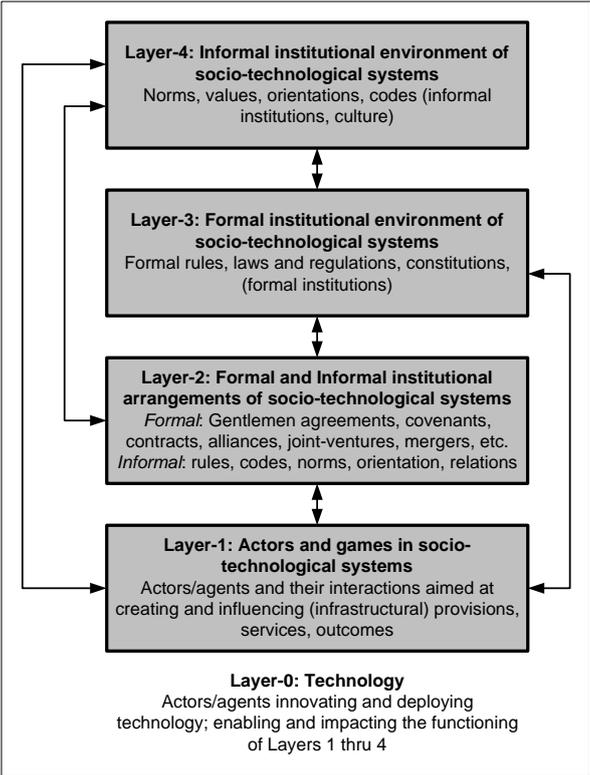
In our exploratory efforts we followed the methodological lead provided by Lawson in “Economics & Reality” (1997, p282-9): “Social explanation, appropriately conceived, is not the attempted deduction of events from sets of individual conditions and constant-conjunction ‘laws’, but the identification and illumination of structures and/or mechanisms responsible for producing, or facilitating, social phenomena of interest”; or in other words, “...[T]he primary aim of science is not the illumination or prediction of events... ..but the identification and comprehension of the structures, powers, mechanisms and tendencies which produce or facilitate them. And this understanding is all that is required for policy analysis and (where feasible) effective action.”

As the market developments are an interplay between technological progress, entrepreneurial activity to exploit the new technological capabilities, and governments safeguarding the public interests and public values, the case studies highlight the policy dimension.

a) The Analysis Of Social-Technical Systems

For the explanation of the broadband market dynamics and the market outcomes, we followed a general framework for the analysis of socio-technical systems, see Figure 1. This framework is developed by Groenewegen and Koppenjan (2005), extended by Lemstra, and is based on the work by Williamson (1998) on transaction cost economics.

Figure 1. Five layer model - levels of Institutional analysis, technology enabled.



The exploration and analysis of broadband markets is necessarily of an historical nature and includes a variety of explanatory variables such as technology, laws and regulations, strategies of the firms, values and norms, etc. The behaviour of the actors concerning broadband service provisioning is largely conditioned by the institutional structures in their environment, such as laws and regulations. On the other hand, these actors have a certain degree of autonomy in realizing their own objectives, to explore new ways, and to change the institutional structures around them. Moreover, actors not only interact with the institutional structures in their environment, they also interact with each other. In doing so they share ideas, they learn, but they also compete and try to control the behaviour of others.

Figure 1 reflects the different layers that can be distinguished in the institutional environment of the actors, with the arrows indicating the interactions. In conceptualizing institutions we follow North in his definition of institutions as “humanly devised constraints that structure political, economic, and social interactions”; and “institutions consist of a set of moral, ethical, behavioural norms which define the contours and that constrain the way in which the rules and regulations are specified and enforcement is carried out” (North, 1990).

At the top of Figure 1 in Layer-4 the so-called informal institutions are located that influence – mostly implicitly – the behaviour of actors. This is the cultural embedding of the key actors involved in the provision of broadband services, which has an impact on the motivation of these actors and on their expectations of how the other (private and public) actors will behave. Our ideas about human rights and equity belong at this level.

While there are many similarities across Europe in norms and values, there are also cultural differences that will play-out at the lower levels. At Layer-3 we show the so-called formal institutions that influence the behaviour of the actors more explicitly. Here are located the laws about, for instance, competition and corporate governance, the EU Regulatory Framework for e-communications, the national telecom laws and regulations. These are examples of explicit institutions that have an impact on the behaviour of the industry actors.

Layer-3 is typically the working domain of public actors, such as the parliament, ministries and public agencies. At Layer-2 formal and informal institutional arrangements are identified, including the institutions that private actors make to coordinate the transactions between them. A distinction is made between the institutions that private actors purposefully create, such as contracts and organizations, and the ones that informally evolve, such as norms that are shared among the actors involved. Examples of purposeful institutions in our context are the GSM Association, the 3GPP, RIPE, PPPs.

At Layer-1 the firm actors are located with their day-to-day routines, in our case operating in the competitive market place providing broadband service. These same actors, often in different roles

and capacities, create and modify the institutional structures at the higher Layers, while being at the same time constrained by them. Examples of such efforts are the lobby groups of operators active at the European level, such as ETNO, ECTA and Cable Europe.

These interactive relationships are reflected by the arrows between the different Layers. As the higher layers condition the actions at the lower layers, the institutional formation represented by these interactive relationships is an important aspect considered in explaining the dynamics of broadband markets. At the lower layers these relationships may be more explicit and traceable, while at the higher layers they are more diffuse and difficult to capture.

Technology plays an important role in the development of broadband. Hence, the model has been extended to reflect technology at Layer-0, which suggest linkages to all other Layers. Technology is considered to be developed by actors/agents in Layer-1, i.e. is man-made. In its application it is impacting Layer-2 through Layer-4; in turn technology is being shaped through these interactions.

Because of the variety of explanatory variables involved at different levels of analysis our case studies are clearly of a multi-disciplinary nature. At Layer 4 the disciplines of history, anthropology and sociology are relevant. Layer 3 is the domain of political science and law as well as of economics (e.g. property rights). For the analysis of the institutional arrangements at Layer 2 we consider institutional economics as particularly relevant, while for the analysis of the interactions between the layers we made use of the insights from evolutionary economics.

B) Role Perception Of Governments

Groenewegen provides a framing for capturing the differences in the roles assumed by governments by relating these roles to the principle operation of the market economy. We summarize the discussion provided in “Markets and public values” (Lemstra and Groenewegen, 2009).

Economies are systems in which social systems, judicial systems, political systems, and economic systems are interrelated and form a consistent whole. Market economies differ in terms of the value system, the role of private and public actors, and the type of laws and regulations. A general characteristic of a market economy is the decentralized decision making. In the Anglo-Saxon perception of markets the grounding is in the individualistic values of freedom, individual responsibility, and accountability. Those values relate to the norm of competition as the right mechanism to allocate scarce resources. When information and knowledge is diffused among individuals, competitive markets are considered to be the adequate governance structures to coordinate transactions. Connected to the individualistic values is the norm that decisions ought to be taken at decentralized level, that the costs should be paid at the decentralized level of the micro unit and that the benefits should be collected at that level. Under these conditions, the actors will be motivated to

search for the most efficient solutions for the allocation questions around production, distribution and consumption. In the value system that supports the decentralized allocation in markets, it is believed that those efficient private decisions will add up to the best possible public benefits. Prices that consumers pay reflect the costs of the inputs. Firms aim at profit maximization, or an increase of market share, innovative products, etc. When things go wrong this is reflected in prices and will initiate private actors to correct their decisions at decentralized level. Therefore markets must be transparent, neutral and flexible. The market may also be assisted by government so it can perform even better. This takes us into the area of indicative planning, in which the supply of additional information as a public good is central.

For analysing the role of governments, Groenewegen defines a spectrum with two poles, two relative extremes in the role perceptions that governments may adopt: the regulatory state and the developmental state. Within the regulatory state the government operates at a distance and plays the role of the ‘night watch’. Such a government is small and first of all a facilitator of what ‘society wants’.

In terms of information production and diffusion it is the ‘lender of last resort’. After all other options have been tried the state plays the role that remains. It monitors and in case it discovers inconsistencies it does not intervene, but feeds information back into the system. The regulatory state is strong with respect to the maintenance of the rules of the game: supervising the process is central and in that respect the state intervenes strongly based on strict rules of competition.

In the ‘developmental state’ the government develops, in consultation or without consultation of the private actors, a vision about the desired future. The state defines the objectives and the instruments to be used to realize the vision. Such a state is well informed, is an authority in society, and usually well respected because of its power to guide and direct structural developments.

3. RESEARCH OUTCOME: RETROSPECTIVE REVIEW OF WIRED BROADBAND MARKET DYNAMICS

Following on the period of dial-up access to the Internet, the wired broadband era started with ‘always on’ Internet access enabled by modem technologies applied on either the twisted pair copper network of the PSTN-operator (i.e. DSL) or on the coax network of the CATV-operator (i.e. DOCSIS).⁴ In most countries in Europe this occurred around the year 2000.

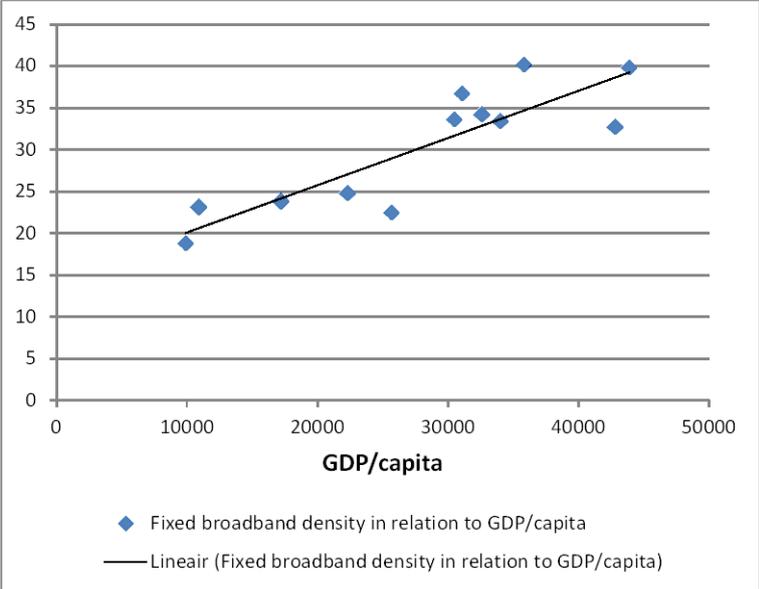
⁴ DSL: Digital Subscriber Line; DOCSIS: Data Over Cable Service Interface Specification. Note that the focus in this contribution is on residential broadband developments. The business broadband market is typically served by the PSTN incumbent and a number of specialized alternative operators.

The ‘always on’ access to the Internet shifts communication services from being centred on voice communication to being centred on data communication.

3.1 First determinant: ability to pay and willingness to invest

A critical determinant for broadband development is the ability of end-users to pay for broadband services and the related willingness of operators to invest in the deployment of broadband networks. Similar to the early development of the telephone network⁵, there is a strong correlation between GDP per capita and broadband uptake, see Figure 2 ($R^2 = 0.748$).^{6,7}

Figure 2. Broadband density in relation to GDP per capita, selected EU countries, 2013



The willingness to pay of end-users relates to the socio-economic setting. The use of the Internet, and thus the need for broadband, is closely related to the penetration of personal computers. This in turn is closely related to educational and income levels.

Furthermore, the use of the Internet by consumers for e-commerce and for e-government is directly related to the degree to which business and governments have embraced the ‘net’ in their business model.

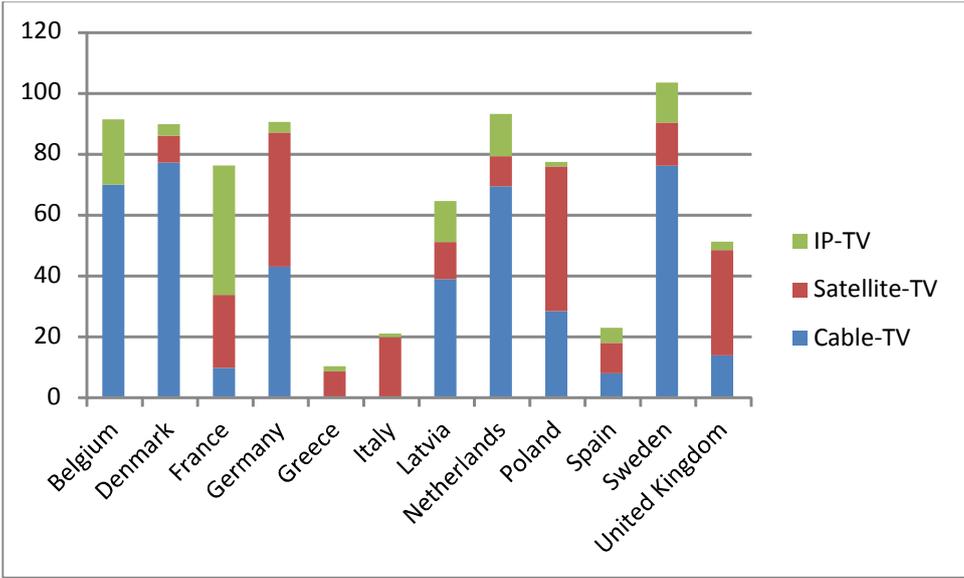
⁵ Source: Siemens (1992).

⁶ Data related to the twelve country case studies included in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda” (Lemstra & Melody, 2015): Belgium, Denmark, France, Germany, Greece, Italy, Latvia, Netherlands, Poland, Spain, Sweden and the United Kingdom.

⁷ For an analysis of the contribution of broadband to economic development see for instance the OECD report “Impact of broadband on the economy: Research to date and policy issues” (ITU, 2012). This report also contains an overview of the literature on this topic. For an econometric analysis of broadband market developments based on the structure-conduct-performance (SCP) paradigm see (Lemstra, van Gorp & Voogt, 2014).

Another important driver is entertainment. As analogue television is being replaced by digital formats, the TV signals can be transported over the Internet. At first this complements terrestrial and satellite TV broadcasting. With delay-TV and TV-on-demand services being offered, the role of IP-TV grows in importance. In fact, the PSTN-based Internet access has become an alternative TV-distribution platform to the existing CATV-based platform. See Figure 3 for an illustration of the infrastructures used for television, excluding terrestrial broadcasting.⁸

Figure 3. Infrastructures used for TV, percentage of households, selected EU countries, 2013



With the bundling of services, the combination of TV and Internet access have become the driving force, telephony being added – for no additional charge. The ability to provide unique TV content, e.g. the coverage of the national soccer league, has become central to the competitive game, with many millions being spent on the acquisition of the broadcasting rights by telecom operators.⁹ In fact, the innovation trajectories of communication, entertainment and computing have come together and have become mutually re-enforcing.

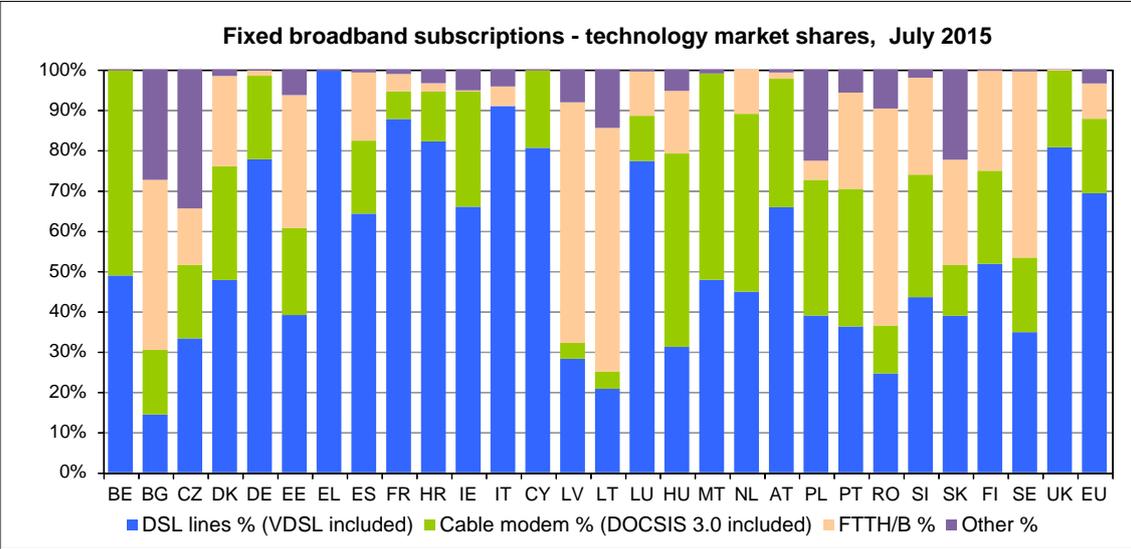
Returning to Figure 2, for the 12 countries covered it shows a substantial difference between the low end and the high end of GDP per capita across Europe and thereby a significant spread in the deployment and uptake of broadband. However, there are clear exceptions to the rule, in particular in Member States that have recently joined the European Union, such as Bulgaria, Latvia, Lithuania and

⁸ Data related to the twelve country case studies included in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda.” (Lemstra & Melody, 2015)

⁹ An example: “BT announced on 9 November 2013 that it had acquired exclusive rights to broadcast live UEFA Champions League and Europa League football matches in the UK and Ireland for 3 years between 2015–2016 and 2017–2018. It paid about GBP900 million (EUR1.07 billion) for the rights. The deal also gives BT rights to highlights and mobile delivery.” See more at: <http://www.analysismason.com/About-Us/News/Insight/BT-sport-article-Nov2013/#sthash.iYTYbaeQ.dpuf>. Retrieved 2016-05-03.

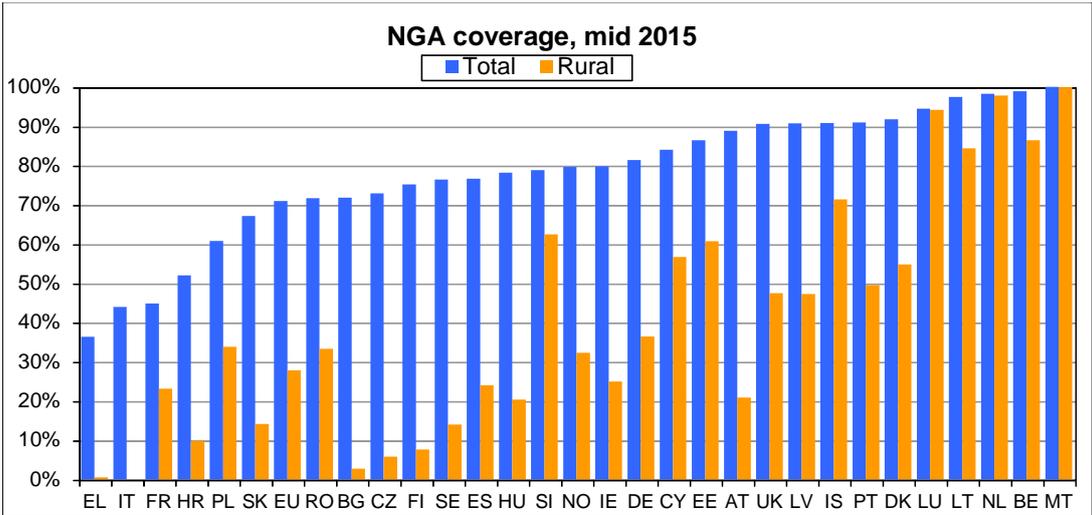
Romania. See Figure 4.¹⁰ Here we can observe a ‘leapfrogging’ in technology, i.e. due to lack of DSL early deployments by telcos and non-telcos of FttH and Ethernet-over-Fibre can be observed. See for a discussion Section 0.

Figure 4. Fixed broadband subscription - technology market shared, July 2015



Following the liberalization of the telecommunications services sector the deployment of network infrastructure is subject to a profitable business case. This means that broadband, in particular next generation broadband, is deployed first and foremost in dense urban areas. The rural areas representing much higher deployment costs are underserved or not served at all. See Figure 5 for the NGA coverage in the rural areas and overall.¹¹

Figure 5. NGA coverage, total and rural, July 2015



¹⁰ Source : <https://ec.europa.eu/digital-single-market/en/connectivity>. Retrieved 2016-05-03.

¹¹ NGA includes FttH, FttB, VDSL, and Cable DOCSIS 3.0. Source: <https://ec.europa.eu/digital-single-market/en/connectivity>. Retrieved 2016-05-03.

In these rural areas municipal and citizen initiatives, as well as government subsidies, play an important role in the deployment of broadband. See Section 0 for the municipal dimension and Section 0 for a discussion of citizen's initiatives.

3.2 Second determinant: policymakers and regulators

The second determinant of broadband dynamics is the policy and regulatory environment in which broadband has developed and is developing. In Europe the telecommunication markets are fully liberalized and the EU regulatory framework for electronic communications is aimed at assuring a proper functioning of these markets.

At the European level, the Green Paper of 1987 (EC, 1987) marked the beginning of the market liberalization process. The date upon which liberalization should become effective was set at January 1, 1998.¹² With the liberalization came the first regulations, including the establishment of national regulatory authorities (NRAs). The NRAs are expected to be independent of government and to be appropriately resourced, in order to be accepted as an expert in their field.¹³

These first regulations were restructured into a comprehensive regulatory package in 2002.¹⁴ In 2009 the package was subject of revision. The current regulatory package consists of: the Framework Directive¹⁵; the Authorisation Directive¹⁶; the Access Directive¹⁷; the Universal Service Directive¹⁸; and the ePrivacy Directive¹⁹.

¹² Most EU countries complied with this target date, some countries in southern Europe were granted some more time to adjust the telecom industry, the rules and regulations towards the new policy situation.

¹³ Note also that the attitude of the regulator and even the personality of the head of the regulatory office make a difference in the way regulation is applied and in its effectiveness. See for an example the Case of UKE the Polish NRA in Chapter 14 *Poland* by Windekilde & Ladny in "The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda". (Lemstra & Melody, 2015).

¹⁴ The main legal acts of the EU come in three forms: regulations, directives, and decisions. Regulations become law in all member states at the moment they come into force. They do not require any implementing measures at the national level and they automatically override conflicting national provisions. Directives require transposition into national laws. Decisions offer an alternative to the two above modes of legislation. They are legal acts which only apply to specified individuals, companies or a particular member state. They are most often used in competition law, or on rulings on State Aid, but are also frequently used for procedural or administrative matters within the institutions. Regulations, directives, and decisions are of equal legal value and apply without any formal hierarchy. Recommendations are not binding but tend to be followed by member states, fostering the single internal market.

¹⁵ Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services (Framework Directive) (OJ 2002, L 108/33) as amended by Directive 2009/140/EC (Better Regulation Directive).

¹⁶ Directive 2002/20/EC of the European Parliament and of the Council of 7 March 2002 on the authorisation of electronic communications networks and services (Authorisation Directive) (OJ 2002, L 108/21) as amended by Directive 2009/140/EC (Better Regulation Directive).

¹⁷ Directive 2002/19/EC of the European Parliament and of the Council of 7 March 2002 on access to, and interconnection of, electronic communications networks and associated facilities (Access Directive) (OJ 2002, L 108/7) as amended by Directive 2009/140/EC (Better Regulation Directive).

¹⁸ Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services (Universal Service Directive) (OJ 2002, L 108/51) as amended by Directive 2009/136/EC (Citizens Rights Directive).

Following their adoption at the EU level, these directives are transposed into national law for implementation. The enforcement of the rules and regulations is the responsibility of the NRAs.

Coordination between the NRAs is considered very important to achieve a harmonized business environment, as part of the EU Single Market objective. At first the coordination was facilitated through the setup of the independent regulators group (IRG) and in 2002 the European regulators group (ERG). More formal coordination and a link with the EU policymaking efforts was established with the set-up of BEREC, the body of European regulators of electronic communications in 2009.²⁰

BEREC tasks are: (1) to develop and disseminate among NRAs regulatory best practices, such as common approaches, methodologies or guidelines on the implementation of the EU regulatory framework; (2) on request, provide assistance to NRAs on regulatory issues; (3) deliver opinions on the draft decisions, recommendations and guidelines of the European Commission as specified in the regulatory framework; (4) issue reports and provide advice, upon a reasoned request of the Commission or on its own initiative, and deliver opinions to the European Parliament and the Council, when needed, on any matter within its competence; and (5) on request, assist the European Parliament, the Council, the Commission and the NRAs in relations, discussions and exchanges of views with third parties; and assist the Commission and NRAs in the dissemination of regulatory best practices to third parties.²¹

As the first regulatory period concerned the liberalization of the market, the emphasis of the regulation was on creating a level playing field, which implied the application of ex-ante regulation to constrain the significant market power of the incumbent PSTN operator and introducing an obligation to interconnect with alternative operators. The various telecom (sub)markets have to be reviewed on a regular basis, typically every three years.²² New findings will result in either the abolishment, the adjustment or the implementation of (new) remedies. These remedies must be based on the underlying problem identified, they have to be proportionate and justified in light of the objectives.

¹⁹ Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications) (OJ 2002, L 201/37) as amended by Directive 2009/136/EC (Citizens Rights Directive).

²⁰ Regulation (EC) No 1211/2009 of the European Parliament and of the Council of 25 November 2009; part of the Telecom Reform package. Source: <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2009:337:FULL&from=EN> Retrieved : 2016-05-03.

²¹ Source: http://berec.europa.eu/eng/about_berec/what_is_berec/ Retrieved: 2016-04-03.

²² The European Commission adopted the first Recommendation on 11 February 2003, and the second, reviewed Recommendation on 17 December 2007. The Recommendation identifies those product and service markets within the electronic communications sector, whose characteristics may be such as to justify the imposition of regulatory obligations set out in the specific Directives. Source: <https://ec.europa.eu/digital-single-market/en/news/commission-recommendation-relevant-product-and-service-markets-within-electronic-communications> Retrieved: 2016-05-03

Originally 18 markets were identified by the European Commission that had to be reviewed by the NRAs, while NRAs could add to the list based on their national market analysis. This list was reduced to 7 markets in 2007 and to 5 markets in 2014.

The regulatory framework does not include specific clauses related to broadband. However, over time a number of Recommendations have been issued that relate to broadband, in particular next generation access.²³ See the discussion below.

The regulatory framework applies to the EU Member States, hence, becomes effective once Member States join the Union. Hence, the different entry dates imply different learning trajectories, in terms of applying and enforcing the regulatory framework, of early Member States in comparison to those Member States who have joined the EU more recently.^{24,25}

3.3 Third determinant: incumbents – legacy networks and competition

The third determinant of broadband market dynamics concerns the degree to which legacy networks have been deployed and could readily be upgraded to provide broadband Internet access. The presence of both PSTN and CATV networks determines the degree to which infrastructure-based competition has been realized. Infrastructure-based competition is considered to be better than access-based competition as operators can exploit the differences between the underlying network assets in the competitive game. The combination of infrastructure-based and access-based competition appears to be superior as the access player can assert price pressure on the whole market.²⁶ (Lemstra, Voogt & Van Gorp, 2015) See also Section 0 on unbundling.

In western European countries the PSTN had been deployed to virtually every home, the density is close to 100% of households. However, in central European countries the deployment of the PSTN had been constrained and following market liberalization has peaked at 60% of households, the preference now being for mobile connectivity. Where there is no PSTN, upgrades to broadband are not possible. This provides a legacy boundary to (pre-)wired broadband.

²³ European Commission Recommendation 2010/572/EU of 20 September 2010 on regulated access to Next Generation Access Networks (NGA) and European Commission Recommendation C(2013) 5761 final of 11.9.2013 on consistent non-discrimination obligations and costing methodologies to promote competition and enhance the broadband investment environment. Sources: <http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=URISERV:si0018&from=EN> and http://ec.europa.eu/smart-regulation/impact/ia_carried_out/docs/ia_2013/c_2013_5761_en.pdf

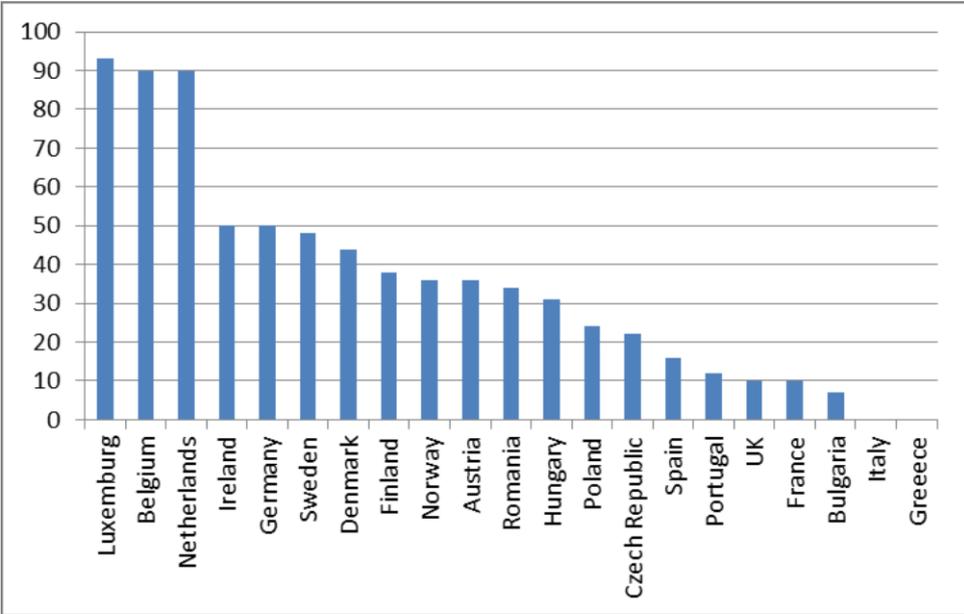
²⁴ The European Economic Community (EEC) was established in 1957 through the Treaty of Rome with 6 participating states: Belgium, France, Italy, Luxembourg, the Netherlands and West Germany. The EEC was preceded by the European Coal and Steel Community set up in 1952 to address and resolve the overcapacity in the Region. In 1973, the Communities enlarged to include Denmark, Ireland, and the United Kingdom. Greece joined in 1981, Portugal and Spain following in 1986. In 1995 the EU gains three more new members: Austria, Finland and Sweden. Ten new countries join the EU in 2004: Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia and Slovenia. In 2007 Bulgaria and Romania, join the EU, bringing the number of member states to 27. In 2013 Croatia joined the EU as 28th Member State. Source: http://ec.europa.eu/enlargement/policy/from-6-to-28-members/index_en.htm. Retrieved: 2016-05-09.

²⁵ For a discussion of the influence of European Union policies and regulation, as well as a discussion of empirical studies into the impact of access regulation on competition see Chapter 3 by Cawley in (Lemstra & Melody, 2015).

²⁶ It has been argued that access-based competition deters investment by the incumbent. However, the literature is inconclusive. In the USA the FCC has used the argument to abolish unbundling regulation in order to stimulate investment in fibre to the home networks.

In many western European countries CATV networks have been deployed and after market liberalization these have been consolidated at the country level typically into a few large players with a number of smaller independent networks remaining. Countries with a high density, up to 95% of households, are Belgium and the Netherlands. Penetrations of around 40-50% of households can be found in e.g. Denmark, Germany and Sweden. In most central European countries CATV networks have been deployed in the major cities. CATV networks have not been deployed in Italy nor in Greece. Figure 6 shows the deployment of CATV-networks at the time of the liberalization. (EITO, 1999).

Figure 6. CATV penetration by household in Europe, 1999



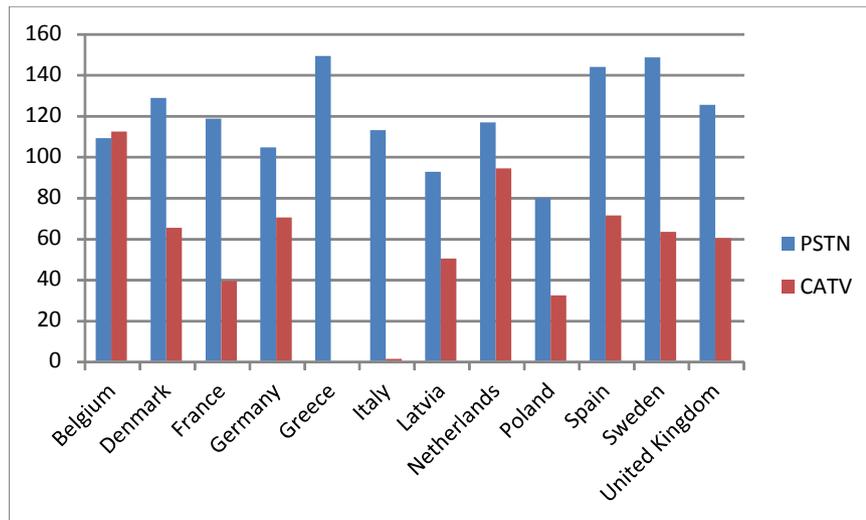
The degree to which CATV networks have been deployed provides the extent to which infrastructure-based competition in broadband can be developed using legacy networks. Figure 7 reflects the approximate PSTN and CATV coverage per household in the selected EU countries. The CATV coverage indicates the upper-bound of legacy infrastructure-based competition.^{27,28,29}

²⁷ Data related to the twelve country case studies included in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda.” (Lemstra & Melody, 2015)

²⁸ The data includes PSTN/CATV lines to business users, hence the density per household is overstated – in particular for the PSTN.

²⁹ Note that the deployment of FttH represents a third infrastructure. The degree to which this increases infrastructure-based competition depends on the degree of network over-build that is occurring. In urban areas the degree is high compared to rural areas.

Figure 7. Coverage of PSTN and CATV per household, selected EU countries, 2000



To promote infrastructure-based competition, the PSTN incumbents were required by regulation to divest their CATV network interests. Depending on the attitude of the NRA this was effectuated earlier or much later. Germany belongs to the latter category, whereby Deutsche Telekom divested its cable assets in 2002. In Denmark the incumbent operator still owns and exploits CATV assets, next to the PSTN and FttH networks.³⁰

From an economic perspective infrastructure-based competition is considered to be better than access-based competition, as the network owners operate independently and can each exploit the properties of the underlying infrastructure into their service offerings. On the one hand, the coax cables deployed in CATV networks are superior compared to the twisted copper wire pairs of the PSTN, in terms of the higher bandwidth that can be used and thus the higher data rates that can be provided. On the other hand, the PSTN is superior in its architecture, whereby each customer premise is connected individually to the local exchange (point-to-point), while in the CATV network, originally designed for the distribution radio and TV signals, multiple users share the final part of the access network (point-to-multipoint).

In countries such as Latvia, where the PSTN penetration peaked at 25.4% of population, the incumbent Latt telecom decided to directly move to deployment of fibre to the apartment buildings, avoiding investments in VDSL. By January 2013 the country enjoyed in terms of technologies to which end-users subscribed a 47.3% market share in fibre, 31.8% ADSL and 3.9% CATV.³¹

³⁰ See for discussion of the CATV case in Denmark Chapter 6 *Denmark* by Henten and Falch in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda”. (Lemstra & Melody, 2015)

³¹ See for the case of Latvia Chapter 15 *Latvia* by Virtmanis and Karnitis in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda”. (Lemstra & Melody, 2015)

3.4 Fourth determinant: municipalities – fibre as superior technology

Introduced around the year 2000, the first generation of modems was providing for ‘always-on’ broadband access at data rates of around 2 Mbit/s on the PSTN and 8 Mbit/s on the CATV networks. Nonetheless the data rates offered were in stark contrast with the 100 Mbit/s that could readily be provided on optical fibre, as an alternative technology to copper. Moreover, fibre could provide this data rate symmetrically, i.e. in the downlink and the uplink. The first Fibre-to-the-Home trials can be traced back to the early 1990s.³² In short FttH was much more future proof. The only drawback was that it had to be newly deployed while the copper-based networks were already in place.

Moreover, in most cases fibre deployment implied an over-build. This was unattractive for the incumbents but could be attractive for an alternative operator, provided it was able to finance the deployment. This was the time that some municipal governments decided to explore the deployment of fibre networks to create a future proof infrastructure in support of the economic development of the municipality, their citizens and businesses.

Probably the earliest example is the city of Stockholm, which decided to create a municipal owned passive optical network infrastructure in 1994. This was at the time market liberalization was being introduced, which had as a consequence that multiple operators would obtain rights of way. Without coordination this could lead to serious inconvenience for citizens and businesses, in particular in the old city centre. By providing an exclusive dark fibre network with open access for all operators and major businesses the impact could be minimized, while the benefits of fibre could be made available early on.

Case Stokab³³

Stockholm, the Swedish capital, is considered to be the most densely fibred city in Europe. This is largely the result of the 1.25 million kilometres of fibre of Stokab, an operator-neutral but exclusive city fibre network that is used by approx. 100 operators and 700 enterprises, while serving more than 100,000 students and school children and 50,000 city employees.³⁴ Stokab’s fibre network facilitated the deployment of the first LTE/4G mobile network in the world and now supports 4 competing mobile players. From the inner city the network has expanded into the suburbs.

³² Source: Tromp, Nijhuis, Boomsma & Bakker (1991).

³³ This section has been drawn from Chapter 7 *Sweden* by Forzati and Mattson in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda”. (Lemstra & Melody, 2015); and the brief by Benoît Felton, *Diffraction Analysis*, “Stockholm’s Stokab: A blueprint for ubiquitous fiber connectivity?” (Felten, 2012) And has been updated to capture recent developments.

³⁴ Stockholm is also the home of Kista Science City, a high-tech suburb with 1,100 ICT-enterprises with approx. 24,000 employees, 6,300 university students and 1,100 researchers.

In 1994, at the time of liberalisation of the telecom networks, Stokab was launched by the City council of Stockholm as a municipally owned passive fibre infrastructure provider. The main aims were to lower the municipal network costs, increase competition for telecoms services in the city and minimize disruption to citizens by limiting private operator's needs for civil works. Stokab sells its dark fibre services to any potential purchaser on a non-discriminatory basis.

The initial network was financed by loans backed by the City and it mainly connected public institutes and universities. It started generated positive cash flows in 1998 until 2003, overextension in network deployment combined with a contraction in demand resulted in a first loss. Following a write-off of €50 million, positive cash flows returned after 2003 and profits in 2008. In 2013 the turnover was SEK 705 million (approx. €70 million) and profits amounted to SEK 175 million (€17.5 million), the best ever.³⁵

As a subsidiary of Stokab, S:t Erik Kommunikation has assumed the responsibility for administering and developing the city's overall internal communications network.

Next to passive fibre lines, Stokab provides physical space in nodes equipped with power, cooling, etc. Stokab's fibre network connects almost all multi-dwelling units and commercial properties in the Stockholm municipality: about 90% of households and almost 100% of enterprises have the possibility to sign up for a fibre-based connection.

An extensive backbone network connects industrial areas, all major healthcare facilities and urban centres in the region. The fibre network is available in all parts of the municipality and acts as an extensive interconnecting network in the region.

Keys to its success have been: (1) timing of the initiative, at the start of liberalization and before alternative infrastructures had emerged; (2) stable political consensus on the need and form of the fibre initiative; (3) a public infrastructure mind-set from the City recognizing the long lead time to profit; (4) a gradual deployment allowing for cash-flow generation early on, as important basis for expansion; (5) avoiding competition with customers for active business by a focussing on passive infrastructure only; and (6) non-discriminatory and transparent pricing policies.

³⁵ Source: <https://www.stokab.se/Documents/%c3%85sredovisning/StokabAnauualRep2013.pdf>. Retrieved: 2016-01-05.

Another case example is the city of Amsterdam, which initiated investigations into a municipal fibre network in 2002.

Case Amsterdam³⁶

The City Council observing ad-hoc plans being made for the deployment of fibre to the business and fibre to the home by private entities placed the topic of fibre networking on the political agenda. The Council was concerned about a possible ‘digital divide’ emerging in the city, which was considered economically and socially undesirable. A second reason for involvement was the wish to channel the related digging activities to reduce the level of inconvenience to the public.

In 2003, the Andriessen report provided the necessary guidelines for the implementation of a city-wide FttH project, with as cornerstone a Public Private Partnership, the implementation of an open access passive network infrastructure, supporting service level competition. In 2004, the municipality started the European tendering for the construction of the network, resulting in the award to the combination of contractors BAM/DRAKA in 2005. In a negotiated arrangement the exploitation of the fibre network on a wholesale basis was awarded to BBned, to provide open, non-discriminatory access to retail operators. Subsequently, for the implementation of the fibre network, the city established a limited liability company ‘Glasvezelnet Amsterdam’ (GNA) in 2006, in which the municipality participated for 1/3, the four housing corporations for 1/3, and investors for another 1/3 – including ING-Bank; each party contributing €6 million. This enabled the first phase of implementation, 40,000 connections, to start in 2006, subject to approval by the European Commission, which was granted December 2007.³⁷

By 2004, out of the top-30 cities³⁸ in The Netherlands 29 cities had (draft) plans for realizing fibre networks to connect governmental buildings, 23 had plans for Fibre-to-the-Business, and 15 had plans for Fibre-to-the-Home.³⁹

By 2009 in Amsterdam, 43,000 homes were passed (approx. 11% of the total of 380,000) and 10,000 connected. By 2014 the number of homes passed had reached 67,000. Meanwhile,

³⁶ This section has been drawn from Chapter 4 *The Netherlands* by Lemstra in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda”. (Lemstra & Melody, 2015) And updated to capture recent developments, e.g. from http://www.ftthcouncil.eu/documents/CaseStudies/AMSTERDAM_CITYNET.pdf. Retrieved: 2015-12-31.

³⁷ A point-to-point architecture was applied and two fibres were deployed, one for Internet and one for analogue TV-distribution. Later digital TV was introduced using IPTV.

³⁸ In 2009, The Netherlands had 441 municipalities.

³⁹ Nonetheless, the debate on the involvement of municipalities in telecom infrastructure development in the Parliament resulted in more tight rules for participation of municipalities (and housing corporations) in telecommunication projects, becoming part of the 2006 revision of the Telecom Law. However, most of these restrictions were removed in the 2010 revision of the law, as part of an overall revision of laws and regulations to stimulate the growth of the economy following the crisis.

the participation of the municipality and housing corporations had been absorbed in a number of steps by Reggefiber and ultimately by KPN.⁴⁰ Moreover, KPN became the second wholesale and end-user service provider in 2010. Other service providers were Alice (Telecom Italia), Concepts ICT, InterNLnet and Tweak. Service bundles were based on 20 Mbit/s and 100 Mbit/s symmetric.

The description of the role of municipalities continues in Section 0 with an emphasis on underserved areas. For the role of municipalities see the OECD Science, Technology and Industrial Policy Papers No. 26. (Mölleryd, 2015)

3.5 Fifth determinant: regulators – unbundling and competition

In the absence of a second infrastructure, the next best solution to create a certain degree of competition is the unbundling of the legacy network through regulatory intervention. A first step was the introduction of the wholesale-resale model for minutes on the PSTN, using carrier select (CS) and carrier pre-select (CPS). A next step was the resale of bitstream-based products. Unbundling of the local loop was first proposed on the national level and became part of the EC regulatory framework in 2000.⁴¹ Two versions were introduced, partial and full unbundling. With partial unbundling the incumbent would retain the telephony service provision, while the alternative operator would provide Internet access on the same pair of wires, using a higher frequency band. In the case of full unbundling the wire pair would be made available to the alternative operator from the MDF in the local exchange building.

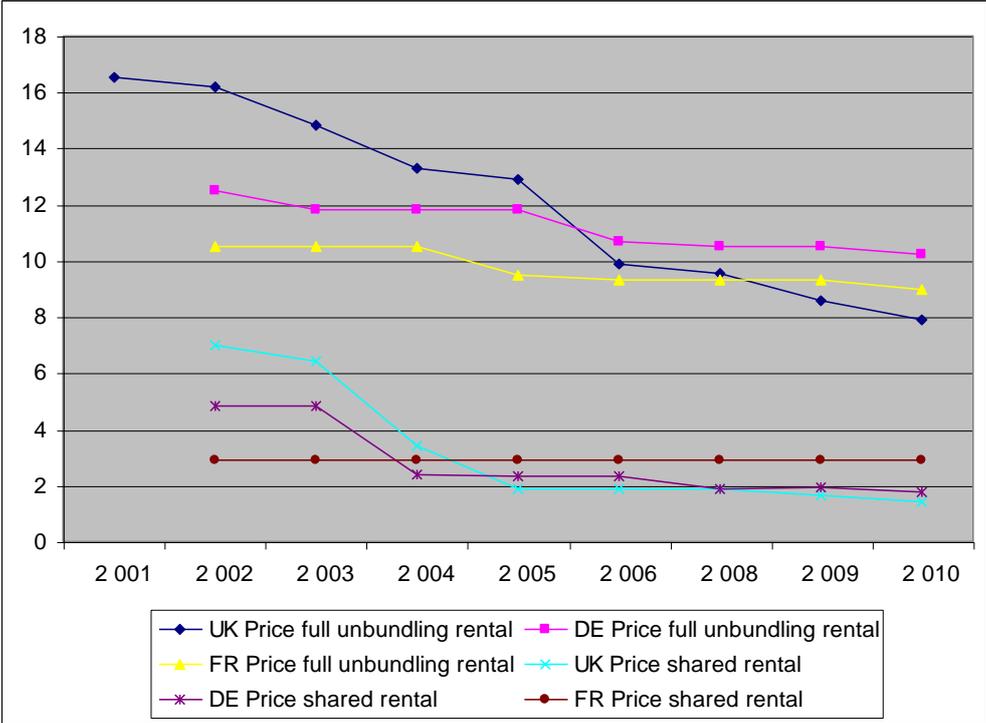
Associated with the unbundling principle was the concept of the ‘ladder of investment’. At the lowest rung of the ladder, market entry is facilitated by resale, requiring a minimum amount of investment to create a customer base. At each higher rung the investment level increases, while the dependency in the incumbent operator decreases. Moreover, at each higher rung the ability to differentiate the offering from that of the incumbent increases. When reaching the highest rung the alternative operator will have invested in realizing its own infrastructure and will have become independent of the incumbent, except for network interconnection. The requirement to interconnect and enter into negotiations on the terms is an obligation imposed on the incumbent PSTN operator, as part of the sector specific regulation. The ultimate outcome of the process would be infrastructure-based competition. (Cave, 2004, 2006)

⁴⁰ Reggefiber emerged from the civil engineering and contracting sector as a provider of open-access FttH networks. For the role of Reggefiber see Section 4.8. KPN is the PSTN incumbent in the Netherlands.

⁴¹ In 2000 the European Commission issued a Communication and a Recommendation on unbundling. Following a decision by the European Parliament and Council the Regulation 2887/2000 on local loop unbundling was adopted December 2000, to become effective January 2001 and ultimately mandated on all dominant firms.

In realizing progress on the ‘ladder of investment’ the role of the regulator is crucial in setting the appropriate wholesale tariffs. The historical record shows that this has been a learning process, whereby a tariff of approx. EUR10 appears to be the point whereby the business case for full LLU becomes attractive for the alternative operator. See for an illustration Figure 8. (Lemstra & Van Gorp, 2013) The take-off of LLU comes about 5 years from the date of introduction of broadband.

Figure 8. Comparison prices for unbundling in the UK, Germany and France, 2001-2010



With the PSTN being omnipresent, unbundling was only enforced onto the PSTN operators. The deployment of the CATV networks being much smaller than that of the PSTN and the opportunity to develop the CATV network into a serious competitor for the PSTN has led regulators to refrain from unbundling the CATV network. At the time also technological arguments were used which claimed that unbundling of the CATV would not be possible in the same way as for the PSTN, as the CATV networks are based on the sharing of the final part of the access among multiple end-users. Nonetheless, virtual unbundling or bitstream access would have been a possibility.

A rather unique case of an alternative operator that has reached the final rung is Free/Iliad in France.

Case Free/Iliad⁴²

Free/Iliad has been an alternative operator since 1997 using unbundling. It provided its first broadband offering based on ADSL2 at €29.99. This was followed by ADSL2+. In 2006, Free/Iliad joined the “Paris-Digital City” initiative, marking the start of fibre deployment in Paris. July 2007, the company announced its first fibre service providing 50 Mbit/s at €29.99. In August, Free announced an upgrade to 100/50 Mbit/s again at €29.99, with two FreeBox units, including router, Wi-Fi functionality and a HD compatible digital video recorder. The company thereby continued its leadership role in providing high data rate triple-play offerings at a highly competitive price. Subsequently the company planned to reach 4 million homes in Paris, Montpellier, Lyon and Valenciennes.

To reduce deployment costs, the company has relied for its early fibre deployments on access to the Paris sewer system. Since the September 2008 ruling by ARCEP, Iliad makes use of the opening of the civil infrastructure of Orange. To further reduce roll-out costs use is made of aerial solutions and of facilities belonging to the municipalities.⁴³

To create a viable fibre-based business case only those areas/neighbourhoods are targeted where the company has at least a market share of 15%, leveraging the density of existing subscribers.⁴⁴ Hence, unbundling is a necessary but not sufficient condition to reach the final rung. Targeted marketing or even more importantly favourable demographic conditions (i.e. high population density) are required.

Free/Iliad is one of the few cases whereby access seekers have been able to reach the final rung of the ‘investment ladder’. Other examples are NetCologne, M-net, Wilhelm.Tel and EWE-Tel among others in Germany, Metroweb in Italy, Statsnet in Sweden, COLT in many municipality business districts, etc. Common to most of those providers is that they operate in dense populated areas. EWE-Tel, however, operates in the very rural north-west of Germany, but again concentrates on the dense populated hotspots and uses high deployment synergies with the gas, water and electrical power distribution networks of its sister companies.

⁴² This case is based on the paper “Unbundling: a necessary but not sufficient condition to reach the final rung of the ladder” (Lemstra & Van Gorp, 2013).

⁴³ See Chapter 11 *France* by Loridan-Baudrier in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda”. (Lemstra & Melody, 2015)

⁴⁴ In the study “The Economics of Next Generation Access” WIK-Consult provides insights into the business case of fibre access. For six countries (GE, ES, FR, IT, PT, SE) they assessed the economic viability using country specific parameters, such as population densities, the properties of the PSTN infrastructure and average revenues per subscriber category. For France, using the P2P architecture, the in-year break-even for a ‘first mover non-incumbent’ requires 22% going up to 92% of the potential subscribers to be connected within the urban cluster (dense urban => less urban). (WIK Consult, 2008)

With progress in access technological comes a diminishing role of access-based competition. After subsequent DSL upgrades the technical limits of a two wire copper loop were reached and higher data rates would only be possible on shorter loops. This led to the introduction of fibre to the street cabinet, with VDSL on the remaining (shorter) part of the copper loop, providing data rates of 24 Mbit/s.

While regulation did require sub-loop unbundling and the provision of a backhaul service, the business case for alternative operators became far less attractive, as the aggregation point moved deeper into the access network – to the cabinet level. Moreover, co-location at cabinet level was not always feasible. As an alternative VULA was introduced, a form of virtual unbundling, in essence a form of bitstream access. This, however, moved the alternative operator down rather than up the ‘ladder of investment’. The latest development is G.fast, which brings fibre to the distribution points and shortens the copper loop to 100 meters or less. G.fast is claimed to provide data rates of 100 Mbit/s or more. This development moves the aggregation point further down into the access network. Unbundling is not expected nor mandated anymore at this network level.

The access case is further encumbered with incumbents moving to an All-IP network, which implies the dismantling of the main distribution frames at local exchange locations. This can lead to stranded assets of the alternative operators and hence requires a mutually agreed transition plan, typically enforced by the regulator.⁴⁵

Hence, one can argue that if an alternative operator has not yet reached the final rung of the ‘ladder of investment’, he/she will not reach that final rung in the future. Furthermore, the prospect of the next incremental DSL upgrade extends the life of copper and pushes the incentives for a PSTN operator to introduce FttH further into the future.

It has been argued that in the presence of infrastructure-based competition there is no need for access-based competition. The arguments focus on the disincentive that regulated wholesale access may have on the investments by incumbent operators. However, others argue that ‘two is not enough’ to create a healthy competitive environment and, hence, access competition is required.⁴⁶

3.6 Sixth determinant: regulators – functional separation

With the network legacy comes the vertically integrated incumbent operator. One may appreciate that the incumbents did not necessarily welcomed market liberalization, which implied privatization and the introduction of competition. As a former monopolist this implied giving room to

⁴⁵ Note that the incumbents obtain significant financial benefits from freeing up real estate at prime locations in towns and cities.

⁴⁶ In an econometric analysis of broadband market performance, using a composite index, a positive 5% difference could be attributed to access-based competition in the case of the Netherlands. (Lemstra, van Gorp & Voogt, 2014)

alternative operators and losing market share. Moreover, privatization implied becoming subject to the rigor of financial markets, with a strong pressure for growth and for increasing profits. As a result, or by nature, market entrants considered the incumbents as uncooperative. In the case of unbundling, the incumbent behaviour, in particular in terms of non-price competition, became subject of strong criticism.⁴⁷ Four cases will be summarized: the UK, Poland, Italy and Sweden.

In the UK, following an extensive market review, complaints from wholesale customers led to the functional separation of the incumbent BT.

Case BT-Ofcom⁴⁸

As early as 2002 some players in the telecoms market began to lobby for a strategic review of telecoms regulation and the break-up of BT. The proponents argued that the market was held back by the vertically integrated nature of BT and that separation would increase dynamic competition in retail markets. Although there was very little evidence brought forward to support the claim, the very low uptake of LLU can be seen as backing it up. April 2004 Ofcom launched the first phase market consultation document. The consultation found that despite the policy of infrastructure-based competition BT dominated the broadband access market at the wholesale level, although the retail market was competitive. The feedback from Cable & Wireless, the UK's second-largest fixed line operator, having absorbed Mercury Communications in 1997, was put in strong terms: *"The example of [...] discrimination are endless. In the world of broadband, BT was allowed to create an LLU product which was prohibitively expensive, not industrialized and not fit-for-purpose, which meant that it was entirely unsuitable for mass-market take-up."* Ofcom's principle proposal arising from the review was to strengthen the non-discrimination remedy by requiring 'real equality of access' or 'equivalence of input', i.e., BT's wholesale customers should have access to: (1) the same or similar set of regulated wholesale products as BT's own retail activities; (2) at the same price as BT's own retail activities; and (3) using the same or similar transactional processes as BT's own retail activities. In its agreement with Ofcom BT committed to change its organizational form and the incentives for managers, the so-called 'Undertakings'. The new organizational form became known as 'functional separation'. It implied a separate access services business unit with a separate brand name: 'Openreach'; a Code of Practice for employees; and the

⁴⁷ Non-price competition includes lack of or delays in providing colocation space, frustrating access to colocation facilities, delays in processing service requests.

⁴⁸ This section has been drawn from Chapter 9 *United Kingdom* by Cadman in "The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda". (Lemstra & Melody, 2015) and Whalley & Curwen (2008).

establishment of an Equality of Access Board as an independent body to ensure BT remains compliant with its commitments.^{49,50}

The case of Poland is interesting because it was not so much the regulation but the personality of the regulator that mattered in convincing incumbent TPSA to transform the attitude of the company towards market entrants.

Case TP-UKE⁵¹

In 2006 the new President of UKE, the national regulatory authority, started a debate on the applicability of an extraordinary remedy in the form of functional separation of TP, the Polish incumbent operator. The analysis conducted confirmed the existence of several barriers to the development of the fixed telephony and Internet access markets: (1) a strong market advantage of TP resulting from its size and market share; (2) anti-competitive behaviour that hindered cooperation with alternative operators and the flow of information within the TP that facilitated and favoured such behaviours; (3) poor quality of the access network; (4) lack of appropriate price setting resulting in a margin squeeze; and (5) ineffectiveness of regulatory activities undertaken so far to eliminate market barriers and lack of prospect for their elimination. Recognizing that functional separation was a far-reaching regulatory measure, TP began negotiations with the participants in the market to improve the conditions for cooperation. It resulted in a Equivalence Charter stipulating: (1) the implementation of rules of conduct that guarantee the same treatment to other operators as to the retail branch of TP; (2) transparency of TP's actions in the wholesale market through the monitoring of key performance indicators; (3) implementation of a 'culture of non-discrimination'; (4) improvement of the wholesale customer interfacing process; (5) development and implementation of regulated services involving all stakeholders; and (6) the establishment of the Telecommunications Forum to provide oversight.

The case of Italy is interesting as the threat of a foreign company assuming a controlling share in Telecom Italia intervenes with the regulatory process.

⁴⁹ It has been said that for BT to agree the Undertakings with Ofcom was the better alternative compared to an investigation, and possible remedies to be applied, by the Competition Authority.

⁵⁰ As Cadman in his PhD reserch observed, the strategic review resulting in functional separation of BT, coincided with the review of wholesale prices by Oftel (now Ofcom). Hence, the increase on LLU will have likely been caused by both phenomena. (Cadman, 2008)

⁵¹ This section has been drawn from Chapter 14 *Poland* by Windekilde & Ladny in "The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda". (Lemstra & Melody, 2015)

Case Telecom Italia - AGCOM⁵²

In pursuing non-discrimination, AGCOM, the National Regulatory Authority in Italy, imposed a set of rules to assure equivalence of access in 2002. Telecom Italia (TI) was prepared to introduce functional separation on a voluntary basis. However, when a controlling stake in the company was put on the market by Pirelli, it became apparent that it might be acquired by a foreign-owned operator, such as AT&T. The government became alarmed at the prospect of TI's core network falling under foreign control. In April 2007, the government accordingly tabled a proposal that would enhance the powers of the regulator, AGCOM, to permit it to ring-fence all of the local loop connections. If AGCOM would not be able to reach agreement with TI over the details of functional separation, the new powers would enable it to impose its own variant of this remedy. The government introduced the new rules into an existing law on liberalization. Its attitude caused AT&T to withdraw and an Italian dominated consortium became the preferred bidders for the Pirelli stake.

In February 2008 Telecom Italia announced that it would create a new unit to manage its fixed-line network. AGCOM accepted Telecom Italia's (TI) undertakings to become effective January 1, 2009, based on the principle of equivalence of output (EoO), whereby the access products offered by the incumbent operator to alternative operators are comparable to the products it provides to its retail division in terms of functionality and price, but they may be provided by different systems and processes. The implementation of EoO became an iterative process with close monitoring, facilitating technical solutions and implementing detailed adaptations of business support and operational support systems.

In the case of Sweden it is the national government that triggers the process that leads to functional separation.

Case TeliaSonera-PTS⁵³

Following government guidance in 2006, PTS, the Swedish NRA, started investigating TeliaSonera, the incumbent PSTN operator. In parallel, legislative activities were started to provide PTS with the powers to apply functional separation as a remedy.

There were two important problem areas identified. First of all, TeliaSonera had a decisive position in the buyer–seller relationship with other operators. Secondly, PTS had difficulties in enforcing regulations, which included a prohibition enforced on TeliaSonera against

⁵² This section has been drawn from Chapter 10 *Italy* by Galino, Leporelli & Nucciarelli in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda”. (Lemstra & Melody, 2015) and Whalley & Curwen (2008).

⁵³ Source: Teppayayon & Bohlin (2010).

discrimination of other operators. Combined with the fact that the company was vertically integrated, both opportunities and incentives were present for the company to favour its own retail organization and to discriminate against other operators to the detriment of competition.

Recognizing the course of events, TeliaSonera implemented voluntary separation along the lines of the legislative proposal, through the creation of Skanova Access AB on January 1, 2008. The main function of Skanova is to sell copper-based infrastructure services on the same commercial terms to all operators on the Swedish market, including its own retail branch. TeliaSonera has also placed the management of its fibre networks with Skanova. Although voluntary functional separation had been implemented, the legislative process continued until the new law came into effect on July 1, 2008.

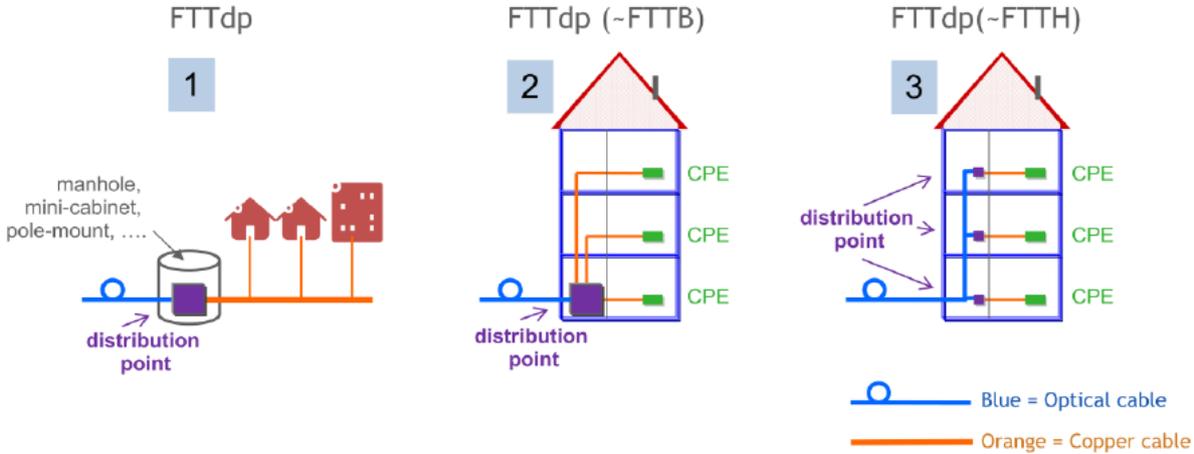
In the more recent case of O2 in the Czech Republic, it appears the reasons for separation were pure internal, i.e., aimed at achieving a better position in serving the wholesale market.

3.7 Seventh determinant: incumbents – incremental technology upgrades

A prudent investment strategy for incumbents calls for supply to be sufficiently ahead of (most of the) demand, but not too much to assure the investments are economically efficient. For these reasons an incremental investment strategy is typically preferred over more lumpy and risky investments. Such a prudent strategy was made possible through subsequent upgrades of modem technologies allowing for increasing data rates to be offered: ADL, ADSL2, ADSL2⁺. But with the upgrades came their limitations, due to the attenuation of the copper loop and to the increase of crosstalk at higher frequencies, frequencies which were required to provide higher data rates. Hence, for two reasons the length of the copper loop had to be reduced: (1) to provide broadband to distant users – above 2-3 km; and (2) to provide higher data rates. This reduction implied rolling out fibre from the local office into the access part of the network. At first, fibre was deployed at the first tier of the access network, i.e. to the cabinets where the copper cables were branching out. Using Fibre-to-the-Cabinet (FttC), higher data rates were made possible with the introduction of VDSL, VDSL2 and VDSL2⁺. A further increase was made possible through the introduction of vectoring, whereby crosstalk is cancelled out. (Segers, 2012; Plückebaum, 2015) This allows data rates to be realized close to the theoretical limit. As discussed in Section 0, the latest development is G.fast, which brings fibre to the distribution points and shortens the copper loop to 100 meters or less. G.fast is claimed to provide data rates of 250 Mbit/s symmetrical. See also Figure 9.⁵⁴

⁵⁴ Source: FttH Council Europe (2014).

Figure 9. G.fast deployment options



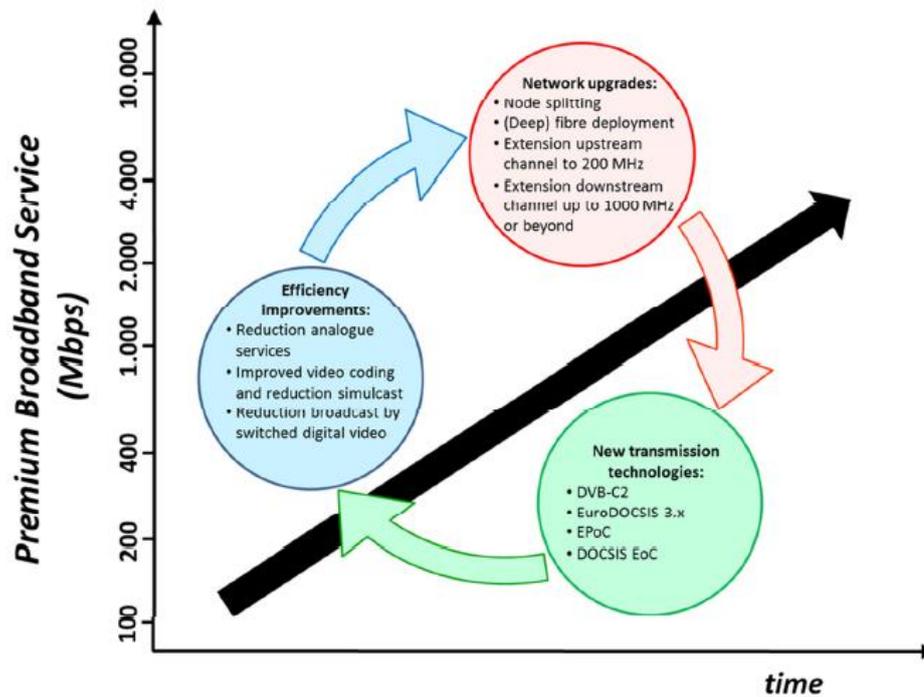
Legend: CPE: Customer Premise Equipment; FTTB: Fibre-to-the-Basement; FTTdp: Fibre-to-the-distribution point; FTTH: Fibre-to-the-Home

In a similar way the data rates in CATV networks have been increased through modem upgrades. The first DOCSIS 1.0 (Data Over Cable Service Interface Specification) was released in 1997. It was adapted for the different TV standard (PAL vs NTSC) and bandwidth plan (8 MHz vs 6 MHz) in Europe under the name EuroDOCSIS1.0. Note that DOCIS deployments are based on fibre being deployed from the CMTS (Cable Modem Termination System) to the fibre nodes hosted in cabinets.

The first generation modems provided for a shared 50 Mbit/s downstream and 10 Mbit/s upstream. Around 2001 follows the release of DOCSIS 2.0, providing an increase in download data rates, and in 2006 by DOCSIS 3.0 providing an increase in both upstream and downstream rates. EuroDOCSIS 3.0 is the prevailing standard used at this time. It can provide a shared downstream rate of 1,600 Mbit/s and upstream rate of 216 Mbit/s.⁵⁵ User rates offered are typically 50 and 100 Mbit/s. Increasing the user data rates in a CATV-network involves multiple options and often a combination thereof, as illustrated in Figure 10. (TNO, 2012)

⁵⁵ For an overview of DOCSIS developments see for instance TNO (2014).

Figure 10. Evolution of the CATV-network



These technological developments are leading to increasingly higher data rates being provided resulting in extending the useful life of copper.

3.8 Eighth determinant: third party actors – punctuation of the waiting game

As the PSTN and CATV incumbents apply gradual upgrades of their networks this leads to a kind of ‘waiting game’ as none of the parties proceeds to implement fibre to the home, the more future proof technology. This is a logical outcome of the strategic options available to the incumbents in the competitive game. First of all a move towards FttH implies an overbuild, i.e. the deployment of a new network that cannibalizes the existing one. Moreover in case of infrastructure-based competition, it will force the competitor to respond with a similar strategy. Hence, the final result will be a similar competitive situation, but only after a write-off of the existing infrastructure and deep investments in a new one.⁵⁶

This provides a third party the opportunity to enter the market with FttH. However, to allow this to happen demand bundling is essential to make the business case viable. Various parties have played a role in demand bundling and thereby in facilitating FttH deployments: housing corporations, municipalities and citizen’s initiatives.

⁵⁶ It has been argued that the incumbent networks have been fully depreciated, so no write-off will be required.

An example of a ‘third actor’ is housing corporation ‘Portaal’ in combination with the construction firm VolkerWessel Telecom in the Netherlands.

Case Reggefiber⁵⁷

A new trajectory in FttH started from an unexpected source, the civil engineering and construction industry. The competition played out between PSTN incumbent KPN, CATV incumbents UPC/Ziggo and alternative operators BBNed/Tele2 had led to high broadband penetration and to increasing data rates. The competition led to FttC, but not to FttH deployment.

The creation of optical fibre company Reggefiber resulted from an initiative by housing corporation ‘Portaal’ in Rotterdam, planning to install fibre to the houses it owned, intending to make its real estate more attractive through FttH. Construction firm VolkerWessels Telecom had already been selected for the implementation. The need for investment capital led to Reggeborgh, the private equity firm of Wessels. From investment partner, Wessels became entrepreneur in fibre networking, through the founding of Reggefiber in 2005.

In its business approach, Reggefiber took a long-term perspective on fibre deployment, applying a real estate model.⁵⁸ The objective was to reach a level of 2 million households by 2013, based on the principle of a passive infrastructure with open access. In 2006, Reggefiber became one of the investors in the Citynet project in Amsterdam. To link the various FttH projects Reggeborgh acquired fibre backbone provider Eurofibre in 2006.

The emergence of Reggefiber as a new player in the infrastructure arena changed the competition dynamics, as the initiatives by municipalities and housing corporations were not isolated any more but became linked. It appeared that Reggefiber was taking the ‘first mover advantage’, and was changing the ‘rules of the game’ forcing the incumbent infrastructure players into services competition. Hence, the strategic move by KPN, to create a joint venture with Reggefiber to provide FttH on a nationwide basis and taking a 41% share in 2008. In 2012 KPN acquired 51% of the shares and in 2014 it obtained full control of the company.

In response to these developments, OPTA, the National Regulatory Authority (now ACM) in the Netherlands, issued a new wholesale regulation, which included the unbundling of fibre at the Optical Distribution Frame. OPTA based its wholesale pricing on the real-life case presented by Reggefiber. It set tariffs based on a long-term horizon while aiming at a large-scale build-out of FttH.

⁵⁷ This section has been drawn from Chapter 4 *The Netherlands* by Lemstra in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda”. (Lemstra & Melody, 2015)

⁵⁸ Its business model is to provide only the passive layer, but due to the absence of interested active operators at that time, it established its own active operator as a temporary measure.

3.9 Ninth determinant: municipalities – expanding the internal network

Returning to the role of municipalities, the case of Sweden is of interest. The statistics show that in Sweden one out of every two municipalities one is involved in a municipally owned fibre network. The case of Stokab, discussed in Section 0, demonstrates the early role of a municipality into fibre networks in the country. The broader involvement has been stimulated by the central government by providing funds for initial network studies, which were followed with funds for network deployments.

Case Swedish municipalities⁵⁹

The broadband evolution started in 1999/2000 with a government bill that was aimed to support national and local initiatives and investments. The headline was Trust to IT, Access to IT and IT Competence. Access implied broadband provision, with national, regional and local network support, including SMEs and schools. The financial support included 2.5 billion SEK (or roughly €280 million) to a national operator-neutral backbone, 3.2 billion SEK (€360 million) to municipalities to develop access (in the form of tax breaks) and 2.6 billion SEK (€290 million) to regional networks and to create local infrastructure plans.⁶⁰

Local fibre networks are considered to play an important role in the broadband market as they represent an alternative to the former incumbent's infrastructure. Many municipalities believe that the open fibre network is strategically important for their development and growth. A recent survey showed that 77% believe that their network has had a significant impact, while 15% believe they have had a positive impact.⁶¹

Sweden has approx. 290 municipalities (*kommuner*). The population size of these municipalities varies from 2,500 (*Bjurholms kommun*, in Västerbotten in the North) to around 800,000 (*Stockholms kommun*, covering the city centre and some suburbs of Stockholm). Around 175 municipalities in Sweden have deployed fibre networks in the past ten to fifteen years, representing more than 50% per cent of the total fibre coverage.⁶²

⁵⁹ This section has been drawn from Chapter 7 *Sweden* by Forzati & Mattsson in “The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda” (Lemstra & Melody, 2015) and updated with recent information.

⁶⁰ In 2014, government subsidies equalled about 10 percent of the total investments made in local fibre network. Source: Swedish Local Fibre Alliance (*Svenska Stadsnäts Föreningen*) <http://www.ssnf.org/Global/Bilder/Rapporter%20och%20informationsmaterial/EU/Dokument/Local%20fibre%20networks%20in%20Sweden.pdf>. Retrieved: 2016-01-06.

⁶¹ Source: Swedish Local Fibre Alliance (*Svenska Stadsnäts Föreningen*) <http://www.ssnf.org/Global/Bilder/Rapporter%20och%20informationsmaterial/EU/Dokument/Local%20fibre%20networks%20in%20Sweden.pdf>. Retrieved: 2016-01-06.

⁶² Ibid.

Some of these municipality networks have recently formed regional associations to interconnect the different networks and to facilitate the access to the providers of end-user services, as well as providing access to wholesale market actors.

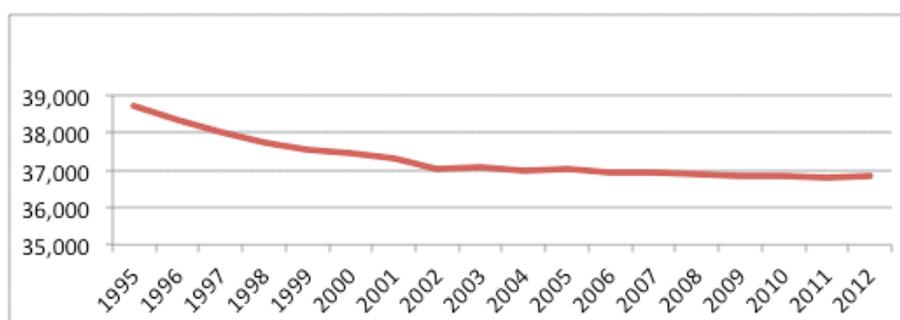
A very important driver to generate interest and support in the deployment phase and high take-up in the operations phase is the presence of local fibre champions and a positive ICT culture. This is of course linked to historic factors, but the lack of such a catalyst can be compensated by visionary politicians and by running extensive and continuous information campaigns among the population.

One of the first effects observed from FttH municipal networks is a saving of 30% to 50% of the total municipal data and telecommunication costs. This is partly due to increased efficiency (reduced equipment, energy consumption, and footprint per unit of transmitted information) and partly due to the fact that the fibre network with high capacity allows for more competition between service providers and thus lower prices.

Indirect effects that were observed included the reduction in migration to larger cities, a problem among rural municipalities in Sweden. See

Figure 11 for the example of Hudiksvall. Since fibre was deployed in 2004, the population of nearby Lindefallet increased by 7.5%, a village that has neither a school, a health clinic, nor an industrial area. The investment in fibre in combination with active associations made Lindefallet a lively and attractive village.

Figure 11. Population evolution in Hudiksvall, Sweden, 1995-2012



The degree to which the role of municipalities in the deployment of telecom networks has been recognized in national laws differs across Member States. In the Netherlands when some of the municipalities became successful the incumbents responded with lobby activities and the parliament adopted an amendment to the telecom law to restrict the role of the municipalities. Following the

economic crisis in the year 2008, laws were enacted to stimulate economic development. At that time also this restriction was removed.

Case of municipalities in France⁶³

Local authorities are involved in several stages. First of all, they develop, usually at the departmental level, the digital territorial development master plan (SDTAN) under Article 24 of the Law on the fight against the digital divide of 17 December 2009. These indicative documents are considered as essential. They provide an inventory of existing networks and digital coverage. Moreover, they identify projects in progress or being planned. They also present the vision of the territory in matters of digital coverage and include action scenarios on how to achieve the vision, according to a strategy to promote consistency between private investment and public intervention. Subsequently, the local authorities are consulted by the operators while they are deploying their networks. Finally, local authorities may decide to take a public initiative for network deployment, such as the law allows in accordance with the regulatory framework. These networks enable FttH deployment beyond the territories that would be covered by private operators. Local authorities' financial contribution to FttH rollouts in sparsely populated areas could be decisive. They depend on the European Commission guidelines on state aid, the role of the Caisse des Depots in helping local authorities to finance FttH projects, and the possibility of public-private partnerships with minority public funding in order to deploy fibre.

In France, to mitigate the risk of a local monopoly, operators are required by regulation to share the terminating sections of their optical fibre networks. The first operator to install fibre in a building should provide other operators access to it under conditions that enable effective competition, through: (1) a co-financing offer prior to deployment; (2) an access offer after deployment as a long-term usage right; or (3) as a leased line offer based on unbundling.

In Poland the municipalities have been designated as 'lender of last investment' by the law. The Act on Supporting the Development of Telecommunication Services and Networks of 2010, introduced a new competence for municipalities: they may build as well as operate telecommunications networks, as part of their own public utility tasks. These tasks are to be financed from the municipal budget. Municipal involvement is only permitted when local entrepreneurs are unable to meet demand for telecom services, in particular Internet access.⁶⁴

⁶³ This section has been drawn from Chapter 11 *France* by Loridan-Baudrier in "The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda". (Lemstra & Melody, 2015)

⁶⁴ This section has been drawn from Chapter 14 *Poland* by Windekilde & Ladny in "The dynamics of broadband markets in Europe – Realizing the 2020 Digital Agenda". (Lemstra & Melody, 2015)

3.10 Tenth determinant: bottom-up entrepreneurship with fibre

The lack of broadband supply by some incumbent operators, in particular in central Europe, has led to bottom-up initiatives by local entrepreneurs providing Ethernet over fibre to their neighbours. This has happened in for instance Latvia and also in Bulgaria.

Case Bulgaria⁶⁵

In 2005, broadband penetration in Bulgaria was less than 1% of population. The steady growth can be attributed to the efforts of local broadband LAN service providers. People were wiring-up their neighbourhood by attaching ‘fibre-to-the-façade’ (FttF) keeping network costs down. In 2010, there were close to 670 official ISPs, while experts estimated the actual number to be close to 2000. The serving area of the ISPs were mostly small, according a survey in 2008: 55% covered a residential area in a city; 16% served one or several cities; 13% a town or city and its vicinity; and 9% provided regional coverage. As a result, by 2010, Bulgaria was leading the EU charts in terms of broadband penetration at 10 Mbit/s or more.

In Latvia, another country with strong entrepreneurial activity, some 240 fixed broadband operators were active in 2013. They compete with the main telecom providers, as well as among themselves, mostly in limited areas, sometimes within one apartment block.

3.11 Eleventh determinant: citizen and farmer initiatives – fibre to the home

When people are living further away from the local telephone exchange building, they are disadvantaged by receiving lower data rates. This applies in particular in rural areas, where the distance may approach 8-10 km. Nonetheless, the demand of residents in rural areas is much the same as that of residents in the urban areas. The families in rural areas also have kids that go to school and are expected to use the Internet as part of their training and social networking. Business owners and their staff detest the much longer response times on the Internet compared to their colleagues in urban areas. Some farmers have data demands that surpass that of urban users, in particular those that apply precision farming. Not being properly served by the telecom providers has led and is still leading to citizen initiatives to deploy fibre networks in underserved areas.

A recent example is the collection of initiatives in a number of neighbouring villages in the Kempen region, in the southern part of the Netherlands, close to the border with Belgium.

⁶⁵ This section has been derived from the TPRC contribution by Rood (2010).

Case KempenGlas, The Netherlands

‘KempenGlas’ is a bottom-up initiative aimed at the realization of open-access fibre networks and the management thereof in rural areas (‘buitengebied’) of the municipalities Bladel, Moergestel, Oirschot and Reusel-De Mierden. The overarching aim is to assure these rural areas remain attractive into the future.

The four local cooperatives, ‘Bladelglas’, ‘MoergestelGlas’, ‘OirschotGlas’ and ‘Reusel-DeMierdenGlas’, have established ‘KempenGlas’ as a second-layer cooperative, to increase the scale, bundle their expertise and to exploit the networks. They are run by volunteers and supported by a project leader in the person of Jo van der Plas, an experienced ICT manager.

The principle is that all members can participate and obtain a fibre connection on equal terms. The members are the future owners of the passive network. A small entry fee (€25 for residential homes and €100 for firms) is used to establish the corporation and perform the initial activities, such as planning, drawing-up specifications, obtain proposals for network deployment and financing. Upon having arranged a sufficient level of commitment the cooperative will become effective and raise capital of its members, which will be up to €500 per home and €500-2500 per firm. The expected monthly fees are €30 to cover network operations and maintenance, interest and repayment of the loans and €35 for the triple-play bundle.

August 2015, the Province of Brabant approved a soft loan for ‘KempenGlas’⁶⁶ for up to 50% of the costs of deployment or approx. €3 million. This will be complemented by a €2 million loan from the Rabobank. The loans mature after 17 years. To date, out of the potential 2,900 households, farms and businesses to be served 2,000 have registered as a member of one of the four cooperatives. Together with the approx. €2.5 million equity from these members the project financing is complete and deployment can start.

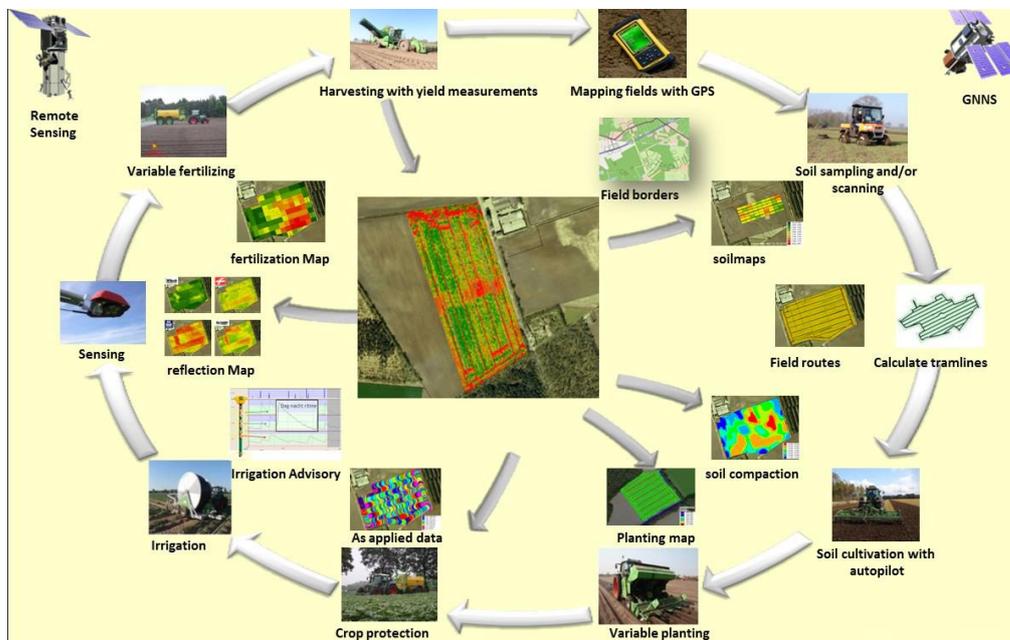
A key participant and beneficiary of the KempenGlas project is precision farmer Jacob van den Borne. This potato grower applies a series of advanced technologies in the cultivation process, such as RTK-GPS⁶⁷ for soil cultivation using autopilot; soil scanning for compaction and conduction; reflection sensing, by satellite and drone, for variable fertilization; crop sensing for variable protection; and soil sensing for variable irrigation. For the processing and storage of

⁶⁶ The Province has created a revolving development fund of €50 million in support of fibre deployments in rural areas and (small) remote business parks. The fund originates from the sale of the shares in the provincial electricity generation plants and networks.

⁶⁷ RTK-GPS: Real Time Kinematic GPS, uses two satellite receivers, one on a known fixed point nearby and one on the mobile vehicle, thereby increasing the accuracy to the centimetre-level. Next to the US NAVSTARR GPS system also the Russian GLONAST satellites will be used.

the date a high data rate broadband connection is required.⁶⁸ See Figure 12 for an illustration. (ZLTO, 2014)⁶⁹

Figure 12. Precision farming at Van den Borne Aardappelen, Reusel, The Netherlands



As of February 2015, the overview of broadband initiatives in rural areas, as maintained by Salemink and Strijker at the University of Groningen, Department rural developments, covers 75 initiatives in 116 municipalities, covering all provinces in the country.⁷⁰ The 75 have been analysed to identify common aspects and to capture their progress. Using a categorization in eight stages, the results are as follows:

Stage	Description	Nbr init.	Stage	Description	Nbr init.
1	Trigger for the initiative: market failure; background of initiator(s)	75	5	Campaign to commit sufficient number of users and raise users equity	15
2	Confrontation with the knowledge gap (technology and economics); decision on network principle (open access)	52	6	Tendering and contracting, legal and financial challenges	12

⁶⁸ The current practice requires transport of the SD-cards with sensing information to a high data rate access point in the village for upload and download of satellite data.

⁶⁹ See also: <http://www.vandenborneaardappelen.com/nl/150/precisie-landbouw-bij-van-den-borne-aardappelen>. Retrieved: 2015-12-30.

⁷⁰ Source: <http://www.rug.nl/staff/k.salemink/tabel-breedband-initiatieven-nederland.pdf>. Retrieved: 2015-12-31.

Stage	Description	Nbr init.	Stage	Description	Nbr init.
3	Investigation of demand; social cohesion; formation of organizational form; go-no-go decision	35	7	Network deployment	4
4	Campaign to obtain financing, to attract the necessary expertise, obtain government support, handle opposition from incumbents	31	8	Operations and maintenance	4

The involvement of so many municipalities in fibre initiatives, both large and small, suggests that infrastructure supply is considered as very important for economic development. The perception of limited bandwidth being available on copper and fibre being considered as future-proof explains their early involvement. While there were many initiatives, not too many have ultimately led to the actual deployment of municipally-led fibre. Issues around alleged state-aid, requiring upfront clearance, and the issue of funding and managing have been too cumbersome in many cases. Nonetheless, the push by municipalities have forced earlier deployments, in the end it are the commercial parties which become involved in the implementation and operations of many municipal fibre networks, in part or in whole.

3.12 Twelfth determinant: financial institutions – funding

While for telecom operators financing is part of the normal business process and while municipalities are used to fund infrastructure projects, for community initiatives financing represents a major bottleneck. They typically lack experience in developing a project business case, nor have they experience in interacting with financial institutions. Moreover, in order to attract financial support from government institutions the project has to comply with state aid rules, which aim to prevent market distortion.

From the experience gained over the past 10 years with financing rural community initiatives in the Netherlands the following observations can be made on the factors that influence success:^{71,72}

- There are many rural community initiatives, very few have as yet become successful, but none has failed after deployment, largely because they were abandoned in the formation phase;

⁷¹ This Section draws largely on the information obtained from the in-depth interview with Henk Doorenspleet, Rabobank, on 2015-12-18. The long-term involvement of Rabobank can be explained by the original nature of the bank as a collection of local cooperatives, and its willingness to invest in local initiatives as part of its local social engagement policy.

⁷² For the results of the assessment executed on behalf of the Province of Gelderland, including the responses of the various market actors, see “Eindrapportage van het onderzoek naar de mogelijkheden voor breedband in ruraal gebied in Gelderland Pilot Breedband Bronckhorst – Berkelland” <http://docplayer.nl/442901-Eindrapportage-van-het-onderzoek-naar-de-mogelijkheden-voor-breedband-in-ruraal-gebied-in-gelderland-pilot-breedband-bronckhorst-berkelland.html> Retrieved: 2015-12-18.

- The local government is instrumental for achieving success, but relying on or pressing the local government to take the lead and to resolve the issue is a reason for project delay and project failure;
- Achieving success implies taking ownership by those that are most affected;

Including residents in grey or black areas into the project appears attractive, as cost can potentially be shared. With sufficient sustainable social cohesion this would allow for internal subsidies and hence make the rural provision more feasible. However, to achieve success the focus should be on real rural network provision, pure white areas, as attempts to include grey or black areas will invoke strong opposition from the incumbent(s) and typically raise issues of state-aid, and create ambiguity in local government support. Including grey or black areas has shown to be a cause for project failure;

- Success depends on effective bundling of demand and creative closure of the investment gap between rural and urban supply. “Mind the gap”, a notion dating back to the fibre pilot project in Nuenen initiated in 2000;
- When raising awareness and support for an initiative, a large gathering appears to be efficient, but is risky as opposition of one outspoken individual can easily create doubts and derail the initiative;
- Convincing residents and firm owners to become members of a cooperative and to provide upfront funding is best done individually ‘at the kitchen table’;
- Social cohesion can be encouraged by placing signs in the front garden. (See the example of OnsNet in Eindhoven in Figure 13)

Figure 13. Public display of membership of a citizens initiative in Eindhoven, The Netherlands



- Assure that initial price indication is such that it will in reality go down rather than up. Price indications going up will undermine the confidence in the project.

In terms of investment the rural projects require on average €3000 against €1000 in urban areas. Two investment/ownership models prevail for the rural area:

- The models differ in terms of asset ownership and hence in the position of the actors to use these assets as collateral for obtaining a loan: (1) community/cooperative owned network; and (2) operator owned network. If no assets are available loans will have to be based on cash flow streams;
- Moreover, equity provided by end-users provides for the lowering of overall risk for providers of a loan and it demonstrates commitment of end-users, which lowers the overall risk perception;
- The operator based model can be distinguished in two variants in how the investment gap is closed: (a) upfront connection fee; and (b) monthly infrastructure fee;
- All variants require a minimum initial take rate.

An example of model 2a is Reggefiber, which will invest €1000 on equal terms between urban and rural, and also charges the same usage fees, the investment gap is to be closed by the end-users upfront. The minimum take rate is 30% in urban areas and 60% in rural areas. An example of model 2b is CIF, which will provide for 100% homes passed based on a minimum upfront take rate of 50% and €10 monthly infrastructure fee.

To close the gap, the initiatives typically call upon the local and/or provincial government for support. Such support is typically limited to a certain level of the investment (e.g. 50%), but once granted it facilitates obtaining a commercial loan for the smaller remaining gap at more attractive conditions.⁷³

3.13 Reflections on broadband performance: the Digital Agenda for Europe

In having a Digital Agenda Europe does not assume an unique position. Around 2000, the USA had a plan under the heading of the “Information Super Highway”. In 2001 Japan launched its plan called “e!Japan”. The same year Hong Kong announced its “Digital 21 Strategy” and Korea followed in 2002 with its “eKorea Vision”.

In Europe, the realisation of an ubiquitous broadband infrastructure has become part of the economic and social policy agenda agreed between the European Commission and the European

⁷³ An interesting gap closing variant is Neer in the Province of Limburg, where the proceeds of the cooperative windmill are used to fund a cooperative broadband project, rather than being used to compensate an individual farmer on which territory the windmill happens to have been built.

Union (EU) Member States in 2000, as part of the so-called ‘Lisbon Agenda’. At that time the European ambition was “...to become the most competitive and dynamic knowledge-based economy in the world by 2010.” The policy goals included: (1) to establish an inclusive, dynamic and knowledge based economy; (2) to produce accelerated and sustained economic growth; (3) to restore full employment as the key objective of economic and social policy. Unfortunately much of the ambition was thwarted through the financial and economic crisis that followed.⁷⁴

The targets were adjusted but remained ambitions. The Lisbon plans evolved through eEurope 2002, eEurope 2005 and i2010. Today, the broadband objectives are part of the ‘Digital Agenda for Europe’. The Digital Agenda reflects a comprehensive plan for Europe consisting of six so-called pillars. Pillar I addresses the completion of the Digital Single Market; Pillar II covers interoperability and standards; Pillar 3 addresses the issues of trust and security; Pillar IV is concerned with fast and ultrafast Internet access; Pillar V covers research and innovation and Pillar IV is aimed at improving digital literacy, skills and inclusion.⁷⁵

Pillar IV “Fast and ultra-fast Internet access” included a target for 2013 ‘Bringing basic broadband to all Europeans’, which was understood as 2 Mbit/s. This target was largely realized. The targets for 2020 are: (1) Ensuring that all Europeans have **access** to Internet speeds of above 30 Mbit/s; and (2) 50% or more of European households have subscribed to Internet access above 100 Mbit/s. Following the agreements on European level, and sometime preceding it, Member States have developed national broadband plans.

Looking at the progress to date, the coverage target has already been reached in a number of countries through the availability of a CATV network enabled with DOCSIS 3.0 modems. Notwithstanding this achievement, reaching a subscription rate of 50% of households for data rates of 100 Mbit/s or more remains a challenge. In other countries good progress is made towards reaching the coverage targets, while subscriptions also remain a challenge. In some central European countries the deployment of fibre brings high data rates to end-users already today. But fibre coverage is mainly in the larger towns and cities. Broadband coverage in rural areas will largely depend on the availability of mobile broadband, see the discussion below.

To realize the Next Generation Access objective the EC has adopted a number of Recommendations. The Recommendation on NGA was released in 2010⁷⁶, the Recommendation on

⁷⁴ Sources: EC (2000, 2004, 2010).

⁷⁵ It could be argued that the DAE also acts as a determinant of broadband development by setting policy objectives, by aligning regulations towards realizing these objectives and by exerting peer pressure as a result of performance monitoring.

⁷⁶ Source: Commission Recommendation [2010/572/EU](#) of 20 September 2010 on regulated access to Next Generation Access Networks (NGA).

Cost Reduction in 2014.⁷⁷ The Guideline on State Aid was aimed to clarify the condition under which government support of broadband deployment was permissible, in particular in support of the deployment of broadband in rural areas. This Recommendation was issued in 2013.⁷⁸

In the translation of objectives into reality the EU Member States take a different role perception. While in all countries broadband developments are largely the result of competitive market dynamics, the Member States differ in the degree of pro-active and re-active interventions. While the UK can be considered to rely largely on market forces, with tendering for state aid in rural areas, in France the central government has given the regional governments an important role in the realization of broadband, in particular in the underserved areas, see Section 0.

3.14 Reflections on the developments in the industrial organisation

The liberalization of the telecom market in Europe was aimed at improving consumer choices and lowering service prices. The liberalization process was premised on latent demand and technological progress that would enable market entry. The liberalization process coincided with strong growth in mobile communications and the emergence and adoption of the Internet.

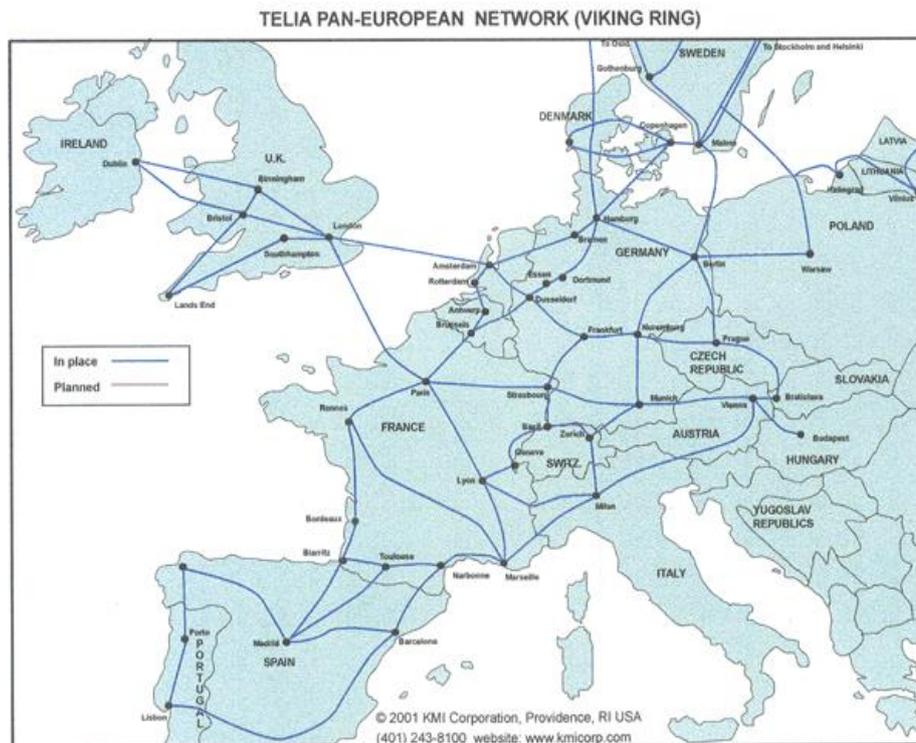
The liberalization enabled and the drivers facilitated a boom in the deployment of optical fibre based pan-European networks, by incumbents and new entrants alike. Figure 14 shows Telia's Viking Ring. Similar networks were constructed by e.g. COLT, Deutsche Telecom, Global Crossing, Interroute, KPNQwest, Telecom Italia and Tiscali. All operators were responding to the same new market opportunity at the same time. In the period 1996-2000 some 17,500,000 fiber-kilometer was deployed.⁷⁹

⁷⁷ Source: DIRECTIVE 2014/61/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 May 2014 on measures to reduce the cost of deploying high-speed electronic communications networks.

⁷⁸ Sources: EU Guidelines for the application of State aid rules in relation to the rapid deployment of broadband networks (2013/C 25/01).

⁷⁹ For a detailed discussion of this period see (Lemstra, 2006).

Figure 14. Telia Pan-European network (Viking Ring)



The high expectations and ample funding being available also attracted many market entrants at the local level, competing with the incumbent to serve end-users, business as well as residential users. The end of the euphoric period coincided with the beginning of the broadband period. All players had to re-focus their activities to survive. Incumbents retreated to their home base and concentrated on the core business. The second round of entrants, not having been able to create a positive cash flow in the short time they had available, typically had to exit the market. Hence, the emergence of broadband coincided with a period of industry consolidation.

Nonetheless, broadband offered a new business opportunity, a real opportunity for competition between the incumbent PSTN operator and the ‘new’ incumbent, i.e., the CATV operator. The new market opening up was also attractive for alternative operators, being facilitated by unbundling of the PSTN. The local exchange was the typical co-location point and provided an attractive level of aggregation. Alternatively, entrants could hire backhaul services from the incumbent and aggregate at a higher level in the network.

However, with the introduction of VDSL the aggregation point moved to the cabinet level, which was less attractive. Alternatively a bitstream service could be used, but this allowed for less differentiation in the services offered. All in all, technological progress did not stimulate a higher degree of competition. As a result the number of ISPs diminished, many being acquired by the PSTN incumbent, which often retained the well-established brand names.

In relation to the non-telco market entrants it appears that the incumbents have improved their position. Relative to the cases discussed above, KPN assumed a 41% share in Reggefiber in 2008, which was increased to 51% in 2012, to full ownership in 2014. In Sweden, the role of network operator has mostly been contracted out to existing operators and in many cases incumbent TeliaSonera is involved. Note that TeliaSonera established a separate division to address the market of municipal networks. For TeliaSonera as service provider, the municipal networks provide access to a large market of high-end customers, without having had the need to invest in reaching these customers.

On the supply side of network equipment consolidation of European players has taken place, while Chinese firms are the new entrants. The most recent consolidation is the take-over by Nokia of Alcatel/Lucent. The latter was a merger that took place in 2005. Ericsson has entered into a strategic collaboration with Cisco. The two main new entrants are Huawei and ZTE.

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