Study on the Implementation of the existing Broadband Guidelines

COMP/2011/006

Authors:
Dr. Karl-Heinz Neumann
Ralf G. Schäfer
Anna Maria Doose
Dieter Elixmann

WIK-Consult GmbH
Rhöndorfer Str. 68
53604 Bad Honnef
Germany

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wik CONSULT

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Preface

This document is the **Final Report** of the "Study on the Implementation of the existing Broadband Guidelines (COMP/2011/006)". The study has been conducted from June 2011 to November 2011 by WIK-Consult GmbH on behalf of the European Commission. It is embedded in the present review process for the Broadband Guidelines of 2009. The findings and recommendations of the study were presented to representatives of the Member States, the European Commission and BEREC on November 14, 2011, during the multilateral meeting "Revision of the State Aid Broadband Guidelines" in Brussels. The results of the study are intended to serve as input to the Commission's revision of the Guidelines in 2012.

The opinions expressed in this report are those of the authors and do not necessarily reflect the views of the European Commission.

Bad Honnef, 7 December 2011

WIK-Consult GmbH

1 Introduction

1.1 Background and context of the study

1.1.1 Policy framework of the European Commission

Since a long time broadband communications networks have explicitly or indirectly been part of the political agenda of the European Commission.

In the year 2000 the Lisbon Agenda was setting the stage for Europe to become "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion" by 2010. In the frame of the respective Presidency Conclusions[1], the European Council has called in particular on the Community and the Member States “to make available in all European countries low cost, high-speed interconnected networks for Internet access and foster the development of state-of-the-art information technology and other telecom networks as well as the content for those networks.”

The 2005 Spring European Council, launching the partnership for growth and jobs as a new start for the Lisbon strategy, called knowledge and innovation the engines of sustainable growth and stated that it is essential to build a fully inclusive information society, based on the widespread use of information and communication technologies (ICT) in public services, SMEs and households. The rationale for this was in particular, that Information and communication technologies are viewed as a powerful driver of growth and employment. Against this backdrop, the European Commission has proposed in 2005 the i2010 strategic framework[2], laying out broad policy orientations towards 2010. i2010 in particular focused on the completion of a Single European Information Space which promotes an open and competitive internal market for information society and media. To create this Single European Information Space four main challenges were identified, one of which was: “speed: faster broadband in Europe services to deliver rich content such as high definition video”.

With its “Digital Agenda for Europe” published in 2010[3] the European Commission stressed that Europe needs widely available and competitively priced fast and ultra-fast Internet access. The Digital Agenda referred to the Europe 2020 Strategy[4] which underlined the importance of broadband deployment to promote social inclusion and competitiveness in the EU. The Europe 2020 Strategy restated the objective to bring basic broadband to all Europeans by 2013 and it seeks to ensure that, by 2020

- all Europeans have access to much higher Internet speeds of above 30 Mbps, and
- 50% or more of European households subscribe to Internet connections above 100 Mbps.

1 See http://www.europarl.europa.eu/summits/lis1_en.htm.
2 See European Commission (2005b).
3 See European Commission (2010e).
4 See European Commission (2010f).

1.1.2 Broadband Guidelines of the European Commission

The present Broadband Guidelines were adopted by the European Commission in September 2009[5]. They form an important part of the EU policy framework under the umbrella of the "Digital Agenda for Europe". In the following we give a short overview of the Broadband Guidelines.[6]

The rules for the control of State aid focus on initiatives intended to install traditional broadband networks (Section 2 of the Guidelines) as well as on initiatives aimed at establishing „Next Generation Access (NGA)" networks (Section 3 of the Guidelines).

(A) State aid rules concerning traditional broadband networks

State aid can be reasonable, but it can also distort competition: It is therefore the primary task of State aid control within the broadband sector to ensure that public provisions do lead to higher broadband coverage and penetration or at least will secure those goals earlier than without State aid. In addition to that, it should be secured that positive effects do outweigh negative effects regarding distortion of competition.

Absence of aid: the application of the market economy investor principle (MEIP)

Where the State supports the roll-out of broadband by way of an equity participation or by direct or indirect capital injections at market conditions into the undertaking company, the Guidelines do specify under para. 17 that in this case, the capital at the disposal of the project undertaker cannot be regarded as State aid.

Absence of aid: Public service compensation for providing „Service of General Economic Interest" (SGEI).

Compensation payments within the provision of SGEI *„Service of General Economic Interest"* do not constitute State aid, if the following four criteria are met ("Altmark criteria"), see Guidelines Section 2.2.2: (1) the beneficiary of a State funding mechanism for an SGEI must be formally entrusted with the provision and discharge of an SGEI, (2) the parameters for calculating the compensation must be established in an objective and transparent manner, (3) the compensation can only cover actual costs incurred under market conditions, (4) a benchmarking with typical and well run undertakings has to be performed for the calculation of the compensation. Broadband can be installed as an SGEI under certain circumstances, i.e. if it is proven that, along with other specific conditions, private investors will not be able to provide adequate coverage of broadband infrastructure for the population, so that a large amount of this population will remain without service provision (see para. 26 and 29 of the Guidelines).

5 See European Commission (2009a).

6 The Commission's policy on broadband State aid is also addressed by several articles in the official Competition Policy Newsletter. In particular, Papadias/Chirico/Gaál (2009) and Chirico/Gaál (2011) describe the political cornerstones and recommend best practices to implement State aid measures for broadband deployment.

In addition to the "Altmark criteria" a measure has to fulfill further requirements in order to be categorized as an SGEI. In particular, an SGEI measure should

- provide universal connectivity to all (residential and business) users in the respective area,
- deploy a passive, technologically neutral and open infrastructure,
- provide all possible forms of network access,
- provide only wholesale services but no retail services.

Analysis of market and competition and the balancing test and its application to aid for broadband network deployment

The objective of the "Balancing Test" is to assess whether an aid measure can be deemed compatible with the Common Market. This is done by weighting the positive impact of the aid measure against its potential negative side effects like distortion of competition or trade. To this end, the European Commission has specified under para. 35 a list of questions. Topics tackled are e.g. the existence of market failure, the predominance of „better" instruments than State aid and the preponderance of advantages over disadvantages. In order to assess the existence of market failures as defined in the State aid action plan[7] the Guidelines use the concept of white, black or grey „areas" (see Sections 2.3.2.1 to 2.3.2.3 of the Guidelines).

„White areas" are those areas, where broadband services are currently not available and where no network expansion plans or roll-out plans are pursued by private investors within the near future (specified as a period of 3 years). In contrast to that, no state intervention is needed in „black areas", since these areas are characterised by at least two broadband network providers and by the provision of broadband services under competitive market environments (facilities-based competition). In „grey areas" defined by a de facto monopoly regarding the provision of broadband services a thorough investigation is needed as State aid is permitted (only) under certain circumstances in those areas. This reflects the fact that some grey areas may cause problems with regard to competition (e.g. no access to the existing infrastructure, abusive wholesale prices) while in other grey areas access-based competition is possible.

General Checklist

The European Commission has specified a set of conditions that have to be fulfilled in any case in order to receive State aid within the broadband sector (see para. 51): Detailed mapping including coverage and market analysis, open tender process, choice of best economic offer, technological neutrality, use of existing infrastructure, wholesale third party access at prices derived from benchmarking, claw-back mechanism to avoid over-compensation.

7 See European Commission (2005a).

(B) State aid rules for NGA networks

Generally speaking, Member States could use different possibilities for market intervention in order to assist the deployment of NGA networks. When assessing State aid regarding NGA networks, the European Commission will as a basic principle use the instruments mentioned above, i.e. the market economy investor principle, the public service compensation for providing SGEI and the Altmark criteria, the balancing test and the general checklist.

The European Commission furthermore distinguishes also in the case of NGA networks between white, grey and black areas. White NGA areas are those areas where corresponding NGA networks do not yet exist and where there will be no operational network provision of NGA within the near future (specified within a 3 year period). A grey NGA area is understood to be the case if there is only one NGA network or it is planned to install a NGA network within the next 3 years without any other installation or provision plans for NGA networks of other operators. If within an area more than one NGA network is already installed and operational or will be provided within the next 3 years, this area is classified as a black NGA area.

The European Commission specifies its assessment criteria within the Guidelines as follows: A State aid for installing a NGA network in a white NGA area is admissible, if there does not exist any other broadband infrastructure or existing operators do regard this area as being unprofitable for the provision of NGA networks. Furthermore, a State aid can be compliant with the Guidelines even in a traditional grey area, where there is already a traditional broadband network. In this case, the Member State has to prove that (i) broadband services, that are provided via the traditional broadband network, are not sufficient (including possible future technological upgrades) to satisfy the needs of private and business customers and that (ii) there is no other less distorting instrument (including ex ante regulation) in order to achieve the specific goal.

For grey NGA areas, the Guidelines under para. 75 specify more detailed assessment criteria. The criteria include topics covering demand-related issues (demand for new services that are not provided by the existing NGA network), market conditions (e.g. the existence of barriers to entry) and supply-related issues (e.g. the lack of effective third party network access possibilities). In black NGA areas (para. 76) the European Commission assumes that an additional state financed NGA network is not compatible with State aid principles. This is in principle true also for those areas, where traditional broadband networks are in place, so that these areas have to be classified as black areas (para. 77). The European Commission views this case to offer enough incentives for the existing operators to invest in NGA networks. If a Member State is able to prove that none of the existing network operators has plans for the development of NGA networks within the next 3 years, then in this case the grant of State aid may be consistent with EU regulation. For this case, Section 3.4.5. of the Guidelines specifies further criteria.

1.2 Objectives of the study

The European Commission is preparing a review of the present Broadband Guidelines by September 2012. This early revision reflects the fact that at the time of passing the Guidelines there was only limited experience at the European Commission regarding State aid notifications dealing with NGA networks. Moreover the revision has to take into account a number of specific questions related to technology which came up with the decision making in the context of public funding of NGA networks. The core objective of the present study is to support the revision process by drawing lessons from the implementation of past decisions and by clarifying a given set of technological issues. Against this background the purpose of the study is twofold.

According to the Terms of Reference the study should

- assess the functioning of the existing framework by assessing the implementation of a selected sample of projects in the broadband sector. Such projects should include both European and non-European ventures, when the latter can provide useful insights due to their possible more advanced stage of implementation. The assessment should focus on an analysis of the potential difficulties experienced with the implementation of the conditions set out in the European Commission authorisation decision as well as on potential implications for the review of the Broadband Guidelines.
- give advice to the European Commission services regarding a limited number of technical issues which are relevant for the implementation of the Broadband Guidelines. The main issues to be addressed are:

  (a) Technological solutions for NGA networks;

  (b) Granting wholesale access to competitors on the subsidized networks and different "open access" products;

  (c) Separation.

The two objectives of the study are intertwined, and at the end lead to consistent recommendations for the upcoming revision of the Broadband Guidelines.

1.3 Methodological approach

Case studies build an important part of the study. A sample of 10 broadband projects[8] which was established in accordance with the Commission services was analysed in a two-step approach. First, we identified the main characteristics of each measure by desk research based on the publicly available decisions and public material of the relevant projects. Second, we collected specific information from the stakeholders by a writ-

8 The selection of case studies is illustrated in Section 2.2.

ten questionnaire and additional expert interviews if needed. Due to the limited number of case studies the sample is not strictly representative in a statistical sense.

For each of the European case studies the Commission services provided information about the relevant contact persons in the respective national authorities or institutions. During the project we experienced that some of these contacts were out of date due to the fact that the notifications of several measures are dated back a couple of years and some of the named people moved to other jobs in the meantime. Eventually, we succeeded to establish a contact for each of the projects.[9]

Our research made obvious that each of the case studies did not provide the same level of detail regarding their empirical information. In some case studies the contact persons only were able to provide rough information due to the fact that the projects were dated back some years and thus gathering information caused serious problems (e.g. involved staff moved away, organizations were closed, projects were finalized long since; notified measures merged into follow-up projects). Other case studies[10] announced their support of the study but at the end they did not provide any information at all despite several attempts by the project team as well as by the Commission services. Moreover quantity and quality of the information received from the case studies depend on the concrete implementation of the measures (e.g. internal monitoring/reporting procedures, status/progress of implementation).

In addition to the case studies our analysis is based on a mixture of our own expertise, literature review, and interviews with experts. As agreed with the Commission services the study does not comprise new own research.

1.4 Structure of the report

This report is structured as follows. Chapter 2 is devoted to the cases studies. After a short description of past State aid cases related to broadband we illustrate the selection of cases studies. Subsequently, each case study is presented in detail. Chapter 3 provides an analysis of the technological issues. Chapter 4 summarizes implications from the previous chapters and presents recommendations for the upcoming revision of the Guidelines.

9 A full list of organisations interviewed in the analysis is provided in Annex A.4.

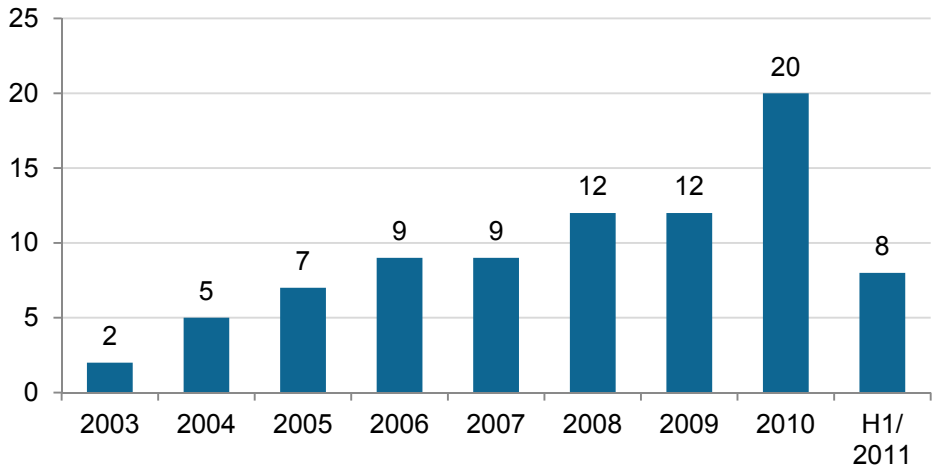
10 C53/2006 (NL) – Citynet Amsterdam, N284/2005 (IRL) – Metropolitan Area Network Broadband Program, N331/2008 (FR) – Réseau à très haut débit en Hauts-de-Seine.

2 Analysis of broadband projects

2.1 State aid cases regarding broadband

Since 2003 the European Commission had to deal with numerous notifications regarding public funding of broadband undertakings under the State aid rules. Up to now (August 2011), the European Commission has made 84 decisions in this context, whereof 82 decisions are publicly available.[11] As the following Figure 2-1 underlines, the number of broadband decisions increased over time.

Figure 2-1: State aid broadband decisions of the Commission by year

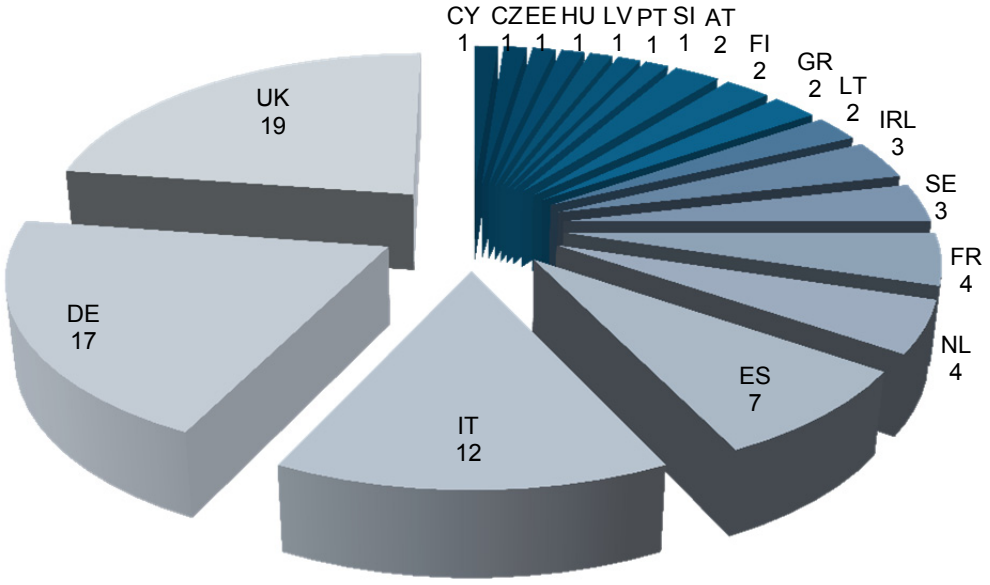


Source: WIK-Consult on the basis of European Commission

Overall, these 84 decisions cover 19 countries. For most countries there is only a small number of decisions as Figure 2-2 shows. For the United Kingdom, Germany and Italy the number of decisions is noticeable high with 19, 17, and 12 decisions, respectively.

11 Sources: http://ec.europa.eu/competition/sectors/telecommunications/broadband_decisions.pdf, and http://ec.europa.eu/competition/state_aid/register/, access on 29. August 2011.

Figure 2-2: State aid broadband decisions of the Commission by country



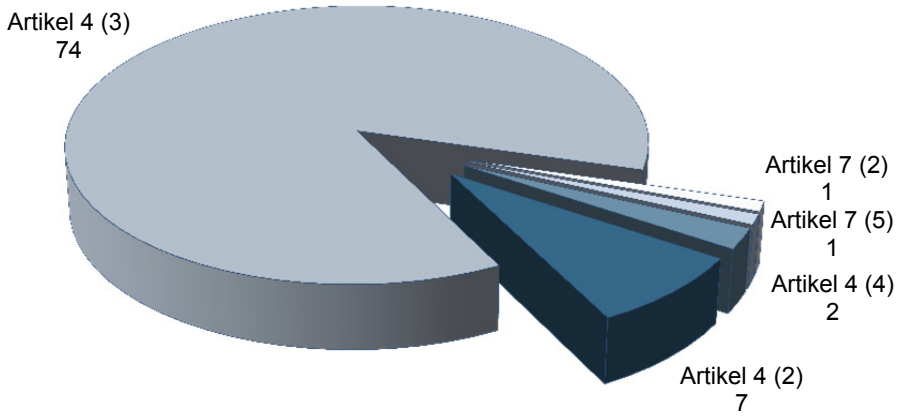
Source: WIK-Consult on the basis of European Commission

In general, the State aid notifications are related to two different specifications of broadband networks. The majority deals with basic broadband infrastructure. The remaining part, which constitutes mainly the most recent notified measures, refers to NGA networks.

Among the decisions one can distinguish several types of decisions according to the Council Regulation (EC) No 659/1999 of 22 March 1999.[12] As Figure 2-3 shows, in the vast majority of cases the European Commission had no doubts that the notified measure is compatible with the Common Market, i.e. it falls within the scope of Article 87(1) of the Treaty ("Article 4(3) decision"). In some cases the European Commission came to the conclusion that the notified measure does not constitute aid ("Article 4(2) decision"). Only twice the European Commission decided to initiate a further formal investigation procedure as there were doubts about the compatibility of the notified measure with the Common Market ("Article 4(4) decision"). In one of these cases the European Commission has decided that the notified measure did not constitute Stat aid ("Article 7(2) decision") and in the other case the notified measure was not compatible with the Common Market and thus should not be put into effect ("Article 7(5) decision").

12 Cf. http://ec.europa.eu/comm/competition/state_aid/legislation/rules.html.

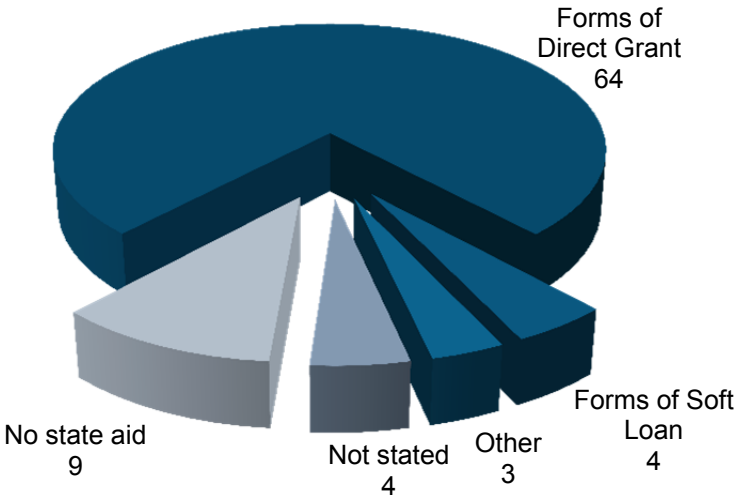
Figure 2-3: State aid broadband decisions of the Commission by decision type according to the Council Regulation (EC) No 659/1999[13]



Source: WIK-Consult on the basis of European Commission

Different aid instruments for different broadband measures were approved by the European Commission. Overall, the vast majority of cases (64) includes forms of direct grants as aid instrument (cf. Figure 2-4). In four cases the State aid represents a form of soft loan. Three cases use other aid instruments. For the remaining 13 cases the aid instrument is not specified in the public databases or these cases do not represent State aid.

Figure 2-4: State aid broadband decisions of the Commission by aid instrument

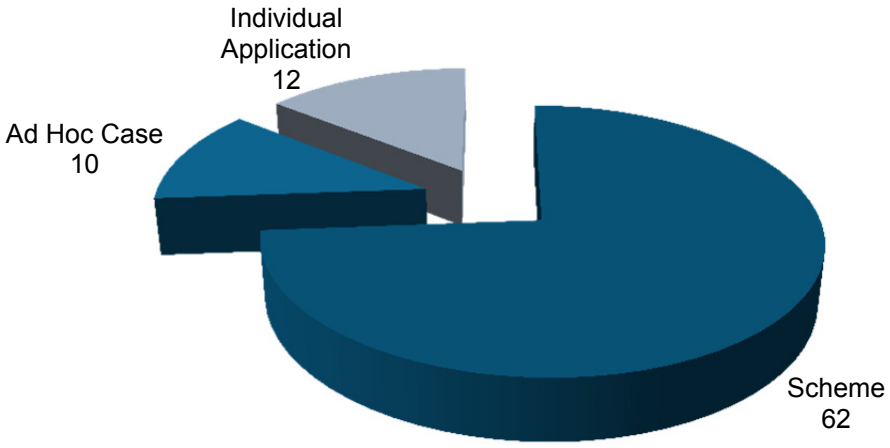


Source: WIK-Consult on the basis of European Commission

13 As one decision falls into two categories (Article 4(2) and Article 4(3)) the total number of decisions in this figures sums up to 85 instead of 84.

Furthermore, various case types can be distinguished. Similar to the former investigation dimensions, there is one outstanding case type exceeding all others by far. This is the case type of “scheme” (cf. Figure 2-5). “Scheme” constitutes a category that involves cases where general aid schemes are authorized. Overall 62 of all 84 notified broadband measures fell into this category. 12 broadband projects were registered by individual applications. An individual application of an aid program means that the aid is conferred based on an already approved scheme for which individual notification is required (e.g. because of widening the approved scheme to subsidizing broadband undertakings). Finally, 10 notified projects fell into the last category of ad hoc cases where aid is not conferred based on an already permitted scheme.

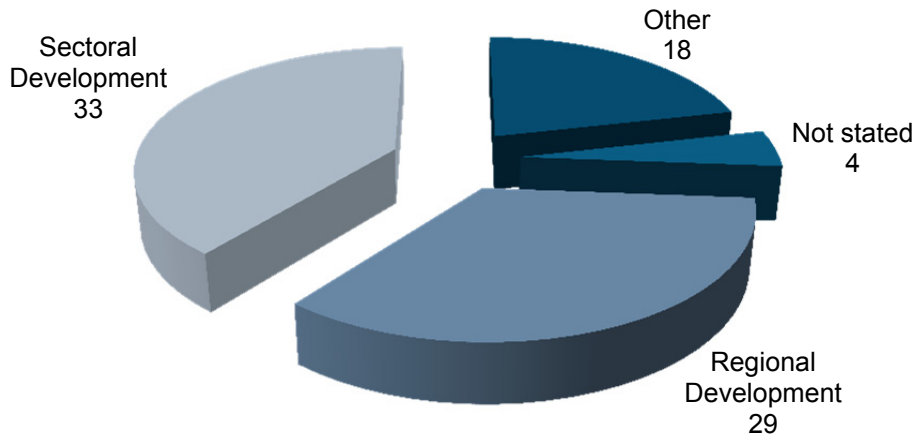
Figure 2-5: State aid broadband decisions of the Commission by case type



Source: WIK-Consult on the basis of European Commission

The 84 broadband measures, notified since 2003, pursue various different primary targets, beyond the deployment of broadband infrastructure. Overall, the promotion of either sectoral or regional development constitutes the most frequently stated superior aim of the notifying institutions (cf. Figure 2-6). Besides these two primary aims, 18 further projects supported other goals (employment, innovation, SGEI, amongst others). For the remaining four broadband measures, no primary objective was stated in the public database.

Figure 2-6: State aid broadband decisions of the Commission by primary objective



Source: WIK-Consult on the basis of European Commission

2.2 Sample of projects

For the purpose of the present study we selected a sample of 10 broadband projects in accordance with the European Commission services. As the different publicly-supported broadband initiatives differ along multiple dimensions the sample aims at enabling the use of cross-case analysis to derive meaningful insights both on different types of decisions and on the many different technical issues in the context of broadband projects, particular with regard to NGA. Moreover, the sample is not restricted to European State aid cases, rather, it includes one non-European project, as the latter can provide useful insights for the objectives of the study, too. Against this background several dimensions were taken into account in composing the sample:

- Time dimension/degree of implementation;
- Type of broadband (basic broadband vs. NGA network);
- Level of intervention (passive layer, active layer);
- Type of intervention (backbone, backhaul, access);
- NGA technology;
- Degree of public ownership;
- Involvement of the NRA;
- Specific conditions imposed by the granting authority .

Finally, the selection process in accordance with the European Commission service led to the 10 projects which are listed in Figure 2-7. This mix of nine State aid cases from Europe and one non-European NGA project ensures that there is a broad range of information taken into account. The results of the analyses of the selected case studies will be described case by case in the following sections of Chapter 2.

Figure 2-7: Overview of the selected cases/measures

Country	Case	Date
	C53/2006 (NL): Citynet Amsterdam	20/12/2006 21/12/2007
	N53/2010 (DE): Federal framework programme on duct support	12/07/2010
	N62/2010 (FI): High-speed Broadband Construction Aid in Sparsely Populated Areas	06/05/2010
	N267/2005 (UK): Rural Broadband Access Project	20/10/2005
	N284/2005 (IRL): Metropolitan Area Network Broadband Program	08/03/2006
	N331/2008 (FR) : Réseau à très haut débit en Hauts-de-Seine	30/09/2010
	N570/2007 (DE): Broadband in rural areas of Baden-Württemberg	23/10/2007
	N596/2009 (IT): Bridging the digital divide in Lombardia	08/02/2010
	N746/2006 (UK): North Yorkshire NYNET Project	21/02/2007
	New Zealand: Ultra-Fast Broadband Initiative	–

Source: WIK-Consult

Several of the selected case studies were approved before the present Guidelines were adopted in 2009. Against this background some of the conditions set out in the Guidelines may not apply to these case studies. Nevertheless, these measures could provide useful information regarding the applicable conditions as the implementation generally has been finished already some time ago.

2.3 Case study 1: N53/2010 (DE) – Federal framework programme on duct support

2.3.1 Main characteristics and development of the project/measure

The German authorities notified the State aid measure "Federal framework on duct support for the creation of universal broadband coverage" (Rahmenregelung der Bundesregierung zur Bereitstellung von Leerrohren durch die öffentliche Hand zur Herstellung einer flächendeckenden Breitbandversorgung) on 12 February 2010. The approval of this broadband measure was announced by the European Commission in July 2010.[14] The scheme is valid until end of 2015.

Against the background of reducing the digital divide between rural and urban areas in Germany and the argumentation that the lack of very high speed services for end-users is often caused by insufficient backhaul capacity and not only by the lack of enhanced technical solutions on the last mile, the German authorities notified the present measure in the context of the German Broadband Strategy[15]. The measure is not a funding scheme for the development of broadband infrastructures itself. Rather it is a national framework for NGA related broadband projects and funding schemes involving public authorities on different administration (in particular local and regional) levels. It defines and substantiates the requirements which have to be fulfilled by the respective projects and measures in order to comply with the Broadband Guidelines. Due to the framework nature of the notified measure there is no need for a case-by-case notification of local broadband projects at the European Commission. The responsibility for the notified measure rests with the Federal Ministry of Economics and Technology.

The national scheme targets at supporting mainly the backhaul level and thereby overcoming the backhaul capacity's shortcomings in the development of NGA networks. As construction works constitute the majority of broadband network deployment costs, the support of passive infrastructure roll-out by providing construction works or offering duct use is regarded as a very efficient way of targeting State aid for this sector taking into account infrastructure-based competition.

Target areas of this scheme are geographical units which are classified as traditional white or grey areas regarding basic broadband and which are underserved with respect to NGA ("white NGA areas"). The latter requirement is substantiated in the way that only those areas are covered by the scheme in which (a) end-users do not and will not (within three years) have access to download speeds of minimum 25 Mbps and (b) business users do not and will not (within three years) have access to download speeds of minimum 25 Mbps and/or to upload speeds of 25 Mbps. Moreover, demand for such download and upload speeds, respectively, has to be demonstrated by the public authorities.

14 See EC: Decision C (2010)4862 on the state aid case N53/2010, 12. July 2011.

15 The German Broadband Strategy aims to achieve two objectives: 1. Basic broadband services of at least 1 Mbps should be universally available until end of 2010. 2. High speed broadband services above 50 Mbps should be available to three quarters of the population until 2014 and as soon as possible universally. For further information, see: Federal Ministry of Economics and Technology Germany (2009).

The notified measure represents a form of non-monetary aid to carriers and service providers, respectively. The overall measure's budget has been estimated by German authorities to amount to approx. € 600 million. It consists of a tripartite support approach on the level of passive infrastructure:

1. Public authorities on any administration level deploy ducts and provide access to third parties. The ducts will remain in public ownership and can generally host several fibre cables.
2. Public authorities deploy ducts which are additionally equipped with one or several fibre cables, and provide access to this infrastructure. The ducts including the cables will again remain in public ownership.
3. Ducts and/or fibre cables are deployed by a market operator at its own costs. The necessary construction works for the ducts, however, are carried out by public authorities.

These three types of public support will basically be granted for a NGA backhaul deployment. Only in certain cases (e.g. if there is specific demand of business users in the particular geographic area) the activities may be extended to the access network so that the roll-out of infrastructure reaches the customers' premises. The notified framework specifies in line with the Broadband Guidelines certain conditions which have to be met by the individual broadband undertakings:

- Use of open and transparent tendering processes with ex ante weighting of qualitative assessment criteria.
- Existing infrastructure should be used to the largest extent possible.
- Ducts must be based on technology and carrier neutral standards.
- Public authorities should guarantee wholesale access to third-party operators to the ducts with or without dark fibre. This obligation is not limited in time.
- The selected operator should grant access to both its passive and its own active infrastructure to third-party operators. This obligation is limited to a period of seven years.
- In general, there are no restrictions to the deployed fibre technology. But in areas which are not white regarding traditional broadband the technology should ensure full and open unbundling and satisfy all different types of network access which operators may request.
- For traditional grey areas there are no measures which are less distortive.

In general, municipalities act autonomously as granting authorities under the notified framework. They are responsible for fulfilling the necessary conditions of the framework as well as of the Broadband Guidelines and they have to provide the funds for financing the construction works. They do not need a specific approval for their undertakings as

long as they do not participate in any other aid programme. But it seems to be usual that the municipalities use further economic development schemes as sources for funding their undertakings.[16] Presently, there are two funding mechanisms at the national level which may be used by the municipalities in the context of the notified framework:

- Joint Federal scheme for the improvement of regional economic structures ("Verbesserung der regionalen Wirtschaftsstruktur/GRW").[17]
- Aid programme for pilot projects regarding high speed networks in rural areas ("Modellprojekte für den Breitbandausbau zur Realisierung innovativer Lösungen und Geschäftsmodelle für den Aufbau von Hochleistungsnetzen in ländlichen Gebieten").[18]

Moreover, some federal States in Germany are about to create aid programmes that can be used for infrastructure deployment under the umbrella of the notified measure. Information on these intended funding schemes are not yet publicly available. Moreover it is unclear, whether there are further programmes in preparation which fall under the responsibility of lower administration levels (e.g. counties, municipalities).

Due to the autonomy of the municipalities there is no formal reporting about the project development and the project results to the Federal Ministry of Economics and Technology. There is only an obligation to include the information about the infrastructure built up with State aid into the national register of broadband infrastructures ("Infrastrukturatlas").

For projects with a funding volume of more than € 500,000 the notified framework contains a claw-back mechanism. Usually five years after completion of a measure the awarding public authorities will assess the development of subscribers in the region. If (a) the actual number exceeds the planned number of subscribers by at least 30% and (b) there was no related reduction of end-user prices the subsidized provider has to reimburse the profit from the turnover by the subscribers above the 30% threshold.

Beside its regulatory tasks based on the telecommunications framework the role of the German NRA regarding the notified measure is focused on supporting its implementation. On the one hand, the NRA has to confirm that in a specific traditional grey area ex ante regulation will not be suitable for the proper provision of NGA services. On the oth-

16 These economic development schemes usually have to be notified at the EC separately. They are not part of the approved State aid case N53/2010.

17 The Joint Federal scheme for the improvement of regional economic structures (GRW) has already been set up in 1969. GRW funding is restricted to selected, structurally disadvantaged regions in Germany. Broadband funding has been incorporated in GRW in 2009, and at the beginning of 2011 NGA was also included. This funding refers to passive infrastructure, i.e. ducts with or without dark fibre. The German Federal Government estimates that approx. € 60 million of GRW funds will be used for the promotion of broadband deployment until 2013.

18 Short description of the aid programme: under the responsibility of the Federal Ministry of Economics and Technology; published in August/September 2010; focus on municipalities with less than 10,000 inhabitants; objective: deployment of passive infrastructure as basis for access networks with downstream rates of at least 50 Mbps; respective end-user services should be available in 2012; more than 25 projects selected; overall funding volume approx. € 8.5 million; volume of each project < € 500,000; deployment of FTTC and FTTB nearly in equal shares; no details published so far (e.g. selected projects, progress, results).

er hand, the NRA is responsible for the documentation of the funded infrastructures within the national register of broadband infrastructures based on information obtained from the subsidized providers. Moreover, the NRA may be involved on request by the public authorities in the context of setting wholesale prices (e.g. information about regulated wholesale services and their prices). The actual responsibility for setting the wholesale prices for access to the subsidized infrastructure, however, remains with the respective public authorities.

In January 2011 the German authorities notified an amendment of the framework programme on duct support which has been approved by the European Commission in June 2011.[19] This update mainly refers to the point that traditional black areas are eligible for State aid under the notified framework (as long as they are white NGA areas). There are some additional conditions which have to be fulfilled in these areas, particularly it has to be demonstrated that there are strong barriers for a NGA deployment on market terms. Moreover, the subsidized providers are obliged to monitor the project development on an annual basis[20] and at the end of the deployment phase they have to prove that the installed network is suitable for the provision of NGA services. In case of traditional black areas, the NRA has an additional task: It may comment on the contracts between the public authorities and the selected providers within a period of 10 working days.

Table 2-1 summarizes the main characteristics of the German framework programme on duct support.

Table 2-1: Main characteristics of the German case N 53/2010

Attribute	Specification
Decision type	Article 4 (3) – no objections[21]
Project type	National framework
Time frame	July 2010 – 2015
Broadband type	NGA
Level of intervention	Passive infrastructure
Type of intervention	Backhaul network, under specific circumstances access network
NGA technology	Not defined
Separation conditions	No requirements
Public ownership	Passive infrastructure
Role of the NRA	Expert opinion, national register of broadband infrastructures

Source: WIK-Consult analysis

19 See European Commission (2011).
20 The first monitoring results will be available in March 2012.
21 Decision not to raise objections: After a preliminary examination, the EC finds that no doubts are raised as to the compatibility with the Common Market of the notified measure, in so far as it falls within the scope of Article 87 (1) of the Treaty.

Due to the decentralised structure of the framework programme there is no information available on an aggregate level about the broadband projects which are supported under the umbrella of the programme. In particular, it is unclear what funds are spent on respective undertakings and to what extent the planned funds have been exhausted. A monitoring process which illustrates the implementation of the framework programme and the development of the respective broadband projects on the local level has not been installed so far. In the context of the amendment of the notified measure and the monitoring requirements for projects in traditional black areas there are considerations about expanding the monitoring to all relevant projects.

Up to now, there are only some indications about the success of the national framework. On the one hand, the national framework came into existence due to a strong demand of the federal States within Germany to support NGA deployment on lower administration levels. On the other hand, the notified measure directly found its way into funding schemes (Joint Federal scheme GRW, aid programme for pilot projects) which shows that it is of practical relevance. But based on our expert interviews with ministries, market players and other stakeholders in Germany we conclude that the practical importance of the measure still is on a low level. There are two main reasons for this assessment. First, the framework is focused on NGA deployment in rural areas, whilst the NGA activities of market participants presently take place in more densely populated areas. Second, political initiatives in the past predominantly addressed the challenge of basic broadband services. Overall, the contacted market participants in Germany expect a strong increase of the relevance of the national framework in the near future.

2.3.2 Difficulties and experiences of the implementation of the measure in light of the Broadband Guidelines

Detailed mapping and coverage analysis (para. 51 a)

The decentralised analysis of present and future broadband coverage is assessed to be time and resource consuming by stakeholders. It requires specific know-how on lower administration levels which is not necessarily available there. Moreover potential synergies are not optimally used, rather there is room for methodological differences between regions.

The survey of broadband providers is seen as a potential source for strategically influencing the local broadband undertakings. Negative responses may aim at taking along subsidies, while positive responses may block the intended funding of public authorities. It remains unclear, to what extent these effects have really occurred in the past.

Another problem is associated with the relevant time frame of three years. The planning horizon of broadband providers appears to cover between one and two years with regard to new broadband deployments. The 3-year period seems to be too long in order to get sound information about planned broadband activities.

Open tender process (para. 51 b)

In general, this requirement does not pose a major challenge. Nevertheless, the decentralized approach may again lead to methodological inequalities and neglected synergies. Moreover, it is a potential source for increasing the search efforts of broadband providers as they have to check official gazettes and websites on the level of municipalities.

Most economically advantageous offer (para. 51 c)

Following the Broadband Guidelines the selection of a bidder rests on the principle of the most economically advantageous offer. This means that the offer requesting the lowest State aid (in case of an abstract tender) or the offer paying the highest amount for using existing public infrastructure, respectively, will be chosen taking into account a set of qualitative criteria which have to be met by the offers.

Regarding these qualitative selection criteria and their respective weights there is no common approach. Each public authority may choose its own criteria and its own weights. This will lead to methodological differences across the broadband undertakings which may just reflect different know-how and experiences on the lower administration levels rather than objective needs for project-specific criteria. Moreover, the missing guidance regarding relevant criteria and weights leads to disputes between different administration levels, i.e. between funding authorities and the local authorities operating the broadband projects.

Technology neutrality (para. 51 d)

The notified framework focuses on passive infrastructure and does not specify any technological requirements beside the use of fibre in the backhaul network. Against this background technology neutrality does not cause identifiable problems to the implementation of broadband projects under the umbrella of this framework.

Use of existing infrastructures (para. 51 e)

This requirement leads to two problems. First, even if the NRA is managing a national register of broadband infrastructures (“Infrastrukturatlas”) there is no complete information about such infrastructures as this register is based on voluntary data provision. Second and more important, obligations to open infrastructure to third parties exist only in the case of (a) operators with significant market power (regulatory obligation) or (b) infrastructures funded by State aid (based on the notified framework). Therefore, there may be infrastructures of other companies (e.g. utilities) which are not available to third parties for deployment of broadband networks.

It is worth to notice that the notified framework secures that funded infrastructure will be integrated in the national register of broadband infrastructures. This will enhance the data quality of this register gradually.

Open access (para. 51 f/para. 79)

The awarded operators *should* grant access to their active and passive infrastructure for a period of seven years. As the programme foresees no strict obligation ("*should*" instead of "*must*") the availability of open access is not guaranteed in general. Up to now, there were apparently no cases where open access has been demanded by third parties.

Even if there are no practical experiences so far public authorities anticipate some challenges in implementing open access. As today only the incumbent Deutsche Telekom is classified as having SMP, many operators active in local broadband projects are not subject to measures of the NRA. So the NRA could not assist the public authorities in enforcing the open access obligations if necessary, e.g. if an operator discriminates third parties (at least while there is no regulation on a regional level). Most probably the public authorities would have to claim back the granted State aid by (long lasting) court proceedings but they would not be able to apply other remedies to the affected operator. This does not seem to be an effective mechanism.

Benchmarking pricing exercise (para. 51 g)

As there was no demand for access to subsidized infrastructures so far setting wholesale prices was not of practical relevance, too. But similar to the issue of open access there are some challenges anticipated by public authorities. On the one hand, missing instruments for enforcing wholesale prices may cause a problem again due to the fact of not dealing with SMP operators. On the other hand, defining appropriate wholesale prices requires specific know-how which in most cases is not available at the municipality level.

Claw-back mechanism to avoid over-compensation (para. 51 h)

Public authorities agree that an over-compensation of the awarded operator should be avoided. Nevertheless, there are some retentions and uncertainties in this regard as the concrete implementation is not specified. Until now it is unclear in which way a local public authority should determine the specific profit which results from the turnover of the subscribers above the relevant threshold. Beside this methodological issue there are further challenges regarding the allocation of cost for the claw-back mechanism and the sufficiency of the legal basis for getting access to business data of the awarded operator. Finally, public authorities worry about the complexity of the process and the required know-how at the local level. Until now the claw-back mechanism has no practical relevance as it would become effective for the first time five years after finishing the broadband undertaking at the earliest. Moreover, so far there has been no broadband project under the umbrella of the notified framework with a funding volume above € 500,000 which would require the application of a claw-back mechanism.

White NGA areas, traditional grey areas (para. 73)

In order to justify State aid in white NGA areas which are traditional grey areas there has to be demonstrated amongst others that the needs of citizens and business users are not satisfied by the existing broadband services. The required demand analysis is very time and resource consuming from the viewpoint of local authorities. Moreover, the results of this analysis show uncertainties as purchase intentions and real purchases regularly diverge. Against this background the benefit of case-specific demand analysis is sometimes questioned. This applies particularly taking into account the long-term goal of comprehensive NGA availability.

2.3.3 Summary of peculiarities of the case N53/2010 (DE)

- Support of public authorities in applying the Broadband Guidelines by substantiation of the requirements of the Guidelines (e.g. definition of “underserved” with respect to NGA).
- Avoiding individual notifications of respective NGA projects on different administration levels because of the framework character.
- Decentralisation of responsibilities to lower administration levels allowing for extensive use of local expertise.
- No need for approval of local projects by higher administration levels if the projects fall under the duct framework only and do not involve other aid programs for financing the measure.
- Low level of distortion of competition due to focus on passive infrastructure and technology neutrality.
- Low level of NRA involvement and thus no consistency with telecommunications regulation guaranteed. No effective price control mechanism in case of non-SMP operators.
- Low transparency about the actual application of the framework and its implementation effects due to missing monitoring/reporting procedures.
- Support of backhaul network deployment as default rule, access network only under special circumstances.
- Requirement of specific know-how on low administration levels and risk of methodological inequalities between regions within Germany due to decentralisation of responsibilities.

2.4 Case study 2: N570/2007 (DE) – Broadband in rural areas of Baden-Wuerttemberg

2.4.1 Main characteristics and development of the project/measure

The German authorities notified the measure “Eckpunkte für die Verwendung öffentlicher Mittel zur flächendeckenden Versorgung des Ländlichen Raums mit Breitbandanschlüssen in Baden-Wuerttemberg” (Eckpunkte) on 2 October 2007. This State aid measure was approved by the European Commission on 23 October 2007. At this time the Broadband Guidelines were not yet in force but the approval was already geared to the basic principles of the future Guidelines.

The notified measure covers the period from November 2007 until October 2012. It represents a regional framework for deployment of broadband infrastructures which aims at the provision of broadband services in rural areas in Baden-Wuerttemberg (or parts of these communities) that do not have affordable[22] access to this kind of telecommunications services and in which no service provider is expected to change this situation in the near future; i.e. traditional white areas. These underserved municipalities are in the majority of cases areas with low population density and thus provide low economic incentives for commercial operators to invest in electronic communications infrastructure.

In detail, the measure’s target is to enable municipalities in Baden-Wuerttemberg to grant financial support to network operators for the provision of retail broadband services to private end-users and businesses in traditional white areas. The “Eckpunkte” actually constitute a document in which the context and general conditions for granting State aid by municipalities have been stipulated:

1. The municipalities have to carry out a market analysis as well as to consult operators in order to find out whether they would be able to provide the envisaged broadband service without public support, before granting any amount of aid.
2. If the respective community indeed can be categorized as a traditional white area, which means that there is no broadband service offered by the market or expected to be offered in the near future, a subsidy may be granted. If this is the case, the respective municipality will publish the envisaged public funding plans in its official journal, on its webpage as well as on the homepage of the clearing center “New Media in Rural Areas” (“Clearingstelle Neue Medien im Ländlichen Raum”), which consults communities regarding broadband provision and conducts special events.
3. The measure also targets at encouraging selected electronic communications operators to grant wholesale access for third-party operators to their networks. Against this background primarily broadband projects should be supported where open access to the infrastructure is intended. Only if technical or financial

22 Apart from expensive satellite or leased line broadband solutions.

reasons apply, a tender may be selected which doesn't provide open access. In this context it is worth to mention that regulatory obligations to SMP operators regarding wholesale access are not influenced by the notified measure.

4. The broadband undertakings have to be carried out in a technological neutral manner. This means that municipalities cannot choose a specific broadband solution without analyzing costs and benefits.

5. The selection of an operator takes into account the fulfillment of the technical specifications, the requested subsidy and the end-user prices. At the same level of performance and quality that bidder will be selected which requires the lowest amount of State aid. A solution which provides a better performance than required by the tender may be selected only if the needed amount of aid is within the same magnitude of the bidder which fulfills the minimum technical specifications.

The municipalities of Baden-Wuerttemberg will determine and grant the actual amount of public support for each of the projects. No direct funding of the Land of Baden-Wuerttemberg will take place. Public funds will directly be paid to the selected operators by the municipalities. The measure will only be effective regarding projects with a total amount of public support up to € 75,000 per project. The authorities of Baden-Wuerttemberg expected the overall annual budget in the range of € 1 million.[23]

Table 2-2 summarizes the main characteristics of the broadband measure for rural areas in Baden-Wuerttemberg.

Table 2-2: Main characteristics of the German case N 570/2007

Attribute	Specification
Decision type	Article 4 (3) – no objections[24]
Project type	Regional framework
Time frame	November 2007 – October 2012
Broadband type	Basic broadband
Level of intervention	No limitation on a certain layer of the infrastructure
Type of intervention	Backhaul and access network
NGA technology	Not applicable
Separation conditions	No requirements
Public ownership	No public ownership
Role of the NRA	Not defined

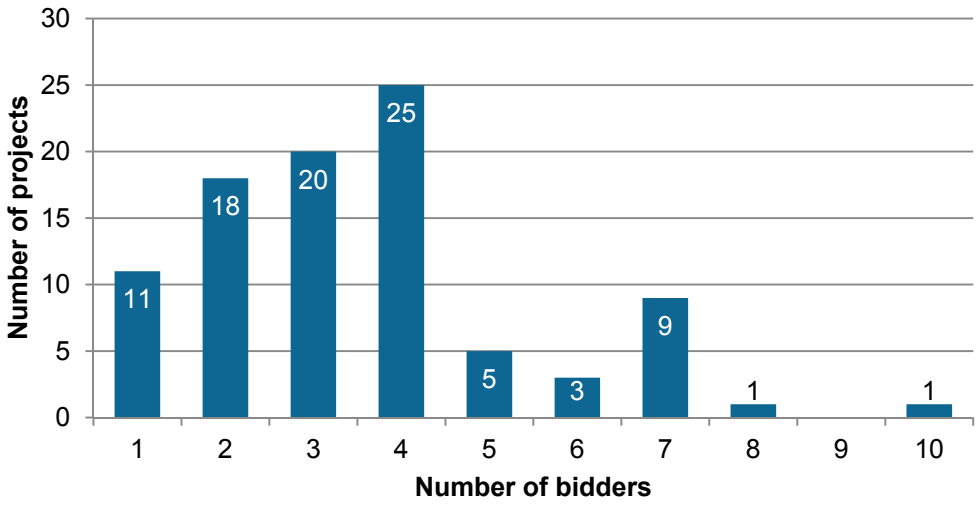
Source: WIK-Consult analysis

23 See European Commission (2007b).
24 Decision not to raise objections: After a preliminary examination, the EC finds that no doubts are raised as to the compatibility with the Common Market of the notified measure, in so far as it falls within the scope of Article 87 (1) of the Treaty.

Up to April 2011 93 broadband projects were subsidized under the umbrella of the notified measure. The municipalities have granted approximately € 1.6 million as State aid to these projects. There is no information available how many households were reached with the deployed broadband infrastructures and how many customers could be attracted by the service providers.

About 80% of the granted projects attracted up to four bidders in their tender procedures (cf. Figure 2-8). A higher number of bidders appears less frequently. The maximum number of bidders is 10 which was reached once.

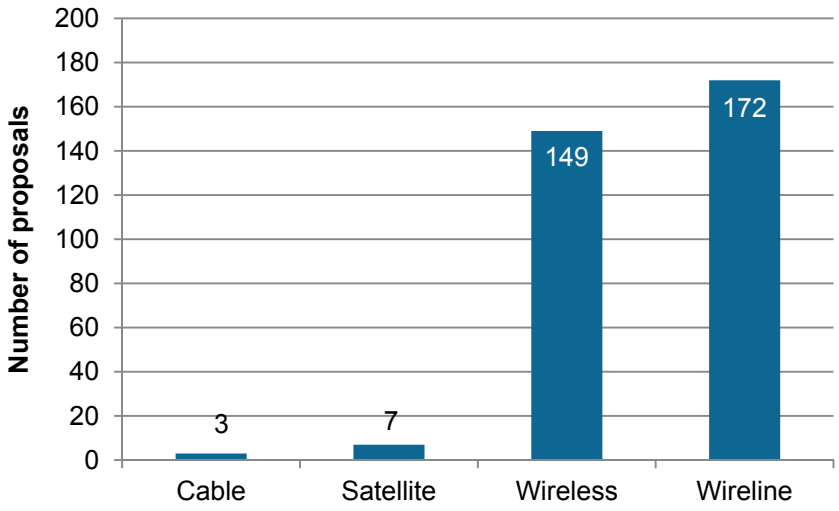
Figure 2-8: Granted broadband projects in Baden-Wuerttemberg differentiated by number of bidders



Source: WIK-Consult on the basis of Ministry for Rural Areas and Consumer Protection of the Federal State Baden-Wuerttemberg

Overall, the 93 broadband projects attracted 331 proposals of 34 different operators. Most of the bidders represent small companies with a specific technological and/or regional focus. Only some of the proposals are based on cable or satellite infrastructures (cf. Figure 2-9). The main part refers to wireless or wireline infrastructures which represent 45% and 52% of the proposals, respectively.

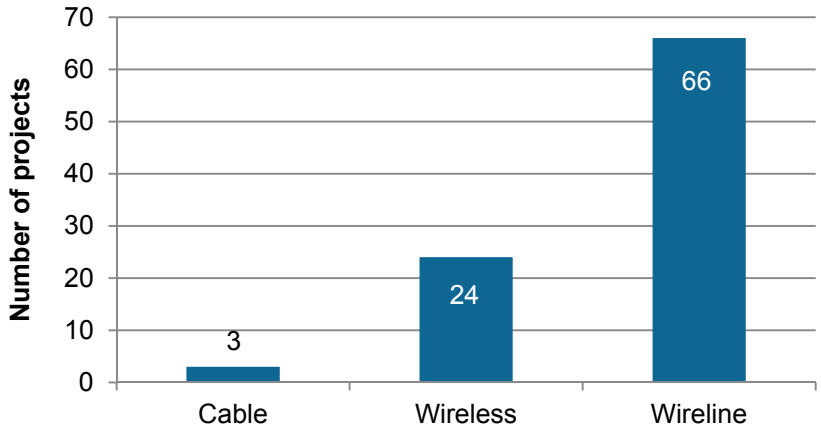
Figure 2-9: Proposals in Baden-Wuerttemberg differentiated by technology



Source: WIK-Consult on the basis of Ministry for Rural Areas and Consumer Protection of the Federal State Baden-Wuerttemberg

In more than 70% of the tender procedures bids on the basis of wireline technologies were selected as the most economically advantageous offer (cf. Figure 2-10) which in fact means ADSL solutions. Approximately every fourth broadband project deploys wireless infrastructure. Only three of the granted projects are using cable infrastructure. Bids using satellite infrastructure were in no case successful.

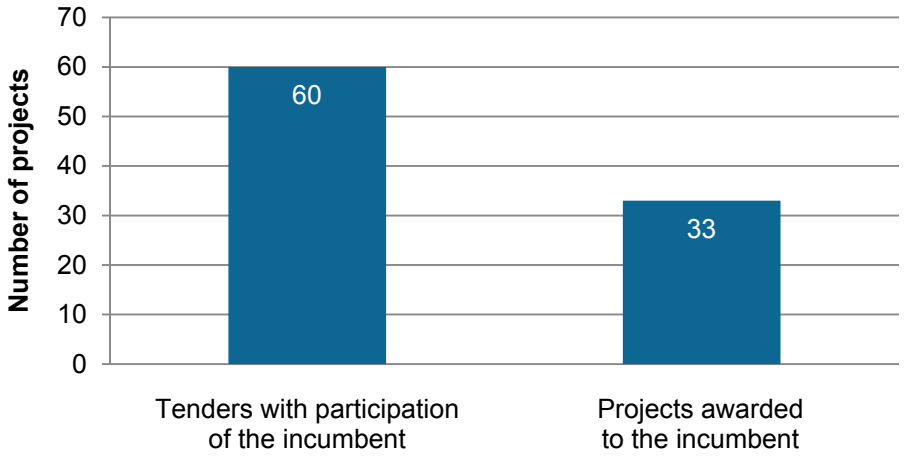
Figure 2-10: Granted broadband projects in Baden-Wuerttemberg differentiated by technology



Source: WIK-Consult on the basis of Ministry for Rural Areas and Consumer Protection of the Federal State Baden-Wuerttemberg

The incumbent Deutsche Telekom participated in 60 of the 93 tender procedures (cf. Figure 2-11). But the incumbent was successful in only 33 cases. Thus, the measure had apparently a positive impact on competition as only about 35% of the broadband projects were awarded to the incumbent Deutsche Telekom.

Figure 2-11: Involvement of the incumbent in the granted broadband projects in Baden-Wuerttemberg



Source: WIK-Consult on the basis of Ministry for Rural Areas and Consumer Protection of the Federal State Baden-Wuerttemberg

2.4.2 Difficulties and experiences of the implementation of the measure in light of the Broadband Guidelines

Detailed mapping and coverage analysis (para. 51 a)

The notified measure does not prescribe a mapping and coverage analysis. Rather the municipalities have to carry out a market analysis on the basis of a survey of relevant network operators. This step does not pose major challenges to the public authorities but it is often perceived to be very time consuming.

The survey of broadband providers again (cf. Section 2.3.2) is seen as a potential source for strategically influencing the local broadband undertakings. Negative responses may aim at taking along subsidies, while positive responses may block the intended funding of public authorities. It remains unclear, to what extent these effects have really occurred in the past.

Open tender process (para. 51 b)

As most public authorities are quite familiar with open tender processes the notified measure does not lead to fundamental problems in this regard. By involving the clearing center “New Media in Rural Areas” the federal state Baden-Wuerttemberg is able to harmonise the open tender process at least to some extent.

Most economically advantageous offer (para. 51 c)

The bidder requesting the lowest amount of State aid at the same level of technological performance will be selected. This procedure does not impose major challenges to the public authorities in general. Problems sometimes arise with regard to technological aspects, as the selection has to take into account the level of performance and quality. Depending on the minimum technical specifications set out in the tender this may lead to solutions with a lower social acceptance, e.g. in case of a wireless solution which just meets the performance requirements and which is criticized by community members due to perceived potential health risks. This issue is directly linked to the requirement of technology neutrality (cf. following passage on para. 51 d).

Technology neutrality (para. 51 d)

The requirement of technology neutrality seems to be a critical challenge in practice. Often, simple wireless solutions tend to be the cheapest technology in order to provide basic broadband services to the rural and remote areas of Baden-Wuerttemberg. But the acceptance of these networks by the general public tends to be on a low level due to perceived potential health risks. Moreover, these solutions are assessed to be less sustainable with regard to future (high speed) broadband applications, e.g. applications requiring high bit rates and specific quality-of-service characteristics like real-time ability in case of video telephony. If the built networks could not be upgraded to higher performance levels the subsidised solutions must be replaced later on by other technologies in order to meet the future requirements regarding bandwidth and performance. As it is hardly possible to include additional specifications like acceptance or sustainability of a technology in the selection process the criterion of technology neutrality (as defined in the notified measure) is sometimes regarded as a problem of practical relevance by the local authorities.

Use of existing infrastructures (para. 51 e)

This requirement of the Broadband Guidelines is not explicitly addressed in the notified measure. Thus, there are no specific challenges as to the implementation of respective broadband projects.

Open access (para. 51 f)

The notified measure does not impose specific access obligations to the beneficiaries.[25] Open access is indeed desired but due to technical or financial reasons public authorities may abandon the open access requirement. This allows to minimize implementation challenges for local broadband projects. Independent from the notified measure open access is mandatory for SMP operators on the basis of the telecommunications regulation.

In practice, it seems that only Deutsche Telekom as the SMP operator is able to offer access for third parties. Thus, the funded projects promote competition on the level of service providers only in a limited way as there are no specific access obligations included in the notified measure.

Benchmarking pricing exercise (para. 51 g)

There are no specifications regarding wholesale access pricing in the notified measure. As open access is of practical relevance only in case of the SMP operator (where prices are set by the NRA as part of the SMP regulatory regime) no specific problems exist in the context of wholesale access pricing for the public authorities.

Claw-back mechanism to avoid over-compensation (para. 51 h)

Due to the low amount of the maximum grant per undertaking there is no claw-back mechanism which has to be implemented.

2.4.3 Summary of peculiarities of the case N570/2007 (DE)

- Avoiding individual notifications of broadband projects on municipal levels because of the framework character.
- Decentralisation of responsibilities to the municipal level allowing for extensive use of local expertise.
- Harmonisation of the tender methodology by involving the clearing centre “New Media in Rural Areas”.
- Reduction of transaction costs for potential bidders by additional publication of the tenders on the website of the clearing centre “New Media in Rural Areas”.
- No involvement of the NRA and thus no link to telecommunications regulation.
- Low transparency about the actual application of the framework and its implementation effects due to rough monitoring/reporting procedures.

25 The measure was notified before the present Guidelines were adopted by the European Commission, so that there was no formal requirement to impose access obligations.

- Requirement of specific know-how on municipal levels, risk of methodological differences between municipalities within Baden-Wuerttemberg and low incentives for using synergies between the individual broadband projects due to decentralisation of responsibilities.
- Operators are only encouraged to provide wholesale access to the subsidised infrastructure, but there is no wholesale access obligation and due to technical or financial reasons the awarded operators may reject open access (as long as they are not SMP operators).

2.5 Case study 3: C53/2006 (NL) – Citynet Amsterdam

2.5.1 Main characteristics and development of the project/measure

The Dutch authorities notified the broadband measure "Citynet Amsterdam – investment by the City of Amsterdam in a fibre-to-the home (FTTH) network" on 17 May 2005. The European Commission stated that it will open a formal investigation procedure as the project might have a strong distorting impact on 20 December 2006. Thus the measure was categorized to Art. 4(4) of the Council Regulation (EC) No 659/1999 of 22 March 1999[26]. After having carried out the formal investigation procedure the European Commission approved the scheme by deciding in favour of Art. 7(2) of the Council Regulation (EC) No 659/1999 of 22 March 1999 that the Citynet Amsterdam project does not constitute State aid.[27] The measure was approved by the European Commission on 11 December 2007. In the following paragraph the whole decision making process will be outlined.

The envisaged measure by the Dutch authorities aims at the roll-out of a FTTH based broadband access network within the City of Amsterdam. The notified measure refers to serving about 37,000 households (approximately 10% of the City of Amsterdam) with broadband infrastructure. Citynet Amsterdam is competing with broadband access based on VDSL and cable infrastructure.

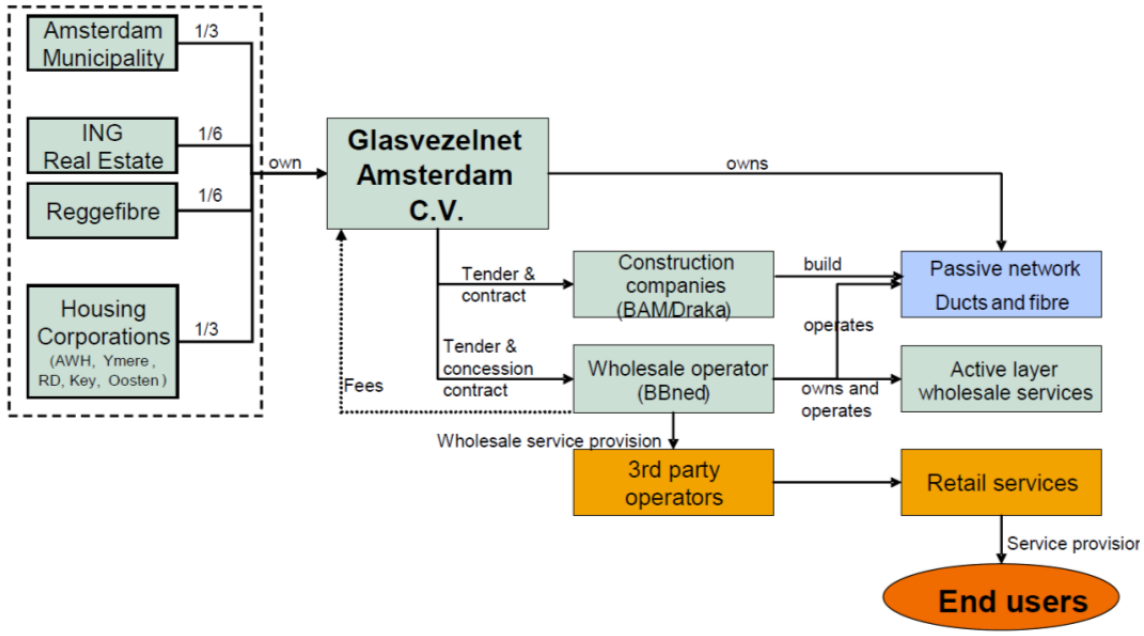
As a basic principle the project follows a three layer approach (cf. Figure 2-12):

- Layer 1 ("passive layer"): The first layer constitutes the passive infrastructure elements such as ducts, fibre, street cabinets.
- Layer 2 ("active layer") The second active layer includes the management, control and maintenance of systems necessary to operate the network, such as switches, routers or splitters. The operator managing and maintaining the network provides wholesale services to retail operators.
- Layer 3 ("retail layer"): Retail operators provide Internet-based services (such as telephony, broadband, TV, etc.) to private and business end-users. Retail service providers will have to invest into their own equipment in order to be able to provide these services.

26 See European Commission (1999).

27 According to this decision the measure follows the Market Economy Investor Principle (MEIP). Referring to this commercial character Citynet Amsterdam and its stakeholders did not provide specific information in our survey. The analysis is therefore (only) based on desk research of publicly available information instead.

Figure 2-12: Basic structure of Citynet Amsterdam at the start of the project



Source: European Commission (2007a)

The municipality of Amsterdam together with other stakeholders in 2006 have set up the public private partnership (PPP) Glasvezelnet Amsterdam CV (GNA) as the operator of the passive network layer.[28] The partnership consists of several companies or institutions beside the municipality of Amsterdam: ING Real Estate and Reggefiber[29] (two private investors) and five subsidiaries of social housing corporations. The GNA partners invest the following amounts: municipality of Amsterdam € 6 million, ING Real Estate and Reggefiber each € 3 million, three housing corporations each € 1.5 million and the remaining two housing corporations each € 750,000. Thus the total investment amounts to approx. € 18 million. The official start of the infrastructure deployment was the 12 October 2006.

BBned[30] has won the public tender for the operation of the active infrastructure elements. These elements include all active network equipment in the network nodes and within the customer premises. BBned leased dark fibre from GNA and undertook the necessary investments for the active layer elements. BBned also has the obligation to

28 The partners for the PPP were selected on the basis of an European invitation to tender which was launched in 2004.

29 Reggefiber was founded in 2005 and specializes in the construction and operation of fibre access networks. The Dutch incumbent Koninklijke PTT Nederland (KPN) and Reggefiber have agreed to bundle their respective NGA activities in a partnership named Reggefiber FTTH. KPN holds a minority stake of 41% in Reggefiber FTTH (including a majority option), while Reggefiber holds 59%. See KPN (2008).

30 At this time, BBNed has been a private broadband operator and a subsidiary of Telecom Italia. It was acquired by the Swedish telecommunications operator Tele2 in 2010. See TeleGeography (2010).

offer wholesale transport and related services to retail operators. Until October 2009 BBned could exclusively act as wholesale operator.[31] BBned is active on the end-user level, too, through its affiliated retail companies Pilmo, InterNL and Bbeyong.

When notifying the present broadband scheme, the Dutch authorities requested the European Commission to confirm that the project does not constitute State aid within the meaning of Art. 87(1) EC Treaty as the investment is in line with the Market Economy Investor Principle (MEIP). The European Commission, however, concluded that the intended aid was potentially not conform with the Common Market (Art. 88(2) EC Treaty) and thus a formal investigation procedure was initiated (Art. 4(4) Council Regulation). The European Commission underlined its decision with the following deliberations:[32]

- The network built may be marketed at conditions below market prices and thus could distort competition even in the downstream markets of retail broadband and other electronic communications services.
- It is assumed that the Citynet Amsterdam project will have an effect on trade within the European Commission as several telecommunications providers that are active in Amsterdam are also active in other countries.
- There are doubts whether the partnership and investments of the municipality of Amsterdam are in line with the MEIP and whether the GNA business plan is feasible.
- The presence of State aid in favour of GNA, its shareholder as well as of BBned cannot be excluded.

On 11 December 2007 the European Commission published its decision regarding the formal investigation procedure in the State aid case of Citynet Amsterdam. The objective of this procedure was, on the one hand, to delve into the European Commission's concerns deriving amongst others from the fact that the City of Amsterdam already invested into the Citynet project before the establishment of GNA, and, on the other hand, to give the Dutch authorities and third parties the opportunity to submit their comments on the present broadband project.

The European Commission came to the conclusion that the Citynet Amsterdam broadband scheme and thus the investment of the City of Amsterdam in GNA did not constitute State aid within the meaning of Art. 87(1) EC Treaty. The project indeed is in conformity with the MEIP. This decision is based on the following argument: All pre-investments of the municipality of Amsterdam, the European Commission's main concern within the opening decision, were reimbursed by GNA. Thus, the City of Amsterdam investments in GNA are conform with the MEIP criteria as it invests under the

31 See FTTH Council Europe (2010). At the end of the exclusivity period a second wholesale operator was awarded (cf. below).
32 See European Commission (2006b).

same terms and conditions as private parties, which are involved in the project and are investing on the basis of GNA's business plan.[33]

Table 2-3 summarizes the main characteristics of the Citynet Amsterdam project.

Table 2-3: Main characteristics of the Dutch case N 570/2007

Attribute	Specification
Decision type	Article 4 (4) – formal investigation procedure[34] Article 7 (2) – no State aid/MEIP[35]
Project type	Individual local case
Time frame	From October 2006
Broadband type	NGA
Level of intervention	Passive infrastructure
Type of intervention	Backhaul and access network
NGA technology	FTTH P2P
Separation conditions	Differentiation of three layers (passive layer, active layer, retail layer) with open tender process on the second layer and non-discriminatory open access to the third layer
Public ownership	Public authority is a minor shareholder of the operator (15%)
Role of the NRA	Not defined

Source: WIK-Consult analysis

In February 2009, Reggefiber announced that it will increase its shares in GNA aiming at acquiring a majority stake. Until this time, Reggefiber already hold an increased stake of 1/3 as ING Real Estate sold its share to Reggefiber beforehand. With the acquisition of additional shares, Reggefiber has a stake of 70% in GNA. These shares were originally held by the City of Amsterdam and housing corporations.[36] The City of Amsterdam and the involved housing companies consequently each hold a share of 15% in GNA. Moreover, Reggefiber formed its joint venture with KPN at this time.

At the end of 2009, GNA has completed the deployment of fibre optic infrastructure to 43,000 homes in Amsterdam and furthermore pursues the plan to connect the rest of the city. At this time 43,000 homes were passed (on the "passive layer"), 10,000 homes were connected (on the "active layer") and 4,000 homes were activated (on the "retail layer"). As deployment method GNA mainly chose buried cable and not ducted fibre

33 See European Commission (2007a).
34 Decision to initiate the formal investigation procedure - where the European Commission, after a preliminary examination, finds that doubts are raised as to the compatibility with the Common Market of a measure.
35 Decision that a measure does not constitute aid - where the European Commission, after formal investigation procedure, finds that, where appropriate following modification by the Member State concerned, the notified measure does not constitute aid.
36 See TeleGeography (2009).

cables. The technology GNA deployed was a FTTH Point-to-Point (P2P)[37] topology. It was selected as this technology (1) would be able to offer total flexibility in terms of the selection of equipment (any technology can be supported incl. Ethernet and (Gigabit) Passive Optical Network (PON)) and (2) was seen the most future-proof technology. Only 120,000 meters of trenching was needed for the first 40,000 connections; an average of three meters per connection. Roughly 80% of the costs were labour costs, while 10% were cost for fibre.[38]

The total amount of investment required to connect the approx. 40,000 households amounts to € 30 million, of which € 18 million are provided by the shareholders of GNA and the remaining € 12 million by debt capital.[39] The further goal is to connect approx. 420,000 households with € 300 million investment until 2013.[40] In 2011 approx. 50,000 FTTH-P2P connections will be realised and the target to connect the whole city was extended until 2016/2017.[41]

Citynet Amsterdam is built as an open-access, passive network that provides the possibility for multiple ISPs to provide retail services on a competitive basis. In particular, this means that also unbundled dark fibre access lines can be rented individually by an ISP that wants to serve a particular customer and that ISPs can get access to APOPs (aggregation points with active equipment) to install their line cards and related equipment, and patch in their customer access lines.

During the deployment phase, the constructors faced a specific problem. As Amsterdam is a very densely populated city, space is a scarce resource. So the question was, where to build the aggregation points. The first idea was to build POPs that are very small (1,000 customers or less) and place them on the street in public ground, but this approach was abandoned because "*these kinds of cabinets tend to become a meeting place where waste is discarded and problems get concentrated*"[42] and small POPs make it very difficult for new market entrants who want to take advantage of unbundling (as small POPs require much more redundant backhaul to reach many access points). The decision made, was to build these POPs into the building rather than outside them. This lead to searching for available space in existing real estate and (partially excessive) negotiations with each owner. Finally POPs inside existing buildings were deployed for sizes between 5,000 and 15,000 connections.

A further challenge which occurred on the active layer of Citynet Amsterdam was that GNA found out that end-users and wholesale customers prefer a competitive service market with multiple operators rather than with solely one, BBned. This was why GNA also contracted KPN as the second wholesale operator in 2010 after the end of the ex-

37 Each home is served by two fibre lines, one for Internet services and a second one for the analogue RTV signal.
38 See Wagter (2010).
39 See GNA (n.d.), p. 9.
40 See Brusic (2010), p. 12.
41 See Woude (2011), p. 15.
42 See Wagter (2010).

clusivity period of BBned. Among the service providers offering retail broadband services to end-users are Alice, Concepts ICT, InterNLnet, Tweak and KPN (as of August 2010).[43] Thus, KPN is involved in all three layers of Citynet Amsterdam (indirectly through a 41% stake in Reggefiber on the passive layer, directly as a wholesale operator on the active layer and as a service provider on the third layer).

2.5.2 Citynet Amsterdam in light of the Broadband Guidelines

Being aware that Citynet Amsterdam does not constitute State aid it might nevertheless be instructive to contrast the notified measure with the conditions set out in the Guidelines. This would enable illustrating differences and commonalities of a broadband project under the MEIP and State aid based undertakings.

Detailed mapping and coverage analysis (para. 51 a)

GNA did a thorough market analysis at the initial stage of the project. The results of this analysis were used as an important input for setting up the business plan of the PPP. As the project follows the MEIP, details of this business plan are available only to the involved stakeholders but not to the public.

Open tender process (para. 51 b)

The founding of GNA rests on an open tender process which was initiated by the City of Amsterdam on the European level in 2004. During this process possible parties of the envisaged PPP were invited to express their interest and to submit proposals. The selection of the stakeholders of GNA in 2006 is based on this tender process.

Two further tender processes were launched in 2005. One was aimed at finding a suitable operator for the “wholesale layer”. The other tender addressed the issue of selecting subcontractors for building and maintaining the fibre infrastructure. Both tender processes led to contracting the partners (BBNed and BAM/Van den Berg-Draka building consortium, respectively) in 2006.

Most economically advantageous offer (para. 51 c)

Details about the selection criteria which were applied in the course of the aforementioned tender processes are not publicly available. As GNA follows the MEIP, economic criteria most probably have been of high importance.[44] Otherwise, the selection of partners/subcontractors would conflict with the idea of profitability and the objective of providing appropriate returns on investment.

43 See FTTH Council Europe (2010).

44 It is at least stated that “*BBned … has submitted the economically most favorable offer for the exploitation of the network”,* cf. http://www.citynet.nl/index.php?pagenr=Ls0k9YOD&taal=ned_.

Technological neutrality (para. 51 d)

Citynet Amsterdam deploys a P2P fibre network. This architecture provides a higher degree of technological neutrality than other architectures. The chosen architecture is regarded as most future proof and pro-competitive by the stakeholders so that it will support their objectives in the best way.

Use of existing infrastructure (para. 51 e)

There is no information available whether the use of existing infrastructure was of relevance for Citynet Amsterdam.

Wholesale access (para. 51 f)

The operators on the “wholesale layer”, BBNed and KPN, provide access to active and passive infrastructure of Citynet Amsterdam to third parties. Service providers cannot establish direct business relationships to GNA, the operator on the “passive layer”. They have in each case to contract with one of the wholesale operators. The concrete design of wholesale services/products is part of the commercial negotiations between operators on the wholesale layer and the retail layer.

Providing wholesale access to third parties is one of the main characteristics of the approach of Citynet Amsterdam. This should allow for stimulating competition on the retail level and thus generate best possible benefits to the population of Amsterdam.

Benchmarking pricing exercise (para. 51 g)

The wholesale operators have to provide access to Citynet Amsterdam on “*comparable conditions for all access seekers on the wholesale level*”. It remains unclear, in which way this requirement (which should secure undistorted competition) is implemented in practice.

The fact that there are two competing wholesale operators may perhaps reduce the risk of predatory pricing or price squeeze on the wholesale layer. Nevertheless this risk is of practical relevance as both wholesale operators are directly or indirectly active on the retail layer, too.

Claw-back mechanism to avoid over-compensation (para. 51 h)

There is no claw-back mechanism relevant as the undertaking does not constitute State aid compensation rather it is an investment according to the MEIP.

2.5.3 Summary of peculiarities of the case C53/2006 (NL)

- PPP with very different partners, competencies and experiences (City of Amsterdam, five housing companies and the two 2 investors ING Real Estate and Reggefiber).
- Participation of housing companies simplifies access to homes as no excessive contract negotiations are necessary.
- Open access approach for the three-layer model is conducive to competing wholesale products and strengthens competition on the retail level.
- Deployment of a future-proof and a priori pro-competitive network architecture (P2P) which gives greatest flexibility for technological choice to all market participants.
- Strengthening of competition is questionable because of the strong role of the incumbent (KPN is involved on all of the three layers, no separation between “wholesale layer” and “retail layer”).
- Arbitrary market entry is possible only on the third layer (“retail layer”) but not on the second layer (“active layer”).

2.6 Case study 4: New Zealand – Ultra-Fast Broadband Initiative

2.6.1 Main characteristics and development of the project/measure

The New Zealand (NZ) authorities announced the national broadband scheme „Ultra-Fast Broadband Initiative" (UFB) in September 2009. This national broadband plan aims at the provisioning of high-speed broadband infrastructure for at least 75% of the NZ population within a ten-year period.[45]

Conceptual Elements of the UFB

The envisaged NGA broadband infrastructure is expected to guarantee broadband speeds of at least 100 Mbps downstream and at least 50 Mbps upstream. The NZ Government refers to a NGA architecture called „*fibre-to-the-premise broadband service*".[46]

Within the first six years the focus of infrastructure deployment is on priority users, i.e. businesses, health services and schools as well as new housing developments and certain tranches of residential areas.

The NZ authorities developed the following deployment strategy. The broadband roll-out will be based on public-private-partnerships (PPPs) between the Government and the private sector. The implementation will take place on two different levels:

1. Crown Fibre Holdings (CFH),
2. Local Fibre Companies (LFCs).[47]

CFH was established by the NZ Government as a Crown-owned company and became operational in late October 2009. CFH's purpose is to financially manage the NZ Government's optical fibre activities. In particular, it will operate the selection processes to determine the PPPs investment partners in one or more determined LFC(s) and to manage the public investments in LFC(s). Furthermore, CFH's task is to operate as "*a successful, profit driven business after a special resolution of shareholders is passed. This phase is anticipated to commence after 2019 when all shares in LFCs convert to ordinary shares as contemplated in the Invitation to Participate (ITP)*".[48] CFH's overriding target is to achieve the UFB objectives until 2019.

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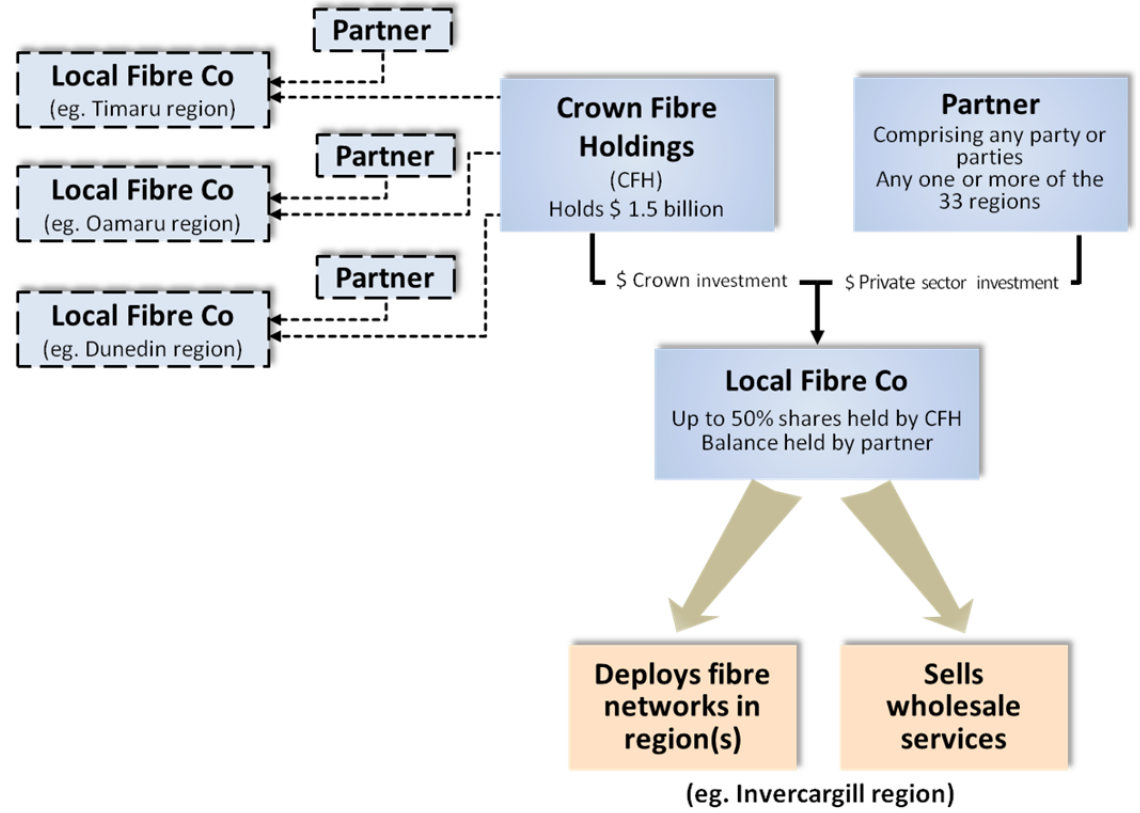
45 Parallel to the UFB Initiative, the NZ Government launched a special broadband program for connecting the remaining (at maximum 25%) rural regions of NZ with NZ$ 300 million public funding in September 2009: the Rural Broadband Initiative. This program has two prior aims: (1) to increase the availability of broadband so that 97% of NZ households and companies will have broadband connections of at least 5 Mbps and the remaining 3% of at least 1 Mbps („the rural community objective"), (2) to deploy fibre connections to 97% of NZ schools so that they can benefit from at least 100 Mbps connections and the remaining 3% from at least 10 Mbps („the rural schools objective"). See Ministry of Economic Development (2010a).

46 See http://www.med.govt.nz/templates/ContentTopicSummary____41902.aspx. There is no formal definition of "*fibre-to-the-premise*" but it seems that the approach refers to deployment of infrastructure up to the building (FTTB). In-house cabling is apparently not part of the UFBI, i.e. the projects does not cover FTTH.

47 See Ministry of Economic Development (2009b).

48 See CFH homepage: Corporate Governance; available at: http://www.crownfibre.govt.nz/about-us/corporate-governance.aspx.

Figure 2-13: Basic structure of the UFB



Source: WIK-Consult according to New Zealand Government (2009)

LFCs are commercial companies which are to be established by the CFH and private partners. LFCs will constitute the operational entity of the UFB deploying the NGA infrastructure. It is foreseen that the state, besides few exceptions, will have stakes in these LFCs that do not exceed 50%. Open tenders will be put in place in order to select the private shareholder for the LFCs.

LFCs' tasks are to deploy optical fibre infrastructure throughout the envisaged target areas in NZ. They will provide dark fibre products on a wholesale basis and will also be permitted to offer wholesale Layer-2 active services. The determined business model of LFCs is focused on a wholesale-only business. LFCs are not allowed to provide retail services.

Overall, 33 NGA deployment target areas ("Candidate Coverage Areas") from all over the territory of NZ were defined, which represent the most densely populated areas in New Zealand and in total cover about 80% of the population (i.e. the objective of providing high-speed broadband infrastructure for at least 75% of the NZ population will be achieved by this approach). Depending on the proposal within the open tender procedure,

each company (applying as a partner for a LFC) is allowed to propose for the NGA infrastructure roll-out in one, more than one or even all Candidate Coverage Areas (national).

There is no NGA technology specified within the UFB and technology neutrality is ensured as long as the infrastructure is based on FTTP. Thus broadband networks based on passive optical network (PON) architectures and point-to-point (P2P) architectures are possible.[49] In any case, LFCs will have to provide their services based on the open access principle.[50] Broadband infrastructure deployment activities of commercial operators should endure.[51] Furthermore, the NZ Government promotes the use of existing infrastructure:

- "*In the case of central business areas, where the market is usually well served by fibre, gaining access to existing networks will generally be preferred if such access can be secured on reasonable terms. However if, notwithstanding the existence of other providers, access cannot be gained on reasonable terms, then overbuilding will be considered. A similar approach will apply to intra-city backhaul.*
- *In the case of residential access networks, such as Telecom's copper and TelstraClear's cable networks, it is clear that they do not have the capability to compete with the performance of fibre-to-the-premise (FTTP) networks in the medium to long term. As a result, it is likely that these networks will eventually be overbuilt. In the short to medium term, consideration will be given to the speed, capacity, terms of access, and price of services on existing networks when investment proposals are considered.*"[52]

The public support of the NZ Government for the LFCs deploying the envisaged infrastructure amounts to NZ$ 1.5 billion (approx. € 891 million).[53] It is expected that with further private investments the overall UFB scheme investments will total to NZ$ 3 billion (approx. € 1.782 billion).[54] This means approx. € 720 respectively approx. € 1,440 broken down into investment per household.[55]

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49 See Butt (2009), p. 3.

50 The NZ Government also points towards different possibilities of open access, depending on the selected technology: „While the Passive Optical Network (PON) fibre access network architecture does not lend itself to unbundled line access as naturally as the Point-to-Point (PTP) architecture, there are methods for providing open access to PONs…. . For example, splitter-level unbundling is possible on PON architectures, and a future version of 'Wave Division Multiplexing PON (WDM-PON)' is likely to provide for wavelength unbundling on a PON architecture." Cf. Ministry of Economic Development (2009b), p. 9.

51 In contrast to the Australian fiber broadband network approach, the existing copper network will not ne be decommissioned in New Zealand. Thus dual networks will persist. See Howell (2011).

52 See Ministry of Economic Development (2009b), p. 2.

53 See Ministry of Economic Development (2009b).

54 See TeleGeography (2011a).

55 These calculations imply 75% of the number of NZ households (100% are approx. 1.654 million) in analogy to 75% of the NZ population. Based on information of Statistics New Zealand, Census 2006. See: http://www.stats.govt.nz/. Exchange rate of 02 September 2011, NZ$ 1 = € 0.59397, source: OANDA - Forex Trading and Exchange Rates Services.

Table 2-4 summarizes of the main characteristics of the Ultra-Fast Broadband Initiative in New Zealand.

Table 2-4: Main characteristics of the Ultra-Fast Broadband Initiative

Attribute	Specification
Project type	National programme covering 33 independent areas
Time frame	September 2009 – 2019
Broadband type	NGA
Level of intervention	Passive and active infrastructure
Type of intervention	Backhaul and access network
NGA technology	FTTP PON/P2P
Separation conditions	Integration of passive layer and active layer on the level of LFCs, separation of retail layer
Public ownership	CFH holds up to 50% of shares in LFCs
Role of the NRA	Comcom acts as advisor to NZ Government/CFH (in particular regarding wholesale access) and sets wholesale prices

Source: WIK-Consult analysis

Status of the implementation of the UFB

Based on the 33 candidate coverage areas CFH prepared a map of NZ in which optical fibre infrastructure is to be deployed within the context of the UFB initiative. The blue marked parts in Figure 2-14 indicate these areas.

Figure 2-14: Candidate Coverage Areas in New Zealand

Source: CFH homepage

The NZ Government determined in its UFB initiative that primarily companies will be taken into account during the open tender procedures for the LFCs that do not simultaneously own both a retail unit and network infrastructure. Those companies that do possess both will have to propose structural separation plans to the NZ Government within the framework of the open tender procedure.

The NZ Government faced severe problems with TNZ's operational separation undertakings imposed in 2006[56] and set out in its Telecommunications Amendment Act from June 2011 the milestones for the incumbent's structural separation.[57] At the end of 2010, TNZ agreed to structurally separate its infrastructure business unit Chorus from the retail activities in principle. It is foreseen that after the separation Chorus will operate as a fixed line access network operator on a nationwide basis offering wholesale services on an open access basis. Thus, Chorus will undertake the network and wholesale business and will be responsible for both the fibre and copper network in the future.

56 For further information regarding TNZ's operational separation see Doose, Elixmann (2011).
57 See New Zealand Government (2011a), pp. 49.

TNZ itself will function as a retail service provider and will operate the mobile network. Subject to several factors, such as the stakeholder approvals and legislative changes, TNZ announced that the separation will take place at the end of 2011. The detailed split of assets between the two entities is unclear to date.

In October 2009, the NZ Government issued an Invitation to Participate (ITP) in order to receive proposals for the commercial partner(s) for the LFC(s) within the context of the UFB measure. In January 2010, the Government received 18 proposals for single or multiple Candidate Coverage Areas from different companies and consortia. After controversial discussions with the relevant parties and other stakeholders, the Government requested changes of the business models and revised the regulatory settings for the UFB initiative.[58] These changes are based on proposed amendments of CFH and thus the Ministry of Economic Development NZ. CFH thereby argued that a greater degree of certainty over the NZ Government's future fibre regulation would be needed in order to make the UFB model more attractive to potential investors. In this way, the likelihood of achieving the Government's UFB targets would increase. These changes, approved in June 2010 particularly include:

- "*Layer 2 fibre access services must be provided by LFCs, including a specified "multi-service provider" open access Layer 2 service;*
- *Layer 1 point-to-point fibre access services must be provided by LFCs on a non-discriminatory basis; and*
- *LFCs will be required to provide unbundled Layer 1 services on an equivalent basis by 31 December 2019 at the latest*"[59]

A request for refined proposals was issued to the already active resp. bidding parties. Their amended proposals were received in August 2010. In September 2010, CFH announced that it will launch prioritised negotiations with three different parties; namely Northpower, WEL Networks[60] and Alpine Energy; and shortlisted 11 other parties.

The NZ Government announced the acceptance of the recommendations of CFH to establish the UFB's first two LFCs in December 2010. These should be built in partnership with Northpower and with WEL Networks' subsidiary UltraFast Fiber in the areas of Hamilton, Tauranga, New Plymouth, Wanganui, Hawera and Tokoroa and Whangarei. The first deployment sites were opened in Whangarei during this time. In March 2011, thirteen telecommunications service providers expressed their interest in selling UFB based broadband services to end-users.[61]

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58 See CFH homepage: http://www.crownfibre.govt.nz/ultra-fast-broadband/how-is-the-ultra-fast-broadband-initiative-progressing.aspx.

59 See Ministry of Economic Development (2010b). The concretisation of respective wholesale services is still ongoing and has not yet been finished.

60 WEL Networks is also known as the Central North Island Fibre Consortium and Ultra Fast Fibre.

61 See CFH homepage: http://www.crownfibre.govt.nz/ultra-fast-broadband/how-is-the-ultra-fast-broadband-initiative-progressing.aspx.

In the meantime, CFH was negotiating with the three companies – Telecom New Zealand, Enable Networks and Flute. On 24 May 2011 CFH announced that Telecom New Zealand (TNZ) through its network arm Chorus was selected as technology partner for 24 Candidate Coverage Areas (including Auckland and Wellington) and that Enable Networks[62] was chosen to cover Christchurch and Rangiora, after having carried out the last open tender processes.[63] TNZ's Chorus and Enable Networks agreed about a collaboration to combine existing optical fibre infrastructure and expertise in Christchurch.[64] Chorus indicated that 95% of its deployment sites should be able to profit from the newly deployed NGA infrastructure by December 2013. Enable Networks intends to complete its roll-out until December 2012.[65]

Overall, CFH fulfilled tenders for all 33 Candidate Coverage Areas in May 2011. More than 72% of the contracts were awarded to TNZ's Chorus. In July 2011, the NGA infrastructure deployment in Hamilton is already completed, connecting approx. 200,000 residential end-users and 4,000 businesses to the newly deployed infrastructure. The infrastructure roll-out in Tauranga and Wanganui is scheduled to start within August 2011.[66]

Initially, the revised regulatory settings also included a restriction of the European Commission's power to recommend regulation.[67] As set out in the Telecommunications Amendment Bill from May 2011, "*during the forbearance period, which would last until 31 December 2019, the Commerce Commission would not be able to investigate the prices that were set for supplying services through the UFB. Price caps would be set in contract between Crown Fibre Holdings (CFH) and the local fibre company (LFC) at the outset of the forbearance period.*"[68] The idea of introducing this forbearance period can be ascribed to the target to guarantee certainty that prices negotiated would not decline during the period in which the fibre network is being built.

When the new telecommunications law was finally enacted in June 2011, this regulatory holidays until 2019 were removed.[69] ICT minister Steven Joyce stated that *"regulatory forbearance on wholesale prices for the ultra-fast broadband network will be replaced with contractual mechanisms"*[70]. These contractual mechanisms will in turn give private investors certainty as the government e.g. will give the supplier more time to pay off any public funding that it received for building up the network from the government in case the NRA determines prices below those contracted.

62 Enable Networks is a fibre company wholly owned by Christchurch City Holdings Limited.
63 Moreover Enable Networks is serving Rolleston, which is not among the 33 candidate coverage areas.
64 See TeleGeography (2011a).
65 See CFH homepage: http://www.crownfibre.govt.nz/news/press-releases/final-ufb-partner-announcements-.aspx.
66 See TeleGeography (2011c).
67 See Ministry of Economic Development (2010b).
68 See New Zealand Government (2011b), p. 3.
69 See New Zealand Government (2011a).
70 See Computerworld (2011).

In October 2011, the New Zealand Commerce Commission published a consultation document dealing with several information disclosure requirements for the LFCs Chorus, Enable Networks, Ultrafast Broadband Limited and Northpower Fibre. These disclosure requirements are intended to answer the purpose of operational, managerial, taxation and statutory reporting. Overall, "LFCs should be capable of providing information about their costs and characteristics, and compliance with the undertaking largely using information from their existing or planned reporting systems"[71].

2.6.2 Ultra-Fast Broadband Initiative in light of the Broadband Guidelines

Taking into account the necessary conditions of the Guidelines for minimisation of potential distortions of competition caused by State aid, we think it is worth to reflect the conditions and procedures of the NZ UFB initiative and to find out in which way the NZ approach conforms with these European Commission criteria or follows a different route.

Detailed mapping and coverage analysis (para. 51 a)

At the beginning of the launch of the UFB Initiative, 33 geographic areas from all over the country of NZ have been selected ("Candidate Coverage Areas"). There is no information available that is indicative of a coverage analysis that has been conducted before. This seems to be plausible as fibre based broadband access does not have significant market relevance in NZ so far.

Open tender process (para. 51 b)

CFH carried out several open tender procedures in order to select the adequate technology partner(s) for the relevant NGA deployment target areas.

Most economically advantageous offer (para. 51 c)

CFH has to select the adequate bidding party in two ways on the basis of the following two categories of criteria: (1) eligibility criteria which must all be satisfied before a proposal will be considered for the next phase of assessment and (2) evaluation criteria.[72]

The eligibility criteria are as follows:

- The respondent has the technical and commercial ability to construct, own and/or invest in infrastructure network businesses.
- The respondent has the financial capability to execute its proposal.

71 See Commerce Commission (2011), p. 2.
72 See Ministry of Economic Development (2009a), pp. 31.

- The network the respondent proposes to supply to the LFC will:
    - meet or exceed the network technical specifications and
    - comply with, and will be capable of operating in accordance with, all applicable laws and regulatory requirements with immediate effect from the commencement of provision of services by the LFC on that Network.
- The LFC will comply with the open access requirements.

The evaluation criteria are as follows:

- Proportion of the population that will be able to access the LFC's services in the proposed coverage area.
- The amount of the cost per premise passed and the cost per premise connected (lower amounts will be evaluated more favourably).
- The maximum amount that LFC will be entitled to charge an access seeker per month for providing the specified Layer 1 service (lower amounts will be evaluated more favourably).
- The build and acquisition schedule for the communal infrastructure.
- Improvements to the competitiveness of relevant markets.
- Avoiding excessive duplication of existing networks.
- Additional benefits proposed by the respondent.

Taking these criteria into consideration, not only financial aspects play an important role when selecting the most adequate proposal, but also more quality related criteria are relevant like the proportion of population envisaged within the roll-out, the Layer-1 wholesale price, the deployment schedule, positive impacts on the telecommunications market's competitiveness, the extent of using already existing infrastructure as well as potential additional benefits. Compared to the criteria of the Guidelines, the evaluation criteria of the public tender in NZ are very specific and comprehensive.

Technological neutrality (para. 51 d)

Under the umbrella of FTTP the criterion of architecture neutrality is fulfilled as both PON and Point-to-Point architectures are used for UFB as long as the deployment meets the common standards.[73] The fact that infrastructure that will be deployed must be interoperable with the current TNZ standards/infrastructure may indeed constrain the technology neutrality criterion slightly.

73 See CFH (2011).

Use of existing infrastructure (para. 51 e)

Already existing fibre infrastructure should be used to the largest extent possible. But in case access cannot be gained on reasonable terms the use of existing infrastructure may become obsolete.

Wholesale access (para. 51 f)

Wholesale access will be available for passive and active services as,

- *"Layer 2 fibre access services must be provided by LFCs, including a specified "multi-service provider" open access Layer 2 service;*
- *Layer 1 point-to-point fibre access services must be provided by LFCs on a non-discriminatory basis*[74]*; and*
- *LFCs will be required to provide unbundled Layer 1 services on an equivalent basis by 31 December 2019 at the latest"*[75]*.*

The question whether full unbundling should be applied generally is still open. The Commerce Commission may discuss about this later. Duct access is not envisaged.[76]

Benchmarking pricing exercise (para. 51 g)

The wholesale prices for the respective technology partner are determined by CFH in collaboration with the LFC. The LFC may sell their services at prices below or equal to the set price caps.[77] Due to Government subsidy the determination of wholesale prices does not follow the principle of cost-orientation. They will presumably be set so as to achieve the desired level of private sector investment from PPP partner(s).[78]

Claw-back mechanism to avoid over-compensation (para. 51 h)

There is no claw-back mechanism envisaged in NZ.

74 Non-discrimination is not clearly defined within the UFB Initiative. Up to today it is not determined how this term will be defined, who will define the term and who will decide in case of dispute.
75 See Ministry of Economic Development (2010b).
76 To the best of our knowledge ducts do not represent a relevant resource in NZ. In many cases cables are buried directly underground due to specific ground conditions.
77 For an example price sheet for wholesale prices of Enable Networks in NZ, see Appendix I.
78 See Howell (2011).

2.6.3 Summary of peculiarities of the Ultra-Fast Broadband Initiative

- UFB initiative complemented by the Rural Broadband Initiative leads to an universal availability of broadband access, thereof high speed Internet access for about 80% of the households.
- High degree of private sector involvement (also financially) via PPP.
- Avoiding distortion of competition through clear separation between wholesale and retail level.
- Transparent and comprehensive evaluation criteria in the public tender.
- No duct access envisaged as wholesale product.
- Long period until unbundled Layer1 wholesale services have to be offered on a non-discriminatory basis (by end of 2019 at the latest).
- The incumbent operator won the open tender procedure for the most attractive regions (in particular Auckland where half of the country's people live). This fact will highly likely strengthen the market position of the incumbent and weaken the competitors' positions in the market.
- Limited technology neutrality as any priority user (e.g. business user) should get broadband access via P2P technology and the deployed infrastructure must be interoperable with the current TNZ standards/infrastructure.

2.7 Case study 5: N62/2010 (FI) – High-speed Broadband Construction Aid in Sparsely Populated Areas, Finland

2.7.1 Main characteristics and development of the project/measure

The Finnish authorities notified the measure "High-speed broadband construction aid in sparsely populated areas of Finland" on 17 February 2010. The measure was approved by the European Commission on 05 May 2010. It aims at developing an electronic communications infrastructure for the provision of high-speed broadband services in sparsely populated areas in Finland where no such infrastructure yet exists and where no commercial operators have planned to deploy an infrastructure in the near future. The notified measure lasts until the end of 2015.

The measure is embedded in the national "Plan of Action" which has been published by the Finnish Government at the end of 2008. This plan has two distinct targets:

1. All Finnish citizens, businesses and public administration bodies should have access to basic broadband services (min. 1 Mbps) by the end of 2010.

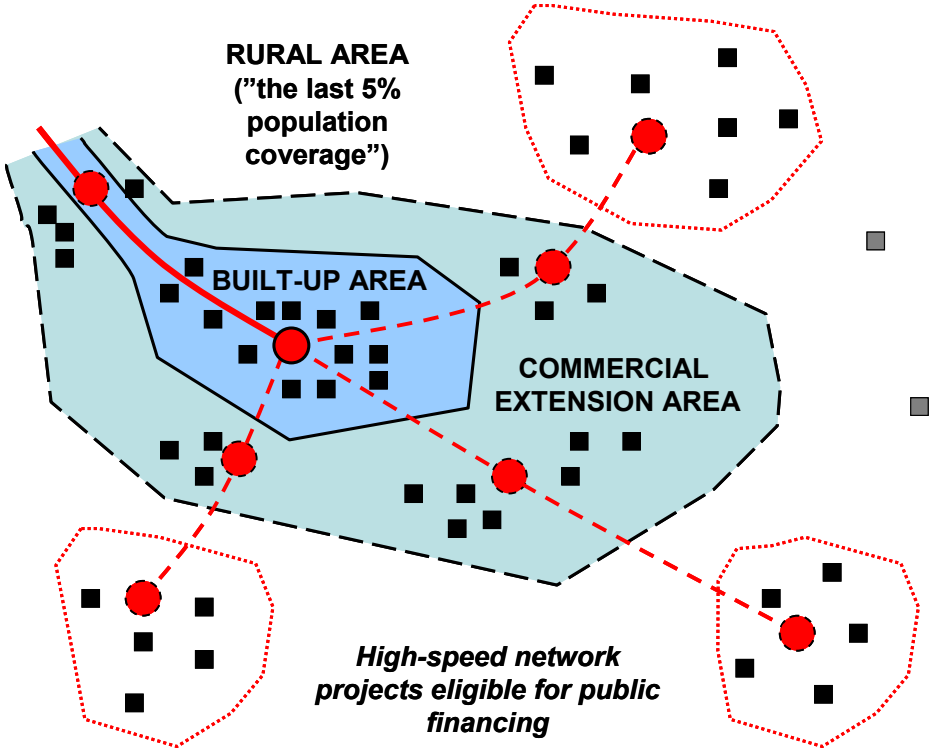
2. Nearly all (> 99%) of Finnish citizens, businesses and public administration bodies should have access to "high speed networks" with at least 100 Mbps by the end of 2015. These NGA networks should be in a reach of at least two kilometres of the end-user.

Moreover the measure is backed by the Act on Broadband Construction Aid in Sparsely Populated Areas 1186/2009.

The notified measure refers to the second target of the national plan. In this context, public aid is granted for building the NGA (backhaul) networks in specific areas.[79] The measure covers both passive and active infrastructure elements. As the Finnish authorities assume that 95% of Finnish citizens, businesses and public administration bodies will be achieved by the NGA roll-out of commercial network operators, only infrastructure deployment for the remaining areas will be subsidised (cf. Figure 2-15). This means that approx. 130,000 households in non-built-up areas where it is not economically viable for commercial operators are in the focus of this measure. These end-users are responsible for getting access to the subsidized backhaul networks at their own expense (if they are willing to use high speed internet services). In general, they can choose an arbitrary access provider and the technology which fits their needs and willingness to pay. The Finnish authorities argue that subsidizing backhaul networks up to access points near to the end-users justifies the investment of end-users in the access network for bridging the last two kilometres.

79 If the distance from an end-user to the backhaul network is longer than 2 km, it is also possible to subsidise the part of the access line which is above the 2 km limit.

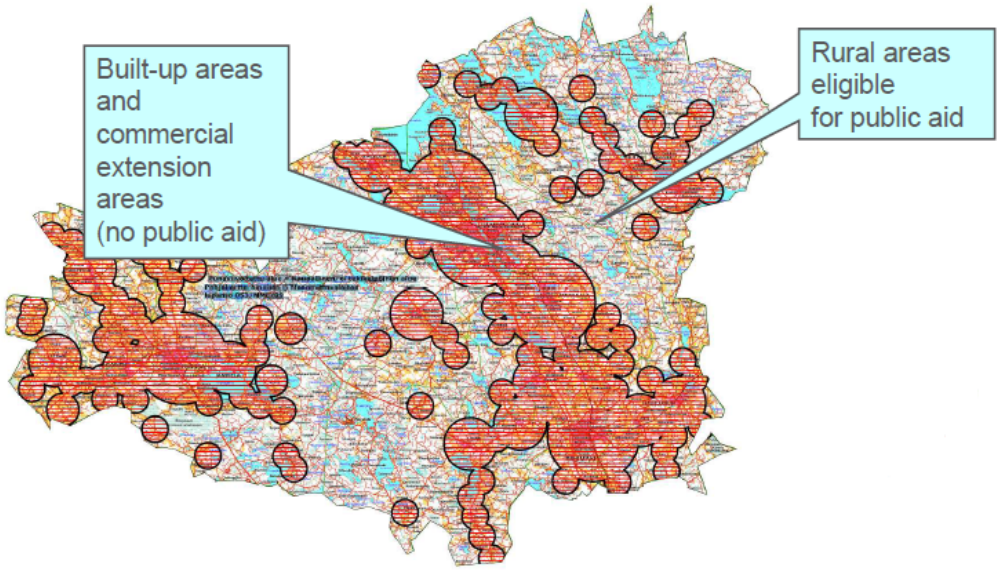
Figure 2-15: Basic principle of the Finnish approach



Source: Ministry of Transport and Communications Finland (2010)

Following the basic principle Finnish NRA FICORA has defined the "*estimated built-up areas in 2015*" and thus also the areas in Finland which are eligible for State aid in the context of the notified measure. Figure 2-16 shows the red marked "*estimated built-up areas in 2015*". In the other (less populated) areas no high-speed networks exist so far and will be deployed by a private operator in the near future, respectively. Only these areas are covered by the present measure. The final map of eligible areas has been published as a Government Decree in 2010.

Figure 2-16: Eligible areas in Finland



Source: Parantainen (2010)

The overall value of State aid is estimated at slightly more than € 130 million. The aid intensity per individual project is limited to 66% of the overall investment. The selected operators have to bear at least one third of the cost.[80] The aid will be granted either by FICORA or (in case of involving the European Agricultural Fund for Rural Development/EAFRD) by regional Centres for Economic Development, Transport and the Environment (EDTE) which are part of the regional governmental authorities. In the latter case the EDTE centres consult FICORA in order to ensure consistency over the different broadband projects. FICORA will in each case perform a market analysis and check whether a project is in line with the national aid legislation and (if applicable) give its opinion to the EDTE centres. Nevertheless, the EDTE centres keep the final responsibility for ensuring compatibility of a broadband project, but FICORA has a veto right.

The Regional Councils of Finland decide which broadband projects shall be initiated and they choose the respective operator for each project on an open tender basis. The selected operator has to offer all possible forms of wholesale services (incl. dark fiber, ducts) to third-party operators for at least 10 years after the network has been installed. FICORA will monitor the pricing development, will ensure that prices are at a reasonable level and will resolve disputes associated with access rights. The subsidised operator also has to provide either own retail services to end-users or to conclude an agreement with another operator who will serve the end-users. Retail services have to be provided for at least 10 years, too.

80 See European Commission (2010c).

Table 2-5 summarizes the main characteristics of the Finnish NGA project.

Table 2-5: Main characteristics of the Finnish case N 62/2010

Attribute	Specification
Decision type	Article 4 (3) – no objections[81]
Project type	National framework
Time frame	May 2010 – 2015
Broadband type	NGA
Level of intervention	Passive and active infrastructure
Type of intervention	Backhaul network (within a 2 km radius)
NGA technology	No requirements
Separation conditions	No requirements
Public ownership	No public ownership
Role of the NRA	"*Central Point of the Finnish broadband measure*"[82]

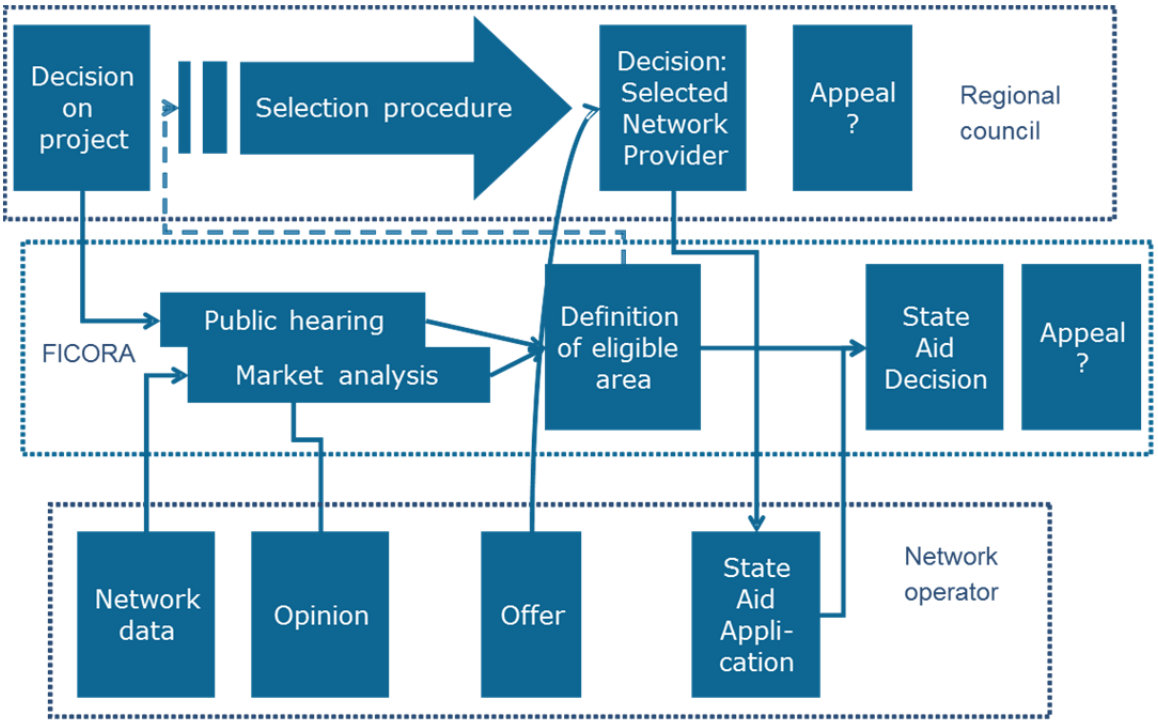
Source: WIK-Consult analysis

Overall, FICORA plays an important role in the preparation of local broadband projects (cf. Figure 2-17). Before granting State aid FICORA analyses the respective market and holds a public hearing in order to decide whether the intended area is eligible for State aid. After the selection of an operator by the relevant regional council FICORA decides about the demanded State aid taking into account the results of the market analysis and the public hearing. Moreover, FICORA grants the aid to the beneficiary if the application does not raise any concerns (e.g. with respect to distortion of competition). The aid will be paid out only after the network deployment has been finished. Moreover, FICORA manages a register of the broadband projects to which State aid has been granted within the notified measure.

81 Decision not to raise objections: After a preliminary examination, the EC finds that no doubts are raised as to the compatibility with the Common Market of the notified measure, in so far as it falls within the scope of Article 87 (1) of the Treaty.

82 See Ministry of Transport and Communications Finland (2010).

Figure 2-17: Relationships in the preparation phase of an State aid project in Finland

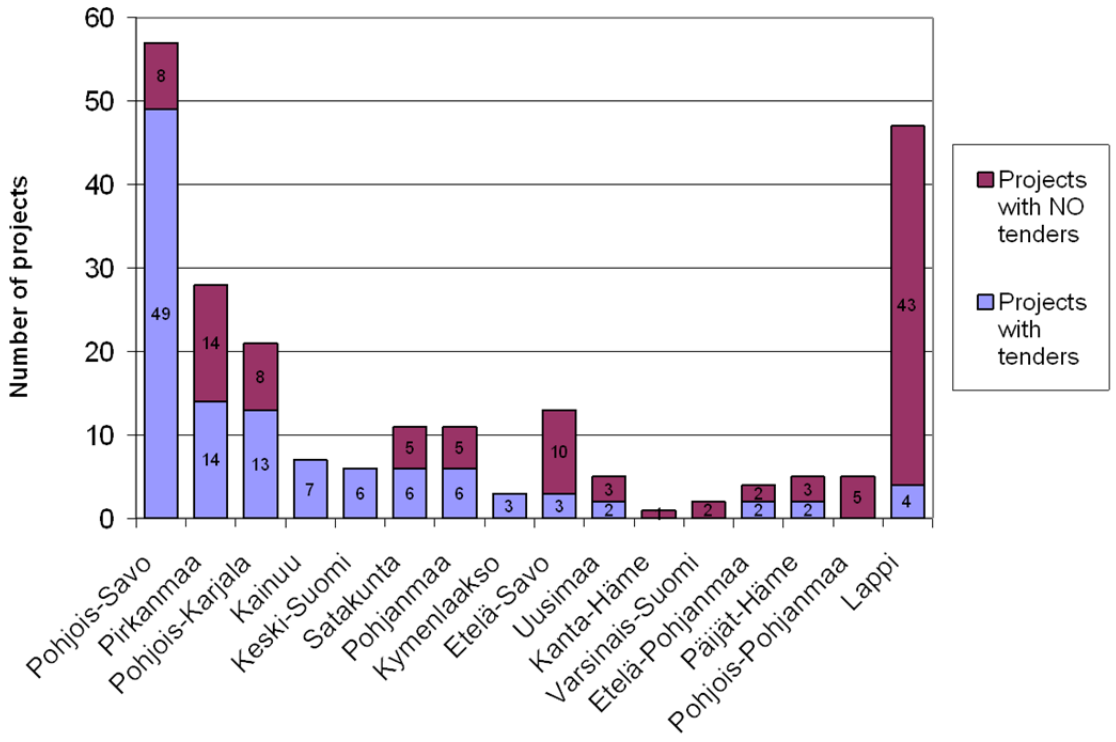


Source: Ministry of Transport and Communications Finland (2010)

Overall, about 800 broadband projects have been proposed by the Regional Councils. Depending on availability of public funds, demand for high-speed broadband services and interest of potential network operators the Regional Councils decide which of these projects will be initiated. Thus, it is not guaranteed that all of the possible projects will be implemented during the duration of the notified measure.

Up to the beginning of September 2011 the Councils have started 226 public tender processes. But applications were received only in 117 of these projects (cf. Figure 2-18), i.e. about half of the tender processes did not attract any operator. In most cases there was only one proposal per tender. Projects without an offer are located in most remote areas with a very sparse population, particular in the northern part of Finland. It seems that due to low density these intended projects are not viable for operators even if there is a public funding of up to two thirds. Thus, high-speed broadband infrastructure will not be available – neither on a commercial basis alone nor by support of State aid of up to two thirds – in regions that are defined too small due to significant unprofitability.

Figure 2-18: Results of calls for tender by region in Finland

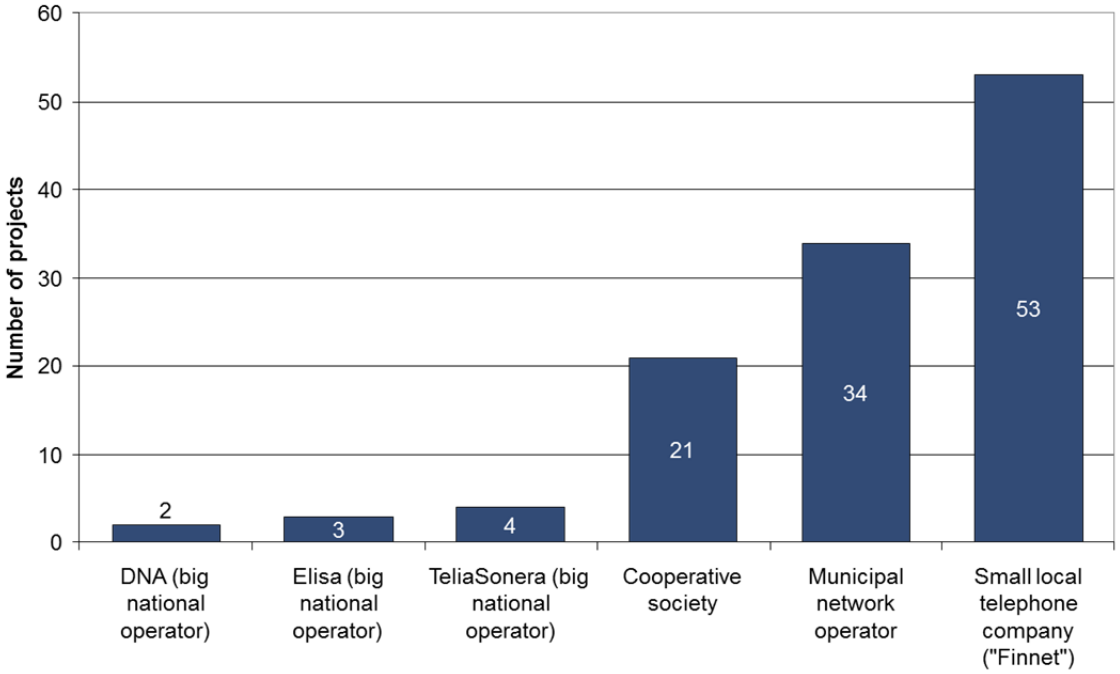


Source: Ministry of Transport and Communications

Proposals were mainly received from smaller local operators (telephone companies and municipal network operators, respectively) as well as from cooperatives (cf. Figure 2-19). The three big national operators DNA, Elisa and TeliaSonera participated only in some cases. Apparently, they prefer investment opportunities in other regions which are associated with higher economic incentives and/or lower risks.

Municipal network operators were typically founded for building networks in remote areas where it has become apparent that no commercial operator will be available. They are usually owned by a municipality or a group of municipalities in the region. In the same way, cooperative societies are small legal entities usually founded by local people or local companies in case that no commercial telephone company has shown interest to build a (subsidized) network.

Figure 2-19: Applications by type of operator



Source: Ministry of Transport and Communications

In about 70 of the 117 projects with an application an operator has been selected so far (beginning of September 2011). Mostly a P2P multi-fibre architecture has been chosen by the awarded operators. Only in some cases PON solutions will be deployed. Just six of these broadband projects have been completed recently and State aid is about to be paid out in two of these cases in the near future.[83] The six pilot projects show a wide spread regarding the share of end-users passed by the subsidized networks who are demanding access lines. As of May 2011 the respective figures are 2%, 20%, 23%, 40%, 50% and 53%. As in some of the project areas there are no wireline access networks available the operators are investigating the possibilities to offer access through wireless technologies in order to increase the end-user demand.

The Ministry of Transport and Communications is just doing a review of the notified measure which shall be finished at the end of 2011. A first input was collected by an open hearing on the functioning of the current scheme. Until now there are no indications that major changes will take place.

83 Source: Ministry of Transport and Communications.

2.7.2 Difficulties and experiences of the implementation of the measure in light of the Broadband Guidelines

Detailed mapping and coverage analysis (para. 51 a)

FICORA in all cases performs a detailed market analysis (including a public hearing) to assess the effects of the planned State aid on competition. For this purpose FICORA also collects network data from telecom operators annually, based on the Act on Broadband Construction in Sparsely Populated Areas. This data is used to map current network nodes from which operators offer or can offer broadband subscriptions of at least 100 Mbps.

Open tender process (para. 51 b)

The Regional Councils of Finland carry out tender processes in order to choose the respective operator for each project. They have to guarantee that the procedures run in an open, equal and non-discriminatory way. The Councils may individually decide about the place of publication (as long as no potential investor is excluded) and the time limit for the application. FICORA offers the opportunity to publish the tenders on the website of FICORA. So far all the Councils have used this opportunity to announce their tender processes.

The fact that the Councils received proposals only for about 50% of the tenders is not caused by the course of the tender processes itself. Moreover the economic prospects of the individual regions are the main factors influencing the response rate of the tenders.

Most economically advantageous offer (para. 51 c)

The Regional Councils are responsible for the definition of individual selection criteria for the projects. The criteria are specified by the Councils in advance and they should be objectively measurable. In order to achieve synergies the contact persons from different Regional Councils meet regularly and exchange experiences and best practices. Some of the Councils cooperate in the way that they have hired a common project manager for their Broadband aid measures.

Some requirements regarding the selection criteria are defined by law:[84]

- *"Amount of public aid applied, relative weighting at least 50 per cent.*
- *Fees to be collected from users (including subscription fees, monthly payments), relative weighting 0-50 per cent.*
- *Commitment to providing services longer than the minimum term of 10 years, relative weighting 0-20 per cent.*
- *Other similar economical or qualitative criterion, relative weighting 0-20 per cent."*

84 See Ministry of Transport and Communications Finland (2010), p 17.

Technology neutrality (para. 51 d)

The broadband projects follow the principle of technology neutrality. i.e. there is no specific technology prescribed by the Regional Councils. But the used technology must be able to provide a symmetrical data rate of at least 100 Mbps by the end of 2015. This requirement limits the relevant technologies to fibre and cable networks in the view of the Finnish government. In practice, mostly a P2P multi-fibre architecture is deployed and only in some cases PON solutions are implemented.

The Finnish authorities further argue that public aid should not be conditional on the use of a determined network infrastructure (such as P2P). In Finland, the broadband measure in fact targets at the most sparsely populated areas in which such an infrastructure deployment would not be viable and needed (regarding the number of competitors) in most of the cases.

Technology neutrality also applies to the open access to wholesale services based on the subsidized network. There must not be any technological restriction which limits the purposes for which the access to the network is used.

Use of existing infrastructures (para. 51 e)

The use of existing infrastructure is envisaged within the notified measure. In some project areas the existing infrastructure is used to connect the subsidized network with other networks.

Open access (para. 51 f)

The beneficiaries have to provide all possible forms of wholesale access to other operators on reasonable prices and non-discriminatory for at least 10 years. The obligations explicitly cover dark fibre, ducts, equipment facilities and network capacity. They deem to by very similar to the ones imposed based on SMP regulation. There are no indications that the obligation to offer wholesale access to the subsidized networks for 10 year is a specific obstacle to operators to take part in the Finnish broadband measure.

The obligations enter into force after the payment of the aid. As only six projects have just been finished and two of them are about to receive aid, there are no practical experiences regarding the implementation issues of open access. Demand for access to these subsidized infrastructures has not yet emerged but it is assumed that such a demand will arise in the future.

Benchmarking pricing exercise (para. 51 g)

The selected operators have to provide their wholesale service (after the final payment of the State aid) at reasonable prices which must be published. It is foreseen that FICORA ex post monitors that the wholesale prices are reasonable and if necessary

sets the level of the reasonable price. FICORA will collect information on wholesale NGN access prices and once there will be enough information for the benchmarking, the NRA will perform the relevant benchmarking of the prices. The concrete methodology is still open and will be finalized based on the experiences of the first cases.

If an operator does not comply with the pricing obligation, as mentioned above, the State aid may be reclaimed.

Claw-back mechanism to avoid over-compensation (para. 51 h)

A claw-back clause is part of each State aid decision. The application of a claw-back mechanism is subject to a funding threshold of € 1 million (which is calculated in a cumulative way across the different broadband projects of a beneficiary). Up to now only very few of the projects exceed this threshold.

FICORA (or if applicable an EDTE Centre in consultation with FICORA) will decide that an operator has to pay back a part of the profit that is more than 12 per cent above the anticipated profit (ROI) in the period of five years after the final part of the aid is paid. The part of the extra profit may be clawed back in the same proportion as the public authorities have financed the eligible costs of the project. The total amount that the operator has to pay back cannot exceed the State aid paid to the operator.

The beneficiaries are obliged to provide sufficient information for the purpose of overseeing that the terms of the State aid decision are observed. Ideally, they should submit a profit calculation of the subsidized project.

Further remarks on guarantees

The Finnish authorities argue that there is indication that in many remote areas, guarantees granted by municipalities would be necessary aid-instruments in order to implement the projects. The main reason for this argument is that the State aid is paid out only after the subsidized network is built. But until now the section on the compatibility assessment of State aid in the Broadband Guidelines does not separately discuss guarantees as aid instruments. The Finnish authorities therefore recommend, when renewing the Guidelines, to clarify the relation between the Commission Notice on guarantees and the Broadband Guidelines.

2.7.3 Summary of peculiarities of the case N62/2010 (FI)

- The measure covers the passive as well as the active network layer and the beneficiary has to provide both wholesale and retail services.
- The obligation to provide (wholesale and retail) broadband services has a long duration of 10 years.

- The NRA FICORA plays a central role in preparation, approval, granting and monitoring of the local broadband projects which fosters consistency between the projects and with regard to the SMP regulation.
- If the EDTE centres bear the overall responsibility for the approval of a local broadband project FICORA is involved at least in a consulting function and FICORA has a veto right.
- The payment of the State aid depends on finishing the network deployment, i.e. there is a strong incentive to complete the network deployment by the beneficiaries in time.
- The decision of initiating a broadband project rests at the Regional councils and thus involves specific local know-how.
- The publication of tenders is supported by a centralization via the website of FICORA.
- Basic requirements regarding the selection of the most economically advantageous offer are defined by law and the Regional councils regularly exchange their experiences about the tender processes among themselves.
- High level of price transparency as wholesale access prices must be published.
- New entrants in some of the project areas (in particular municipal network operators and cooperative societies) have increased competition in the broadband market at least slightly.
- The measure provides incentives for complementary investments as end-users have to invest in the deployment of access lines between their home and the subsidised networks in order to bridge a distance of at most 2 km.
- A beneficiary has to bear at least one third of the project cost which could be problematic in small regions with very low population density, i.e. if the regional clusters are too small to allow for a viable business case due to missing or low opportunities for internal cross-subsidisation.
- Depending on the source of the funds there may be a different overall responsibility, i.e. FICORA or the EDTE centres decide about the eligibility of a project.
- Access obligations become relevant only after the payment of aid (which itself takes place after finishing the network deployment) so that access seekers can compete with the beneficiary only with a delay.

2.8 Case study 6: N746/2006 (UK) – North Yorkshire NYNET Project

2.8.1 Main characteristics and development of the project/measure

The State aid measure "NYNET North Yorkshire Advanced Broadband" (NYNET) has been notified by United Kingdom (UK) authorities on 15 November 2006. The measure was approved by the European Commission on 21 February 2007. The project is focused on improving the availability of backhaul connectivity in North Yorkshire in order to enhance the availability of broadband access, in particular with transmission rates above basic broadband services.

North Yorkshire authorities faced the problem that most parts of the region were lagging behind regarding broadband availability and that there were no prospects that this might change under market-economy conditions within a few-year period. Based on specific research the authorities identified two main reasons for this situation:

- Cost for backhaul connectivity from the incumbent and market-dominant operator BT: These costs were considerably higher than in more densely populated areas due to large distances in North Yorkshire.
- Population density in North Yorkshire: The density is low and leads to only a small number of potential broadband subscribers and thus generates small incentives for network operators to invest.

The notified measure addresses primarily the first of these challenges. It aims at the creation of a backhaul ring infrastructure with points of presence (PoP) that are in a distance of at most 25 km to nearly all 132 exchanges in the respective region. The operator of the backhaul network ("technology partner") has to deploy all passive and active network elements and he is in charge of operating the network. The technology partner is not allowed to provide end-user services itself. Its scope is limited to the provision of network capacity to third parties. In order to provide end-user services to residential and business users, respectively, service providers have to assemble the access network using any technology (e.g. copper, fibre, wireless) which meets their commercial requirements in combination with the backhaul services of the technology partner.

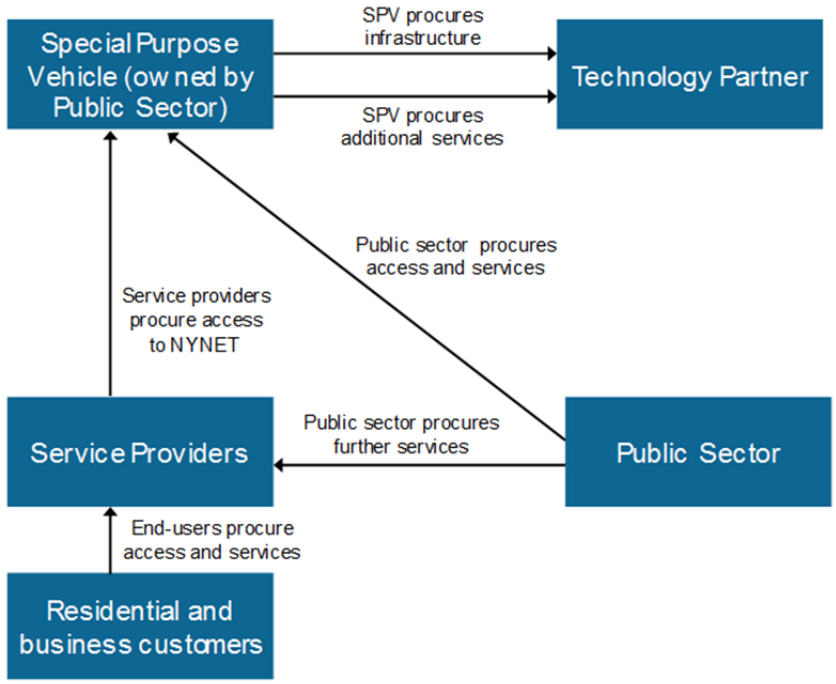
The marketing of the subsidized network is not part of the technology partner's responsibility. This is done by a public-sector Special Purpose Vehicle (SPV). The SPV has been formed in April 2007 and was named NYnet.[85] It is controlled by the North Yorkshire County Council.[86] The SPV purchases the contractual right to use the network (including the right to sublicense network capacity to service providers) from the technology partner for a scheduled period of 10 years. On the one hand, the SPV provides

85 See Lister (2008).
86 See European Commission (2007c).

wholesale access (DWDM) to the subsidized backbone to third-party operators on a transparent and non-discriminatory basis. On the other hand, the SPV directly provides (VPN) broadband services to the public sector in North Yorkshire. The first public sector customer signed contract with NYnet in January 2008.[87] As of July 2011, NYnet has 14 public sector customers with a multiple number of sites.

The following Figure 2-20 gives an overview of the basic structure of the NYNET approach and the relationship between the involved parties/operators.

Figure 2-20: Basic structure of the NYNET approach

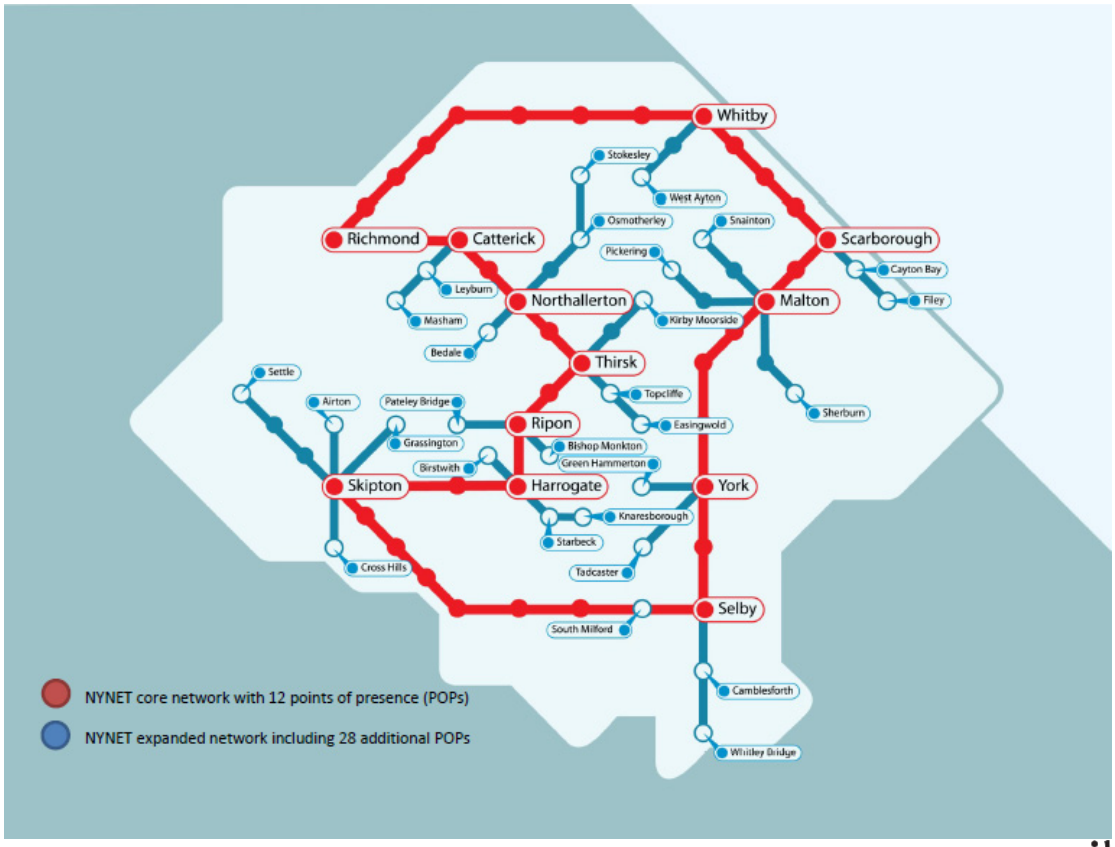


Source: WIK-Consult on the basis of NYnet

The selection of the technology partner followed an open tender process via the Official Journal of the European Union (OJEU). This process was set up as a negotiated procedure, which in the end led to three bids. Based on a mix of different criteria BT was selected as the awarded operator for the backhaul network. As the project is widely based on existing infrastructure BT had to deploy only 12 new POPs in North Yorkshire which were integrated in the existing core network of BT (cf. Figure 2-21). The NYNET project offers connectivity to service providers and/or the public sector only beyond these new POPs and not beyond any of the existing POPs in order to avoid distortion of competition. NYNET expanded its reach on top of the POPs in the core network of BT by 28 additional POPs which are located behind the State aid funded POPs of BT.

87 See Lister (2008).

Figure 2-21: Network structure of NYNET



Source: NYnet

Up to now, eight service providers/channel partners are already working with NYnet in order to provide end-user services to residential and business customers. In the first two pilot projects for residential customers symmetrical broadband speeds of 10 and 20 Mbps, respectively, became available to end-users.[88]

The public financing of the project derived from several institutions' funds, namely the European Regional Development Fund (ERDF), a Regional Development Agency grant and funding from North Yorkshire County Council.

Table 2-6 summarizes the main characteristics of the NYNET project.

88 See NYnet homepage: http://www.nynet.co.uk/index.php.

Table 2-6: Main characteristics of the UK case N 746/2006

Attribute	Specification
Decision type	Article 4 (3) – no objections[89]
Project type	Individual regional case
Time frame	February 2007 – December 2016
Broadband type	Supports a priori basic broadband and NGA
Level of intervention	No limitation on a certain layer of the infrastructure
Type of intervention	Core network/PoP
NGA technology	Not applicable (as access network is not part of the measure)
Separation conditions	Integration of passive layer and active layer on the level of the beneficiary, separation of retail layer
Public ownership	No public ownership
Role of the NRA	Consulted in the preparation of the measure, no active participation

Source: WIK-Consult analysis

2.8.2 Difficulties and experiences of the implementation of the measure in light of the Broadband Guidelines

Detailed mapping and coverage analysis (para. 51 a)

The North Yorkshire authorities performed an extensive market analysis and consultation exercise involving all market players. The main challenge with regard to the mapping analysis was to gain reliable information from telecom operators about their development plans within the next 3 years. One major operator refused to give detailed information and limited its feedback to broad pronouncements on ambitions for national coverage. Other operators adopted similar positions, too.

From the perspective of NYnet the process would have been easier and faster if the authorities would have had the opportunity to make their own forecasts after there has been no meaningful responses by operators about the likely development in the near future instead of repeatedly asking for sound information.

Open tender process (para. 51 b)

The tender process took place in an open manner on a European level using the Official Journal of the European Union (OJEU). The negotiated procedure led to a total of three offers. All bidders were telecoms operators. The low number of bidders might be a result of the fact that the project strongly relies on existing core network infrastructure.

89 Decision not to raise objections: After a preliminary examination, the EC finds that no doubts are raised as to the compatibility with the Common Market of the notified measure, in so far as it falls within the scope of Article 87 (1) of the Treaty.

Most economically advantageous offer (para. 51 c)

The selection of the successful bidder followed the principle of the most economically advantageous offer. On the one hand, the assessment was designed to minimise the cost of investment and the associated public funding. On the other hand, the process aimed at ensuring an appropriate level of service and a maximal coverage with the given limits of public funding.

Technology neutrality (para. 51 d)

The tender process did not force a specific technological approach for the creation of the desired backhaul ring infrastructure. Rather, the requirements of the tender referred to a defined level of service which has to be fulfilled by the tenderer. The concrete technical design was proposed by the bidders.

As the deployment of access networks is not part of the notified measure there were no limitations or requirements regarding the access technologies which may be used by the service provider in order to serve end-users.

Use of existing infrastructures (para. 51 e)

In order to avoid unnecessary duplication of physical infrastructure and to minimize the investments the use of existing (owned or leased) infrastructure plays an important role in the NYNET project. However, the project is not intended to provide the same network services that are already in place in the North Yorkshire territory and that are implemented on the existing infrastructure (e.g. distance related leased lines, xDSL wholesale or retail services). Rather, the focus is on DWDM based backhaul connectivity to specific PoPs in the territory which is not distance related as far as pricing is concerned.

Open access (para. 51 f)

Passive access usually is assessed to be less distortive, but the project experiences show that in remote rural areas there are not sufficient incentives for operators to invest in active equipment. Understanding the reluctance of market players to invest substantial capital in the North Yorkshire territory proved the case for the need for both passive and active access to subsidised infrastructure.

Benchmarking pricing exercise (para. 51 g)

Price obligations were set against national benchmarks of comparable services based on the regulated infrastructure of BT. These prices were published on an open and transparent basis by BT. Against this background the benchmarking process did not pose specific challenges.

Claw-back mechanism to avoid over-compensation (para. 51 h)

The subsidised operator receives payments only for specific bandwidth and services procured by the SPV over the duration of the contract. As the prices for these services follow the regulated prices of BT the possibility of excess profits is virtually excluded.

NYnet as a public sector owned special purpose vehicle markets the infrastructure to service providers and retains any margin to reinvest in other activities of public interest in the context of the present project. In particular, any surplus should be used within the notified measure

(i) to achieve a greater broadband coverage,

(ii) to offset the contribution from State funds,

(iii) to reduce bandwidth charges imposed on public sector users, or

(iv) to support the provision of digital public sector services in the most socially challenged areas.

Further topics

The project had limited success with regard to promote investments in NGA networks due to its limitation on the backhaul infrastructure[90]. The authorities concluded that the problem of insufficient broadband coverage in North Yorkshire could only be overcome with a backhaul plus access (NGA) solution. Subsequently they notified another State aid measure (N559/2009, Extension of Next Generation Broadband in North Yorkshire) in order to overcome this challenge.

2.8.3 Summary of peculiarities of the case N746/2006 (UK)

- Aggregation of demand of the public sector via the SPV.
- Public availability of regulated wholesale prices as a basis for price benchmarking.
- Reinvestment of any surplus of the SPV.
- Measure is limited to the backhaul network and does not support the deployment of access networks.
- Extensive use of existing infrastructure.

90 This can be illustrated e.g. by the comment of one of the major ISPs: "… Even if NYnet backhaul were free – we would still not invest in North Yorkshire …" (source: NYnet).

2.9 Case study 7: N267/2005 (UK) – Rural Broadband Access Project

2.9.1 Main characteristics and development of the project/measure

The State aid measure "Rural Broadband Access Project" (RBAP) has been notified by UK authorities on 31 May 2005. The project was approved by the European Commission on 05 October 2005. At this time the Broadband Guidelines were not yet in force but the approval already took into account main principles which later became part of the Guidelines. The notified measure targets at the deployment of an open wholesale broadband network (West Midlands Regional Broadband Network/WBRBM) in the three rural territories of West Midlands, South West England and East Midlands.

The geographical remoteness as well as the rural nature of these determined areas result in a lack of investment of private communications providers in adequate broadband infrastructure. For that reason the Regional Development Agency for the West Midlands, "Advantage West Midlands" (AWM), decided in the context of its strategy for sustainable economic growth to foster the availability of affordable broadband services. The Regional Development Agencies of the South West of England and the Middle East Region affiliated themselves to AWM in order to create synergies when deploying broadband infrastructure within their regions.[91]

The RBAP project in detail aims at the rural regions of the three territories which are currently not served and where there are no plans for commercial broadband deployment in the near future. The operators are selected by an open tender procedure as this is seen as an appropriate tool for minimising the State aid due to competition between bidders. The beneficiaries are obliged to offer wholesale broadband services to arbitrary Internet Service Providers (ISP) as long as they operate the subsidised network (which must be at least until end of March 2010)[92]. Their wholesale services must allow for end-user offers with a minimum bandwidth of 512 kbps downstream and 256 kbps upstream. Further technological requirements were not specified, i.e. the measure follows the principle of technology neutrality. ISPs will offer retail broadband services to end-users at conditions and prices that should be comparable to those of BT in urban areas. The chosen operators may also provide their own retail services to end-users.

The public funding of the infrastructure providers is allocated by the Regional Development Agencies of the three territories. It is paid as a one-off fee at the time of starting the provision of network services as defined in the contracts with the beneficiaries. The funding only covers capital cost for the deployment of the networks but no operational

91 At the time of this analysis AWM was in the final stage of closing down and all staff actively involved in the RBAP had left already and were no longer available for advice/comment in spite of all attempts. In addition, as part of the closure process the project files have been sent for archiving off-site. Even though the contact person of AWM supported our survey at its best our analysis is mainly based on desk research.

92 At least one of the awarded operators discontinued its service after this period due to lack of commercial viability.

costs of the beneficiaries. The public authorities do not take ownership of any broadband infrastructure or telecommunications equipment deployed.[93]

Table 2-7 summarizes the main characteristics of the Rural Broadband Access Project in UK.

Table 2-7: Main characteristics of the UK case N 267/2005

Attribute	Specification
Decision type	Article 4 (3) – no objections[94]
Project type	Regional programme
Time frame	October 2005 – December 2006
Broadband type	Basic broadband
Level of intervention	No limitation on a certain layer of the infrastructure
Type of intervention	Backhaul and access network
NGA technology	Not applicable
Separation conditions	No requirements
Public ownership	No public ownership
Role of the NRA	Not defined

Source: WIK-Consult analysis

AWM founded the West Midlands Networking Company Ltd. (WMNC) in January 2003 already. WMNC became responsible for preparation and implementation of the notified measure on behalf of the all three Regional Development Agencies involved in the RBAP. Apart from this, WMNC itself delivers a data transfer network system with appropriate network services across the West Midlands to public sector subscribers of the WMRBN.[95] WMNC is a not for profit business, delivering the WMRBN wholesale services for the benefit of the region, reinvesting any surplus funds back into the WMRBN.[96]

WMNC defined the geographic areas where no broadband is available or foreseeable on the basis of postal codes. Each of these (about 70) areas was treated as an individual lot in the open tender process. Potential operators could bid for individual lots as well as for all lots as a whole. Overall, WMNC received proposals from 11 bidders for the areas in the West Midlands territory.[97] The tenders were evaluated by WMNC involving an internal peer review in order to guarantee transparency and compliance with

93 See European Commission (2005b).
94 Decision not to raise objections: After a preliminary examination, the EC finds that no doubts are raised as to the compatibility with the Common Market of the notified measure, in so far as it falls within the scope of Article 87 (1) of the Treaty.
95 This service is not part of the notified measure. i.e. no State aid is granted for this service.
96 See AWM (2005).
97 See West Midlands Networking Company (2007). The bids in each case referred to a group of lots.

relevant procurement requirements. The assessment of the tenders was based on a weighted matrix scoring system.

Beside the required amount of State aid wholesale access pricing represented an important criterion for the evaluation of tenders. Potential operators had to illustrate in their tenders in which way they will set their access prices. Bids with pricing schemes that allow ISPs to set end-user prices comparable to those on similar networks were rated with higher values. As a reference point for the assessment of wholesale and retail prices, respectively, WMNC used those of BT which was assumed to be the industry standard at that time.

In order to avoid over-compensation the notified measure includes a specific claw-back mechanism. This is based on the idea that a beneficiary does not achieve excessive profits caused by the State aid in comparison to an alternative investment at the operator's internal rate of return. The awarded operators have to report the relevant figures for the respective calculation on an annual basis from the date of starting the service until end of March 2010. The data of the operator are assessed by an specialised consulting firm. The outcome of this assessment was, that none of the beneficiaries in the West Midlands territory achieved excessive profits.

Table 2-8: Key figures of the broadband activities in West Midlands

Broadband activities in West Midlands	Number of premises passed	Coverage in % of West Midlands	Ready for service
State aid to BT (24 exchanges)	6,304	0.26%	May 2006
State aid to Avanti (18 lots)	1,097	0.04%	July 2006
State aid to Qicomm (18 lots)	871	0.04%	December 2006
Sum of the notified measure	**8,272**	**0.34%**	**—**
Individual grants (RBAG/RABBIT)[98]	728	0.03%	November 2007
Sum of all public aid schemes	**9,000**	**0.37%**	**—**
Commercial activities	**n/a**	**99.63%**	**—**
Overall	**n/a**	**100.00%**	**—**

Source: WMNC

98 RBAG = Rural Broadband Access Grants (grants for individuals) .
RABBIT = Remote Area Broadband Inclusion Trial (grants for businesses).

In the West Midlands territory three carriers have been selected for deployment of broadband infrastructure: BT, Avanti and Qicomm. BT enhanced the broadband coverage in the West Midlands by upgrading 24 exchanges to ADSL (cf. Table 2-8). This increased the broadband coverage of 99.63% (which was achieved by commercial activities) by 0.26%. Avanti and Qicomm each won 18 lots which could not be reached by the ADSL solution of BT. Both operators built wireless networks which in sum results in a rise of another 0.08% for the broadband coverage. Nine smaller lots were not contracted because the low population density made them uneconomic and they have been covered by individual grant schemes.

As of November 2007, the broadband coverage in West Midlands reached the target of 100%. WMNC declared its insolvency in August 2008 and has been dissolved in November 2009.[99]

2.9.2 Difficulties and experiences of the implementation of the measure in light of the Broadband Guidelines

Detailed mapping and coverage analysis (para. 51 a)

As market data have shown that West Midlands on average is well served in terms of broadband coverage the authorities had to provide meaningful information about shortcomings in specific geographic areas within the territory. WMNC met this challenge by defining the relevant areas for the notified measure on the basis of postal codes taking into account information about the present broadband coverage of individual operators and foreseeable developments of infrastructure deployment.

Open tender process (para. 51 b)

In order to receive a high number of proposals the tender process followed a two stage approach. First, operators were publicly invited via the Official Journal of the European Union (OJEU) to express their interest. This phase was supported by an event where potentials operators were informed about the intended project. Based on the expressions of interest selected operators were invited to submit proposals in the second stage of the tender process.

In line with the objective of increasing the number of bidders and to strengthen competition within the tender process interested operators could bid for individual lots as well as for all lots within the territory as a whole.

99 See http://opencorporates.com/companies/gb/04627011.

Most economically advantageous offer (para. 51 c)

The selection of the successful operators was based on a weighted matrix scoring system. One of the main important criteria was the amount of State aid required by the bidders. Moreover the wholesale access pricing played an important role in the selection process. Bids with pricing schemes that allow access seekers to set end-user prices comparable to those on similar networks were rated with higher values.

Technology neutrality (para. 51 d)

The tender did not specify a certain technology to be deployed in the unserved areas. From a technological perspective only a minimum downstream and upstream bandwidth were required. This approach resulted in an optimal mix of different technologies. BT was deploying ADSL solutions in its areas while Avanti and Qicomm complementarily installed wireless networks in the remaining areas.

Use of existing infrastructures (para. 51 e)

There is no information available whether the use of existing infrastructure was of relevance for the Rural Broadband Access Project.

Open access (para. 51 f)

The selected operators have to provide wholesale services to any access seeker. This obligation is relevant as long as the subsidised network is operated by the beneficiary. There are no details available about the concrete wholesale services which were offered by the operators.

Benchmarking pricing exercise (para. 51 g)

Price obligations take into account wholesale as well as retail prices. In both cases the prices of BT are used for benchmarking. These prices are published so that benchmarking pricing exercise does not impose a challenge.

Claw-back mechanism to avoid over-compensation (para. 51 h)

The assessment of profits takes place annually until the end of the minimal operational period (March 2010). The beneficiaries are obliged to report the relevant data to WMNC. There is no information available whether excessive profits could be identified and the claw-back mechanism came into force for one of the beneficiaries.

2.9.3 Summary of peculiarities of the case N267/2005 (UK)

- The beneficiaries are obliged to offer wholesale broadband services to arbitrary access seekers as long as they operate the subsidised network.
- The public funding is paid as a one-off fee at the time of starting the provision of network services.
- WMNC became responsible for preparation and implementation of the notified measure on behalf of the all three Regional Development Agencies involved in the RBAP.
- Wholesale access pricing represented an important criterion for the evaluation of tenders.
- In the West Midlands territory three carriers have been selected for deployment of broadband infrastructure, resulting in a mix of wireline and wireless technologies which from the perspective of WMNC allows an optimal broadband coverage under cost-benefit considerations.
- Some lots were not attractive and received no tenders so that they had to be supported by other funding schemes.
- Insolvency/dissolving of the organisation responsible for implementation and monitoring of the measure before the end of the minimum required operational period.

2.10 Case study 8: N284/2005 (IRL) – Metropolitan Area Network Broadband Program

2.10.1 Main characteristics and development of the project/measure

The "Regional Broadband Programme: Metropolitan area Networks (MANs) – phases II and III" has been notified by the Irish authorities on 10 June 2005. The measure was approved by the European Commission on 08 March 2006.[100] Its main objective is to deploy fiber based open backhaul infrastructures in up to 123 towns all over Ireland where the respective infrastructure is not yet available. The measure builds upon a phase I which was launched in 2002 and already covered 26 towns in Ireland. At the end of the project open fibre infrastructures shall be available in all towns with a population of at least 1,500 people. Phase I is not part of the notified measure which is described in this section.

Against the background that there have been too little incentives for commercial operators to invest in next generation broadband infrastructure and an increasing digital lag regarding broadband availability for the Irish population and businesses, the Irish Government took a leading role in the roll-out of an open access wholesale broadband infrastructure. Under the National Development Plan 2000-2006[101], the Irish Government put aside € 200 million for funding broadband infrastructure projects, primarily for the MAN project.

The measure addresses the passive layer as well as the active layer of NGA networks.[102] But the involvement of the public authorities differs between these two layers:

1. Passive layer: The passive layer comprises the deployment of passive infrastructures for the MAN. Local and regional authorities receive funds from the central government and add their own funding. The authorities commission civil works for the deployment of network infrastructures (ducts, fibers) and for the construction of operator-neutral co-location facilities. The passive infrastructures are completely funded by public authorities and therefore remain in ownership of the Irish state.
2. Active layer: The active layer involves the management of the MAN infrastructure and the provision of wholesale services: The management, activation (i.e. deployment of active telecommunications equipment) and commercialization of the network infrastructure is carried out within the framework of a public-private-partnership by a private-sector management service entity (MSE). The MSE has to offer wholesale services and access to the passive infrastructure (i.e. ducts

100 See European Commission (2006a). The following part of this section is mainly based on this information and on desk research.

101 For further information see: http://www.ndp.ie/documents/publications/ndp_csf_docs/NDP_complete_text.pdf.

102 The underlying three layer concept is illustrated in the case study of Amsterdam for example (cf. Section 2.5).

and dark fibers) to third-party operators on an open and non-discriminatory basis. In order to ensure neutrality of the MSE the MSE is not allowed to provide retail services and the MSE must not be owned or controlled by an electronic communications operator who provides services on the basis of the MAN.

Table 2-9 summarizes the main characteristics of the Metropolitan Area Network Broadband Program (Phase II/III) in Ireland.

Table 2-9: Main characteristics of the Irish case N284/2005

Attribute	Specification
Decision type	Article 4 (3) – no objections[103]
Project type	National programme
Time frame	March 2003 – 2008
Broadband type	NGA
Level of intervention	Passive infrastructure
Type of intervention	Backhaul network
NGA technology	Not applicable (as access network is not part of the measure)
Separation conditions	Differentiation of three layers (passive layer, active layer, retail layer) with open tender process on the second layer and non-discriminatory open access to the third layer; limitation of the MSE to the active layer
Public ownership	Passive infrastructure and PPP on the wholesale layer
Role of the NRA	Not defined

Source: WIK-Consult analysis

The privately-owned company E-Net won out of 44 applicants the open tendering process for the MSE.[104] In 2009 the authorities contracted E-Net for a period of 15 years from start of service operation.[105] E-Net does not gain any direct public funding, rather it has to make payments to the Irish authorities in terms of a Service Confession Fee which consists of three elements: (1) a revenue share related to the sales of infrastructure, (2) a bonus revenue share for achieving predetermined profitability levels, and (3) an annually agreed amount for profits from infrastructure reinvestment. After the contracting period E-Net has to confer the active network (including its own investments), its customers and any other assets associated with the active network to the Government. E-Net has to fulfill reporting requirements on several performance indicators towards the government on a quarterly basis.

103 Decision not to raise objections: After a preliminary examination, the EC finds that no doubts are raised as to the compatibility with the Common Market of the notified measure, in so far as it falls within the scope of Article 87 (1) of the Treaty.
104 E-Net already won the tender process for MAN phase I in 2004.
105 See http://www.dcenr.gov.ie/Communications/Communications+Policy/Metropolitan+Area+Networks/.

The concession E-Net received from the Irish Government for operating in the telecommunications market contains the following features:

- "*Manage, maintain and market the MANs on behalf of the Irish Government in the knowledge that the asset always remains in the State's ownership.*
- *Provide fibre based services to authorized operators on a wholesale basis.*
- *Contribute to the development of the regions in Ireland through the open delivery of affordable, state of the art telecoms services.*"[106]

E-Net provides wholesale services to authorized operators only and does not have the right to provide end-user services itself. As of July 2011 customers of E-Net are for example: UPC, Vodafone, Aptus Broadband, BT, Magnet Business, Smart Telecom, AT&T, Cable&Wireless Worldwide, Strencom, CiaraCom IT Solutions, Plannet21, CIX, Verizon, HEAnet.

E-Net offers a wide range of unbundled products, in particular

- duct and sub-duct access,
- fibre ring/sub-ring access,
- P2P connections,
- drop connections,
- co-location facilities.

In July 2010, E-Net announced that it has successfully completed the handover process for Phase 2 of the MAN programme, covering exchanges in 66 additional towns. The deployment phase for the 66 towns only took 12 months compared to 18 months for 28 towns in phase I.[107] Figure 2-22 outlines the locations where MANs have been built during phase I and phase II of the MAN programme.

106 See E-Net homepage http://www.e-net.ie/e-net-the-mans.html.
107 See E-Net (2010).

Figure 2-22: Towns developed by the MAN programme

Source: E-Net (2010)

2.10.2 Difficulties and experiences of the implementation of the measure in light of the Broadband Guidelines

Detailed mapping and coverage analysis (para. 51 a)

The measure explicitly refers to towns only where no local fibre ring exists which is comparable to the envisaged MANs with regard to open and non-discriminatory access (in particular wholesale products and pricing). In order to secure this requirements local and regional authorities play an important role. Based on the local knowledge of authorities and their advisors they have to provide evidence that the planned MAN does not displace existing infrastructures. If a network operator claims that it already possesses an infrastructure the authorities have to proof whether this network will be suitable to meet the requirements of the intended MAN.

Open tender process (para. 51 b)

Both on the passive layer and on the active layer open tender procedures were applied. The local authorities awarded the construction of the passive networks to civil engineering companies on the basis of open and competitive tendering procedures. Moreover, the MSE responsible for construction and management of the MANs was selected by the Irish government in accordance with rules and principles on public procurement on the European level.

Most economically advantageous offer (para. 51 c)

The evaluation of tender followed a four step approach:

1. Assessment of administrative compliance.
2. Ranking of bids according to several criteria and selection of shortlisted tenderers.
3. In-depth evaluation of the shortlisted bids with regard to a set of selection criteria.
4. Negotiation with up to three bidders who lead the evaluation in step 3.

The proposals were assessed by an independent consultant on behalf of the national ministry.

Technology neutrality (para. 51 d)

The MANs deployed within the notified measure follow the principle of technology neutrality. The services offered by the MSE may be relevant for fixed line operators, wireless operators, mobile operators, Internet service providers, TV cable operators and solutions integrators.[108] The services are in no way limited by the fibre technology itself and they allow for different types of services (e.g. voice, data, entertainment).

108 See E-Net (2010).

Use of existing infrastructures (para. 51 e)

According to the Irish government the market situation in Ireland was characterised by a lack of alternative infrastructures at time of notifying the measure. Only the incumbent Eircom possessed relevant network infrastructure. But the existing infrastructure was not comparable with those of the MANs with regard to extent and reach nor with regard to the conditions under which this infrastructure was available to third parties. Against this background the use of existing infrastructure did not play an important role in the deployment of the MANs.

Open access (para. 51 f)

The MSE acts as a neutral wholesale operator. It is in no way involved in the provision of any retail services, neither directly nor indirectly via a separate entity or by an intertwining with a retail operator. This strict separation avoids conflicts of interest on the level of the MSE, e.g. with regard to forms or conditions of access to the subsidized infrastructure.

The MSE has to provide access on a transparent and non-discriminatory basis to arbitrary third party operators. The details of this open access obligations are defined in the rules of the concession agreement between the government and the MSE. The service conditions in the Dublin area serve as a reference for the access obligations to the MSE.

Benchmarking pricing exercise (para. 51 g)

The notified measure aims at uniform prices across the MANs in order to balance regional differences that are associated with traditional distance-based pricing. The details on wholesale pricing are defined in the concession agreement between the government and the MSE. The pricing conditions in the Dublin area serve as a reference for the pricing obligations to the MSE.

Claw-back mechanism to avoid over-compensation (para. 51 h)

The MSE has the right (and the obligation) to operate the MANs and to provide wholesale services. As a compensation for this right the MSE has to pay a Service Confession Fee to the government. This fee is designed to avoid excessive profits. In particular, any additional revenues from reinvestments of the MSE are shared between the government and the MSE.

2.10.3 Summary of peculiarities of the case N284/2005 (IRL)

- The Broadband program covers all towns with a population of more than 1,500 people but no rural areas.
- State aid funded investments are focused on the deployment of passive infrastructure.
- The public sector plays a strong role in order to avoid discrimination of market players.
- The measure rests on a strict separation between the wholesale and the retail layer.
- One single MSE is responsible for all MANs across the country securing unique access conditions for wholesale products.
- On the wholesale layer the measure is based on a PPP model, i.e. all investments of the MSE have to be handed over to the government at the end of the contract period.

2.11 Case study 9: N331/2008 (FR) – Réseau à très haut débit en Hauts-de-Seine

2.11.1 Main characteristics and development of the project/measure

The French authorities notified the project "Compensation de charges pour une Délégation de Service Public (DSP) pour l'établissement et l'exploitation d'un réseau de communications électroniques à très haut débit dans le Département des Hauts-de-Seine" (THD 92) on 27 June 2008.[109] The project was approved by the European Commission on 30 September 2009. The Commission came to the assessment that the notified measure does not constitute State aid, rather the project THD 92 was categorized as a service of general economic interest (SGEI) according to section 86(2) of the EC Treaty. The European Commission explained its decision by concluding "*that the public funding amounting to €59 million would be used to offset the cost of complying with the obligations of a service of general economic interest imposed following an open and transparent tendering procedure, and did not therefore constitute state aid. In particular, the compensation does not exceed the cost of rolling-out the network in the non-profitable areas of the French department. The Commission's examination found that the plan is in accordance with the precedent established in the Court of Justice 'Altmark' case and with the new Guidelines on the application of state aid rules to the financing of high-speed and very high-speed broadband networks*".[110]

In the department Hauts-de-Seine numerous French and international companies including SMEs are located. The French authorities are convinced that for these companies as well as for the citizens the availability of a reliable and future-proof electronic communications infrastructure is of great importance in order to achieve economic growth and productivity gains. Against this background the department of Hauts-de-Seine in 2004 decided to deploy passive infrastructure for a fiber based NGA network. The respective activities were integrated in the project THD 92.

The main objective of the project THD 92 is to deploy the relevant infrastructure within a time frame of six years in the whole department, even in the less densely populated areas. The resulting dark fibre infrastructure will be made available to third parties operating on the active network layer in an open and non-discriminatory manner. Wholesale prices for access to the subsidized infrastructure are the same all over the department of Hauts-de-Seine. The built infrastructure will allow service operators to focus on the active layer, which remains their sole responsibility. Private end-users, businesses or public institutions are free to choose between a wide range of service operators.[111]

109 The responsible authorities and contact persons did not provide specific information in our survey. The analysis is therefore (only) based on desk research of publicly available information instead.
110 See European Commission (2009b).
111 See European Commission (2009c).

In classifying the project as SGEI the four Altmark criteria play an important role. These criteria require that

1. "*the beneficiary of a State funding mechanism for an SGEI must be formally entrusted with the provision and discharge of an SGEI, the obligations of which must be clearly defined,*
2. *the parameters for calculating the compensation must be established beforehand in an objective and transparent manner, to avoid it conferring an economic advantage which may favour the recipient undertaking over competing undertakings,*
3. *the compensation cannot exceed what is necessary to cover all or part of the costs incurred in the discharge of the SGEI, taking into account the relevant receipts and a reasonable profit for discharging those obligations,*
4. *where the beneficiary is not chosen pursuant to a public procurement procedure, the level of compensation granted must be determined on the basis of an analysis of the costs which a typical undertaking, well run, would have incurred in discharging those obligations, taking into account the relevant receipts and a reasonable profit.*"[112]

Taking into account the information provided by the French authorities the European Commission concluded after a thorough investigation that the project THD 92 meets the aforementioned Altmark criteria.

Table 2-10 summarizes the main characteristics of the measure Réseau à très haut débit en Hauts-de-Seine.

Table 2-10: Main characteristics of the French case N331/2008

Attribute	Specification
Decision type	Article 4 (2) – no State aid/SGEI[113]
Project type	Individual regional case
Time frame	September 2009 - September 2015
Broadband type	NGA
Level of intervention	Passive infrastructure
Type of intervention	Backhaul and access network
NGA technology	FTTH
Separation conditions	Differentiation of three layers (passive layer, active layer, retail layer) with non-discriminatory open access to the second layer and competitive access on the third layer; limitation of the awarded operator to the passive layer
Public ownership	Passive infrastructure
Role of the NRA	Not defined

Source: WIK-Consult analysis

112 See European Commission (2009a), para. 21.

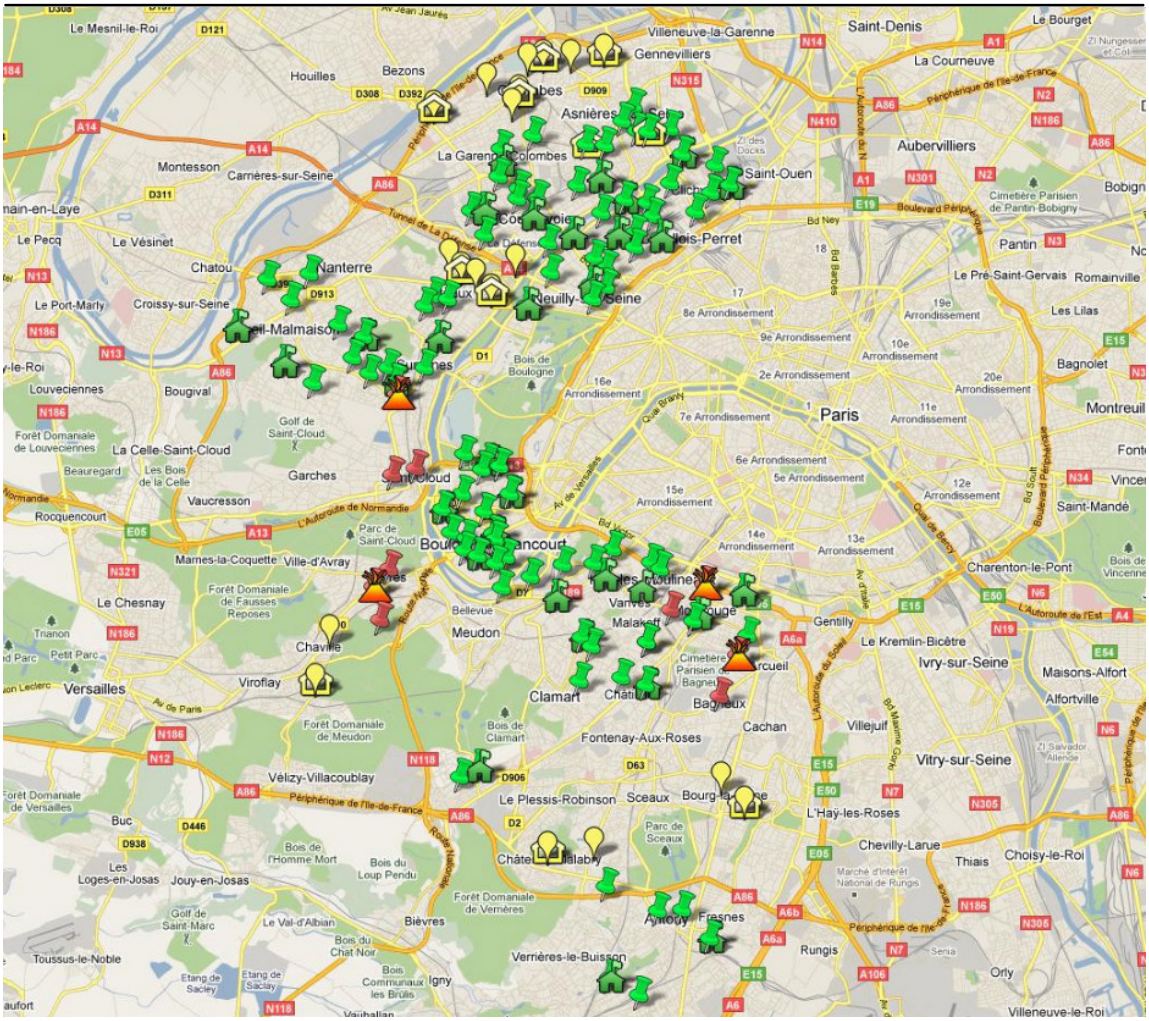
113 Decision that a measure does not constitute aid - where the European Commission, after a preliminary examination, finds that the notified measure does not constitute aid.

Based on an open tender process the French authorities in December 2007 awarded the contract for the passive layer of the fibre infrastructure to an industrial consortium called Sequalum. Stakeholders of this consortium are the network operators Numericable (80%) and LD Collectivités (5%), a subsidiary of SFR, as well as the construction company Eiffage (15%).[114] On the one hand, Sequalum is responsible for the deployment of the relevant infrastructure within a time frame of six years. On the other hand, the right to use the passive infrastructure is assigned to Sequalum exclusively for a contract period of 25 years.[115]

In the first deployment phase (2008 – 2010) the fibre infrastructure is rolled out in 26 communities of the department with more than 420,000 homes/businesses passed. The remaining 400,000 homes/businesses are passed with fibre infrastructure in the second phase (2011 – 2013). By deploying more than 2,500 km fibre cables, the NGA infrastructure will finally be available for all of the 750,000 homes and 80,000 businesses.[116] As Figure 2-23 shows the deployment seems to take place even faster than planned.

114 See Ichay & Mullenex Avocats (n.d.).
115 See Ichay & Mullenex Avocats (n.d.).
116 See ARCEP (2008), p. 83 et seqq. and ANACOM (2011).

Figure 2-23: Status of NGA deployment in the department Hauts-de-Seine



Green point: infrastructure has been deployed
Yellow point: infrastructure currently is deployed
Red point: infrastructure is not yet deployed

Source: Sequalum homepage

The total cost of the project are estimated to a sum of € 422 million. The public funding is limited to € 59 million. This financial support is granted in two instalments of € 25 million and € 34 million, respectively, according to the aforementioned deployment phases. The grant is designed as a compensation for the additional costs which are associated with the specific requirements of providing an SGEI (e.g. serving unprofitable areas). Despite the big share of private investment (approx. 86%) the infrastructure will remain at the department Hauts-de-Seine at the end of the 25 year contracting period.

As of July 2011 Sequalum has contracted with several network operators (e.g. Completel, SFR, Numericable, Bouygues Telecom, Free) who will provide wholesale and/or retail services on the basis of the subsidised infrastructure.

2.11.2 Difficulties and experiences of the implementation of the measure in light of the Broadband Guidelines

Detailed mapping and coverage analysis (para. 51 a)

Before notifying the measure the French authorities carried out an extensive market analysis. Based on the results of this analysis they concluded that the requirements regarding availability and performance of the fibre infrastructure in the department Hauts-de-Seine could not be met by any of the existing operators. Moreover it became obvious that the achievement of an universal NGA coverage without public intervention is highly unlikely within the relevant time frame due to high investments and low revenues in sparsely populated areas of the department.

Open tender process (para. 51 b)

For the selection of the operator the French authorities launched an open tender which was published on the European level as well as on the national level. Six potential investors expressed their interest. All of them were asked to make a proposal but only three bids were received. These bids were each submitted by consortia of telecommunications operators and constructing companies. The incumbent France Telecom expressed its interest in the project but it did not apply with a proposal due to the limitation of the compensation payment for providing an SGEI to a maximum of € 70 million.

Most economically advantageous offer (para. 51 c)

The selection of the most economically advantageous offer is based on a mix of several criteria with different weights. In practice, the assessment of bids takes into account the following dimensions

- Technical quality of the offer (weight: 40%).
- Amount of State funding required (weight: 30%).
- Consistency of technical and commercial characteristics with the objectives for NGA development in the department Hauts-de-Seine (weight: 20%).
- Deployment plan (coverage, speed and coherence) (weight: 10%).

The selection criteria were published in different bulletins of the department beforehand.

Technology neutrality (para. 51 d)

The fibre infrastructure deployed on the passive layer is designed as a FTTH architecture. The passive infrastructure does not force a certain technological approach for the provision of broadband services. Depending on the equipment installed by third party operators on the active layer the infrastructure could be used for broadband services based on P2P or P2MP topologies. In this sense the project THD 92 is technology neutral.

Use of existing infrastructures (para. 51 e)

The awarded consortium in its proposal widely relies on existing infrastructure. This approach allows for reducing the investment costs and for accelerating the deployment.

Open access (para. 51 f)

The passive infrastructure is provided to third party operators in an open and non-discriminatory way. The wholesale services of the awarded consortium Sequalum comprise the following products[117]:

- Long-term rights of use for fibers between MPoP and buildings for use within P2P or P2MP topologies;
- Long-term rights of use for fibers within buildings;
- Annual rental of dark fiber (P2P) as single fiber or fiber pairs;
- Co-location in the MPoPs;
- Interconnection with local broadband networks.

Benchmarking pricing exercise (para. 51 g)

The French authorities set guiding prices for the services of the awarded consortium Sequalum which are part of the contract with the consortium. These wholesale prices are uniform within the department. They are designed in a way that they should allow for end-user prices that are comparable to the prices of existing broadband services. Sequalum may request an adjustment of the wholesale prices for each existing services, up or down, by a margin of 15% once a year. Beyond this threshold, any change requires a formal amendment of the contract which has to be agreed by the General Council of the department Hauts-de-Seine.

Claw-back mechanism to avoid over-compensation (para. 51 h)

There is no information available regarding measures to avoid excessive profits.

117 See http://www.sequalum.net/operateurs/les-services-thd-seine/.

2.11.3 Summary of peculiarities of the case N331/2008 (FR)

- Public funding of the passive NGA infrastructure falls
- under the concept of SGEI.
- Infrastructure deployment covers 100% of the homes and businesses in the department.
- Public funded activities are limited to the passive layer so that competition on the active and retail layer in principle is not touched.
- Two of the three members of the awarded consortium are engaged on the active and/or retail layer, too.
- Contract period of 25 years for the right to use the passive infrastructure by the awarded operator.
- The passive infrastructure completely remains at the authorities of the department Hauts-de-Seine at the end of the contract period.

2.12 Case study 10: N596/2009 (IT) – Bridging the digital divide in Lombardia

2.12.1 Main characteristics and development of the project/measure

The Italian region of Lombardia has dealt with broadband coverage of its territory since 2005. At that time the regional authorities were beginning to set up a dialogue between ISPs and telecom operators in order to establish a better and deeper knowledge of broadband coverage, performance of the offered services and interest in new instruments. Fixed network operators like Fastweb, Colt, Albacom, Telecom Italia, Wind but also companies like Telespazio, Vodafone, Convecr, Infratel, Selex Communication, Prysmian, Alcatel-Lucent, Motorola, Enter, Ibax, Linkem and Sirti were included into this exploratory phase. The authorities received, however, mixed results, especially concerning broadband coverage, grey and white areas and possible threats of digital divide in mainly rural areas.

Having received such diverse information, Lombard authorities decided first of all to define the term lack of broadband coverage as having no broadband connection at all, with broadband being defined as having a connection (wired or wireless) to the Internet that guarantees 2 Mbps to every user. With more detailed specifications on broadband and coverage, the authorities were able to identify the relevant number of municipalities that were affected by a digital divide and the lack of broadband coverage. These municipalities were characterised by the absence of commercially viable and area-wide broadband offerings (xDSL, fibre or mobile) resulting in a digital divide.

In 2007 and 2008, several roundtables and workshops were organized with representatives from regional, provincial and local administrations, aiming at sharing proposed broadband strategies, defining priorities in broadband infrastructure, divulging information on broadband coverage and coordinating all working streams under a single direction.

After more than 3 years of consultation and investigation on the matter of digital divide in Lombardia, the final list included 707 municipalities, with roughly 1 million inhabitants. The remaining 840 municipalities in Lombardia with more than 8 million inhabitants are considered to be highly populated areas, where State aid is not necessary in order to bridge the digital divide as there are enough incentives to invest for telecommunications companies in broadband services. In addition, it was revealed that those areas affected by digital divide were characterised by very low business penetration rates, only 0.036 business per km^2 instead of 37 business per km^2 in Lombardia overall. Population density in digital divide areas was also significantly lower than in areas without digital divide: 153.7 residents per km^2 vs. 400 residents per km^2 on the whole territory.

Starting from February 2009, the region of Lombardia initiated a public consultation (through a website) in order to receive contributions from citizens, operators and asso-

ciations on the matter of broadband coverage. In particular, the aim of this consultation was to receive additional feedback on areas without broadband coverage and feedback on performance and price of existing access lines. Together with the previous evidence collected on the matter, the authorities were able to compare the findings of the consultation with existing material. About 650 citizens responded, mostly claiming inefficiencies in service provision, actual lower speed than advertised and high costs. The results of the consultation were incorporated in the conceptual design of the measure “Bridging the digital divide in Lombardia”.

The notified measure was approved by the European Commission on 08 February 2010. The main objective of the project is to expand the existing ADSL broadband coverage with a minimum of 2 Mbps to 99.7% of the population in Lombardia.[118]

The funded infrastructure covers both the backhaul and the access network. Public funds available are at € 41 million, equaling about 70% of the whole investment. The winning operator has to invest the remaining 30% of the investment, becoming the owner of the whole infrastructure under fulfillment of certain conditions. The ownership of the network would remain private, as long as wholesale and retail access would be transparent and non-discriminatory, in accordance to Italian law, i.e. in particular the network allows for equal access to every telecommunication operator within a reasonable pricing structure.

The call for tender was launched in August 2010, and the final decision on the winning bid mas made in December 2010. The tender aimed at creating an affordable network as a mix of optical fiber (to transport the high capacity flow) and wireless (or wired) technology to connect end-users. The authorities defined the tender by criteria like high performance, high coverage, up-to-dateness/sustainability, benefiting from the roundtable meetings and workshops with the relevant stakeholders in previous years.

Specifically, the criteria for the transport network were:

- Continuity in service provision, incorporating all consumers demanding broadband services, at adequate minimum broadband speed;
- Continuity in service provision, disregarding any service disruptions caused by weather conditions (e.g. rain, snow, lightnings, ...);
- Avoiding any interference with other existing networks;
- Ability to support local and regional online public administration processes;
- Ability to support services in the sector of telemedicine and video surveillance;
- Ability to use existing infrastructure or infrastructure which is soon to be installed.

118 See European Commission (2010b).

For the access network, the criteria were:

- Most robust network with the best performance and efficiency both for transport and access;
- Lowest possibility of capacity saturation over time and highest possibility for future capacity upgrades;
- Highest coverage regarding resident population in municipalities with digital divide.

As the funds will be granted only gradually (after 18 and after 24 months), the winning bid had to enclose a milestone plan of investment works, giving priority according to the intensity of presence in the territory of

- public administration (schools, hospitals, libraries, …),
- industry and SME business,
- citizens, and
- further priorities according to local authorities.

In addition to that, the winning bidder has to guarantee the operation of the infrastructure within 3 years, develop a solid business plan, reach break-even after a maximum of 4 years and guarantee the service provision at market prices (i.e. defining a maximum price range). The tender process admitted any telecommunications operator, be it a single company or a (temporary) consortium, with a particular regard on prohibited cross-ownership participations. The tender posed certain administrative and economic prerequisites (experience in wireline/wireless infrastructure, ISO 9001 certificate, at least a combined revenue from 2006-2008 of € 100 million and a combined revenue stemming of business with infrastructure from 2006-2008 of € 30 million).

The selected operator has to keep separate accounts, in relation to both the retail and the wholesale market, in order to preserve economic transparency and in order to facilitate financial profitability monitoring regarding the investment project. Eventual profits in excess will then be used to recoup part of the State aid granted in excess. For this purpose, the region of Lombardia will use the services of an external advisor, who after 4 years since start of broadband services will closely monitor financial and economic profitability and follow-up on cost development and subscription rates. In case of economic returns in excess of pre-defined maximum returns, the operator will have to return the difference between these two financial figures or the operator may by requested by the Region to re-invest the excess profits to expand the network to still unserved areas or to further improve the quality of the services provided.

Concerning technical and economic standards, the Lombard authorities made precise conditions that had to be met by the winning bidder. Activation costs for private con-

sumers and business consumers are not allowed to exceed € 50 and € 60 respectively. The maximum monthly flat fee tariff for basic broadband services of up to 7 Mbps allowed is at € 25 and € 35 for private consumers and business consumers respectively. Any other tariff and product schemes will have to exceed the performance requirements of the basic product offering. Technically, the broadband connection has to have an availability on an annual basis of at least 98%, with a factor of simultaneous usage of 90%.

Only two bids were received by the authorities, one from Telecom Italia (offering a fixed network solution) and the other one from a consortium consisting of Vodafone, Fastweb and Wind (offering a wireless solution). The proposals were evaluated by two external advisors and four internal experts.[119] Taking into account all relevant criteria the bid of Telecom Italia has been selected in December 2010.[120] Telecom Italia offered the implementation of a fibre infrastructure for the backhaul and the upgrade of hardware in the exchanges to provide ADSL service through twisted copper pair. The final agreement with the winning operator was signed in June 2011. The duration of the works in Lombardy is scheduled to last 24 months, deploying about 3,700 km of fibre.

By the end of October 2011, 80 municipalities are covered with ADSL services. Periodically, updates on roll-out status and municipalities covered are published by Lombard authorities every 2 months. A close cooperation with public authorities, local technical offices and Telecom Italia is being established. For example before envisaged technical and civil works start, the local authorities are informed and asked for their collaboration. This includes identifying existing duct structures that are able to contain fibre lines and facilitating permission for civil works in the targeted areas. Telecom Italia will chose its timing and work schedule according to the following priorities:

- areas where optical fiber or ducts are available;
- areas with high density of population;
- areas with high density of SMEs;
- areas with relatively easy geographical/geological characteristics.

119 See Regione Lombardia (2010a).
120 See Regione Lombardia (2010b).

Table 2-11 summarizes the main characteristics of the broadband measure for bridging the digital divide in Lombardia.

Table 2-11: Main characteristics of the Italian case N596/2009

Attribute	Specification
Decision type	Article 107 (3) – no objections[121]
Project type	Individual regional case
Time frame	February 2010 – June 2013
Broadband type	Basic broadband
Level of intervention	No limitation on a certain layer of the infrastructure
Type of intervention	Backhaul and access network
NGA technology	Not applicable
Separation conditions	Accounting separation
Public ownership	No public ownership
Role of the NRA	Not defined

Source: WIK-Consult analysis

2.12.2 Difficulties and experiences of the implementation of the measure in light of the Broadband Guidelines

Detailed mapping and coverage analysis (para. 51 a)

As outlined before, authorities faced some difficulties in creating a detailed overview of broadband coverage in the region. The careful mapping of broadband coverage was initially tackled by more or less intense round tables and workshops with major operators. The intent was to receive reliable information on areas of digital divide, in order to structure the tender process accordingly. But the process of detailed mapping and coverage analysis, which started back in 2005, was becoming more and more a lengthy process. As operators were struggling to compile and finish detailed mapping, the authorities turned towards public consultation in order to complete the remaining pieces of coverage analysis. It is with the help of 650 citizens who participated in the public consultation that the final mapping and coverage analysis was concluded successfully, so that the tender process could be initiated.

121 Decision not to raise objections: After a preliminary examination, the EC finds that no doubts are raised as to the compatibility with the Common Market of the notified measure, in so far as it falls within the scope of Article 87 (1) of the Treaty.

Open tender process (para. 51 b)

The Lombard authorities had to guarantee that the procedures would run in an open, equal and non-discriminatory way. All currently available information indicates that this was clearly the case. However, there were only two participants in the tender process (Telecom Italia and a consortium led by Vodafone). These two participants were covering most of the Italian telecommunications market, as with Telecom Italia, Vodafone, Wind and Fastweb, the four major operators were participating. It is worth noting that no smaller operator was participating in the tender process – be it because the tender was perceived to be less attractive or be it because there is an implicit perception that an individual bid would not be successful in any case compared to the possibility that the four major operators would participate and thus leverage their financial and infrastructural competency.

Most economically advantageous offer (para. 51 c)

The decision for a particular bid is based upon a balanced score that is computed for every bid. A set of criteria is compiled and listed by the authorities, who give their individual score and thus rate the presented project. Criteria include presentation, proposed architecture of infrastructure, factor of simultaneous usage, network dimension and transportation capacity, availability of broadband connections and coverage, signal latency, help-desk and call-center services, marketing and promotion activities and proposed timeline for service activation.

Technology neutrality (para. 51 d)

The tender requirements do not explicitly prefer a single technology platform. The two bids received in the tender process were based on different approaches (fixed network vs. mobile network).

But nevertheless technology neutrality posed a problem as the subsidised solution should guarantee a reliable, fast and secure network. Therefore, broadband satellite technologies were treated in a special way as from the perspective of the Lombard authorities these services are still lacking the necessary speed and other performance criteria in order to fulfil the broadband requirements set by the authorities. Download and upload speed via satellite are not perceived to be satisfying. In addition to that, the objective to use existing broadband infrastructure would not be met, as broadband services via satellite do not rely on existing telephone lines. Furthermore, broadband satellite equipment requires sometimes substantial infrastructure installations and costs (satellite dish) at the consumer premises. It is also assumed that broadband satellite technologies tend to establish de-facto monopolistic structures and to limit open access. Against this background broadband satellite technology could be of relevance in the tender process only for covering the remaining maximal 10% of the population which could not be served adequately by other technologies.

Use of existing infrastructures (para. 51 e)

It was the clear intention of the Lombard authorities to prefer bidders that commit themselves to use existing infrastructure, as this will reduce the investment costs.

Open access (para. 51 f)

The winning bidder is required to guarantee access to the subsidised infrastructure for a time period of at least 7 years in an open, transparent and non-discriminatory manner. Access has to be provided to both active and passive infrastructure. Regarding ducts which have been built under the notified measure the access obligation is not limited in time.

Benchmarking pricing exercise (para. 51 g)

The conditions for granting open access follow the existing national regulation in the telecommunications sector. They are checked by an external advisor.

In addition to the wholesale pricing, there are requirements regarding the price range of broadband offers for end-users: Activation costs for private consumers and business consumers within a maximum of € 50 and € 60 respectively; the maximum monthly flat fee tariff for basic broadband services of up to 7 Mbps at a maximum of € 25 and € 35 for private consumers and business consumers respectively; any other tariff and product schemes will have to exceed the performance requirements of the basic product offering.

Claw-back mechanism to avoid over-compensation (para 51 h)

Four years after the start of the broadband services there will be a formal investigation whether the economic returns from broadband activities exceed the maximum amount of allowed returns according to the following equation:

$$Rmax = (C \times WACC) + Amm + Cop$$

where *Rmax* is the imposed revenue cap, *C* the invested capital, *WACC* the weighted average cost of capital (which is set at 10%), *Amm* the amortization in relation to the capital invested and *Cop* the operating costs incurred for providing the service.

In case there is an extra profit the beneficiary has to return a share (proportional to the aid intensity) of this sum or the operator may by requested to re-invest the excess profits to expand the network to still unserved areas or to further improve the quality of the services provided.

Up to now there is no practical experience about the claw-back mechanism as the network is still in the deployment phase.

2.12.3 Summary of peculiarities of the case N596/2009 (IT)

- The measure covers both the backhaul and the access network so that there is no need for additional investments in network infrastructure by end-users.
- Extensive specifications to the beneficiary particularly regarding start of operation, reaching the break-even point, end-user prices, availability of services and factor of simultaneous usage.
- High transparency through separate accounts for wholesale and retail services.
- Use of synergies in civil works through cooperation of public authorities, local technical offices and the beneficiary.
- Inclusion of end-users in the coverage analysis in order to become independent from internal information of network operators.
- Access to subsidized ducts has to be provided not limited in time.
- Pricing obligations for wholesale access follow the SMP regulation.
- Excessive profits may be clawed back or the beneficiary may be obliged to re-invest these profits in still unserved areas of the respective region.
- Only the incumbent and a consortium of the three major competitors participated in the tender process.
- The use of satellite technology is restricted to covering the last 10% of the population which could not be served adequately by other technologies.
- The assessment of excessive profit takes place only once.

2.13 Cross-case assessment: experiences related to the Broadband Guidelines

In this section we will highlight the overall assessments which we derive from the experiences of the 10 case studies. The respective findings primarily reflect challenges which are associated with the implementation of specific requirements arising from the Guidelines. They will be incorporated in our recommendations for the review of the Guidelines.

The presented issues are not necessarily relevant in any individual State aid case. Rather, they may be more or less important in a specific State aid case, as on the one hand, our analysis is based on just 10 case studies which are not strictly representative in a statistical sense, and on the other hand, the case studies do not provide comprehensive empirical data/information in each individual case.

Relationship between SMP regulation and State aid rules

The Guidelines include requirements regarding access and wholesale pricing obligations to be imposed to the beneficiaries (cf. para. 51 f and g). The respective State aid based access obligations usually are limited to a period of at least 7 years. After this period obligations may be imposed only based on the SMP regime.

If State aid based obligations regarding access and wholesale pricing are defined independent from respective/comparable SMP based obligations there may be relevant differences regarding scope, structure and qualitative or quantitative specifications of the obligations. At the end of the validity period of the State aid based obligations these differences may lead to discontinuities in the wholesale services on which access seekers have built their business models. This would probably result in a negative impact on the respective broadband market as alternative service providers may be required to modify their running business models.

In some of the case studies (e.g. North Yorkshire NYNET, Rural Broadband Access Project West Midlands, Lombardia) the incumbent operator is the beneficiary of State aid. As in these cases the incumbents are subject to SMP regulation the respective SMP obligations also apply for their activities in the State aid funded projects. Therefore in these cases there is no distinction between access obligations imposed under SMP regulation and under State aid. The Finnish case is characterized by a systematic und intensive involvement of the NRA FICORA which leads to a harmonization of SMP regulation and State aid based obligations. Altogether, there are several State aid cases where the relevant SMP obligations, in particular regarding wholesale pricing, form an integral part in the definition of State aid based obligations. Thus the risk of inconsistencies and discontinuities with regard to wholesale services is reduced.

In other cases there is no explicit link between SMP regulation and State aid rules which may cause differences in the access obligations. For example in the French case of the department Hauts-de-Seine the designated wholesale operator offers passive services (e.g. dark fiber, co-location) but no duct access. Duct access on the other hand is a general obligation in the SMP access portfolio of the NGA Recommendation. In the German case of the Federal framework programme on duct support the potential obligations indeed comprise all possible forms of access (including duct, dark fibre, bitstream). As the measure only requires that the network *should be capable* to provide these forms of access it is not guaranteed that these forms of access are in the end really available to potential access seekers in any of the State aid supported projects.

Involvement of NRA

The adequate definition of access and pricing obligations (which follow para. 51 f and g of the Guidelines) supposes specific technological and methodological know-how. NRAs possess this know-how and have a broad experience in the development of access and pricing obligations based on their SMP cases. In general, the responsibility for defining access and pricing obligations in the State aid cases rests with the local granting authorities.

Based on the case studies we have got the impression that local authorities can only in particular cases rely on the required competencies. Usually the local staff is not that experienced with the specific topics of access and pricing obligations.

First, this implies the risk that awarded operators (which are dealing with broadband cases very often) try to fleece the less experienced local authorities in the context of defining access and pricing obligations. This could result in unwarranted advantages over competitors.

Second, the decentralized definition of obligations and the resulting differences in obligations for beneficiaries may significantly increase transaction cost of network operators if there is no harmonization on a national level between the different State aid projects for deployment of broadband in the individual regions.

In some State aid cases (e.g. Finland, France) the NRA is deeply involved in this step or former decisions of the NRA regarding wholesale access prices (e.g. UK, Italy) are explicitly taken into account. This allows for limiting the risk of competitive distortions and for reducing the transaction cost of operators.

Detailed mapping and coverage analysis (para. 51 a)

The analysis of present and future broadband coverage imposes several challenges to the responsible authorities as the experiences in the different case studies show.

First, authorities seem to have problems to receive sound projections from private investors on their potential broadband or NGA roll-out activities in the near future. It seems that relevant planning projections for a 3 year horizon are difficult to be formulated or at least difficult to be communicated by operators to public authorities. Moreover, the survey of broadband providers is seen as a potential source for strategically influencing the local broadband undertakings. Negative responses may aim at taking along subsidies, while positive responses may block the intended funding of public authorities.

Second, some market players and public authorities claim that they feel unable to perform the detailed mapping and consultation analysis due to its requirements regarding resources and know-how. Moreover, a decentralised approach for the analysis leaves room for methodological differences which are not caused by regional dissimilarities, and it neglects the use of synergies between regions.

Thirdly, authorities faced uncertainties regarding the distinction between grey and black areas if different broadband services within one region (e.g. based on DSL and on LTE) are offered by only one network operator. It is not clear enough how such an area has to be classified.

Finally, although not having sound empirical information we got the impression that there may be a potential conflict of interest in conducting the market analysis by public authorities due to their dual function (i.e. conducting market analysis as well as being involved in the intended broadband measure).

Open tender process (para. 51 b)

In general, the open tender process does not pose specific challenges to the public authorities. The procedures for broadband projects are geared to national and European requirements which overall apply to public procurement procedures.

From the perspective of potential bidders some challenges are associated with the open tender process. On the one hand, market players claim that the open tender process is not sufficiently transparent for all potential investors in case tenders are published only locally. On the other hand, they conclude that the tender requirements formulated at a decentralized local level vary significantly but unnecessarily across the different regions within a MS, thereby increasing the transaction costs of tendering for potential investors.

In several State aid cases only a few bidders participated in the tender procedures. For example this becomes obvious in Finland where the authorities (if at all) often received just one bid for some regions. But also in the cases of North Yorkshire or Lombardia the number of bids received was very low. This effect results from the perception of potential operators that the tendered projects do not offer sufficient economic incentives to engage. There are two main reasons for these perceptions from our perspective. First, the foreseeable revenues are too small to compensate the needed investments over time (even if State aid is granted or in case of a limitation of the State aid to a certain share of the investment costs). This may in particular be the case if the tendered regions are very small with regard to the number of potential (residential or business) customers so that there are no chances for cross-subsidization between different customers. Second, the chances of success may be too low from the viewpoint of potential bidders (e.g. due to anticipation of strong competitors or due to specific requirements of the tender process).

Most economically advantageous offer (para. 51 c)

The amount of aid requested by the bidders always plays an important role for the selection of operators. The Guidelines offer the possibility to take into account additional qualitative criteria in the tender process. The case studies show that often there are no requirements or recommendations regarding additional criteria which public authorities should and/or could use for the evaluation. In contrast, the Finnish authorities by law defined some basic requirements with respect to selection criteria and their weighting.

The final responsibility for defining the selection criteria and their respective weights in any case is assumed by the public authorities on lower administrative levels. Based on our case studies we have got the impression that these authorities often feel uncertain about the relevant criteria which could be used in the selection procedure in addition to the amount of aid. Due to this lack of information/know-how there is a risk that the authorities do not use all relevant broadband specific criteria and the tender process consequently leads to an economic suboptimal selection of a bidder. This may be for example the case when a solution with a greater impact on competition requires more aid than a proposal with a low impact and at the same time impact on competition is not taken into account in the selection of the operator.

Technology neutrality (para. 51 d)

According to the requirements of the Guidelines State aid funded broadband projects should not favor a priori a certain technological platform for the provision on broadband services. The technology to be deployed should be proposed by the bidders based on the requirements laid down in the tender specifications and selection criteria, respectively.

Nevertheless, ensuring technology neutrality might cause a challenge for the public authorities. Depending on the intended type of broadband access to be provided there may be technological solutions which are in principal not suitable to deliver the requested performance. Against this background the Italian authorities for example limited the role of satellite technology in the Lombardian case to a niche contribution to broadband coverage.

It is our assessment that up to now it is not sufficiently transparent to all stakeholders that not all technological solutions support any type of broadband access. This situation potentially complicates the tender procedure as bidders may propose solutions which are unsuitable for the specific type of broadband access to be provided (e.g. ultra-fast broadband), and at the same time they insist on an equal treatment of all technologies. Thus, within the tender procedure resources will be wasted both on side of the bidders and of the public authorities.

Use of existing infrastructures (para. 51 e)

Integration of existing infrastructure for new broadband projects is often seen as an instrument to reduce the amount of State aid by avoiding unnecessary duplication of physical infrastructure. But in practice the actual use of existing infrastructure is associated with two major challenges for stakeholders.

First, relevant and accurate information about the availability of infrastructure is often missing. This may hold true even if there is a central register of broadband infrastructures as the example of Germany (“infrastructure atlas”) shows. The lack of information makes it difficult (if not impossible) for operators to account for synergies in their network planning in order to reduce the amount of aid needed. In order to enhance the level of information about existing infrastructure there are cases (e.g. e.g. Federal framework programme on duct support in Germany) where the beneficiaries are at least obliged to include information about the funded infrastructure in the central register of broadband infrastructures.

Second, access to infrastructure is not provided at all or not necessarily in a non-discriminatory way (e.g. with regard to prices or time). This situation follows the fact, that in general there is no obligation for the owner of any infrastructure to share this infrastructure with third parties. Only under certain circumstances there may be respective obligations, e.g. if the infrastructure owner is designated to have SMP under the telecommunications regulatory regime. In some cases (e.g. Federal framework programme on duct support in Germany) there is an additional obligation which refers to the infrastructure funded by State aid.

Overall, market participants raise concerns that incumbents may be favoured in tendering proceedings because they easily know the availability of their infrastructure and they have immediate access to their own infrastructure at no or lower opportunity costs compared to their competitors.

Open access (para. 51 f)

Non-discriminatory access to the subsidized infrastructure plays an important role in the conceptual design of the analyzed State aid funded broadband projects. Nevertheless, the level of empirical information is only low, in particular regarding details of the access products and the real demand of third parties for access to the subsidized infrastructures.

Based on the case studies we have got the impression that in rural and remote areas there is often only limited demand for access. Economic incentives for third parties to engage in these areas may be still too small in comparison to other regions even when there are wholesale services available. In particular this holds true with regard to wholesale services on the passive layer as in this case access seekers have to make additional investments in active equipment. Moreover, large (national) operators tend to be reluctant to demand access to local broadband infrastructures as long as there is no harmonization of access products and conditions across the different State aid funded projects within a country. This is mainly caused by the fact that a high number of local projects with different access regimes leads to high transaction costs and reduces the economic incentives to participate.

According to our estimation the open access requirement of the Guidelines does not seem to be sufficiently specified to market players and to public authorities. We perceive an uncertainty in the market with regard to the question which access products are able to meet the requirement of an “effective wholesale access”. Moreover there seems to be a lack of transparency about the set of potential wholesale products which could be mandated, at least on the side of public authorities.

The minimum time frame for the provision of open access (at least seven years) apparently does not lead to specific challenges in the implementation of the State aid measures. We also have found no indication that this requirement poses a hurdle for potential operators to engage in State aid funded broadband projects. This holds true even in the case of Finland where the obligation is effective for 10 years. From our viewpoint it is remarkable that in the Lombardian case the access obligation is unlimited in time for ducts which have been built under the notified measure.

In some cases (e.g. Finland, UK RBAP) the payment of the State aid depends on completing network deployment and starting the provision of network services, respectively. This forms a strong incentive to complete the network deployment by the beneficiaries in time. If the access obligations enter into force after the payment of the State aid only, this approach may lead to disadvantages as access seekers have not sufficient time to prepare their own services and thus they can compete with the beneficiary only with a delay.

Benchmarking pricing exercise (para. 51 g)

In case of operators which are designated to have SMP no specific problems exist in the context of wholesale access pricing for the public authorities as prices are set by the NRA within the SMP regulatory regime. At the most, if State aid based access obligations to SMP operators would use other wholesale access products than in case of SMP regulation there may arise problems and inconsistencies, respectively.

Based on the case studies we have got the impression that regarding non-SMP operators public authorities attempt to profit by the existing national regulation in the telecommunications sector. Pricing decisions of the NRA sometimes play an important role in the State aid measures (e.g. North Yorkshire, UK RBAP, Lombardia). Nevertheless, wholesale access pricing may pose serious challenges to public authorities as benchmarking wholesale prices is a complex regulatory task even for experienced NRAs. Public authorities in particular at a local level are often missing a comparable expertise as well as specific know-how and therefore are unable to assess wholesale price proposals of awarded operators effectively. This holds true even when relevant benchmarks are potentially available (e.g. if they are published).

In the UK case RBAP wholesale access pricing is of relevance not only in the implementation phase of the project when open access has to be provided to third parties. The authorities included wholesale access pricing already in the selection of the operator where it was an important criterion for the evaluation of tenders.

Claw-back mechanism to avoid over-compensation (para. 51 h)

Avoiding over-compensation is an important objective for virtual all State aid funded broadband projects at least from a conceptual perspective. But the practical relevance is on a low level mainly because most of the funded projects fall below respective thresholds. In the implementation of some cases (e.g. Federal framework programme on duct support in Germany) there even seems to be a trend to limit the funding volume of relevant projects below the threshold of the notified measures in order to avoid the application of a claw-back mechanism.

This behavior indicates that there are several challenges and uncertainties, respectively, associated with the claw-back mechanism. First, the Guidelines do not specify any requirements regarding methodology or time for identifying an over-compensation so far. Second, the implementation of the claw-back mechanism tends to be a very complex process and requires specific know-how at the local level. Altogether, public authorities seem to have problems to define effective claw-back mechanisms at low cost of administration.

Usually, the beneficiary has to return (a share of) the identified extra-profits to the funding authority. But in some cases (e.g. Lombardia) there is a second option for dealing with potential excessive profits. The operator may by requested to re-invest the relevant profits to expand the network to still unserved areas or to further improve the quality of the services provided. As there are no practical experiences regarding the re-invest option it is unclear whether the implementation leads to virtual advantages compared to the pay-back option.

In order to facilitate the monitoring of profits and to increase transparency about use of State aid some cases are linked with a separation condition. In Lombardia for example the awarded operator is required to keep separate accounts, in relation to both the retail and the wholesale business. This approach makes it easier for public authorities to assess the existence of excessive profits (and the appropriateness of wholesale prices).

Framework programmes

A couple of State aid measures is designed as national or regional framework programmes (e.g. Federal framework programme on duct support in Germany, Broadband in rural areas of Baden-Wuerttemberg, High-speed Broadband Construction Aid in Sparsely Populated Areas of Finland). In these cases individual notifications of broadband projects on different administration levels become obsolete and thus administrative processes are significantly simplified which leads to a greater overall efficiency at all stakeholders.

Indeed, framework programmes bear the risk of less transparency as there may be no need for an approval of local projects by higher administration levels. Information about the actual application of a framework and its implementation effects may be hardly available if the programme is no accompanied by adequate monitoring/reporting procedures (e.g. a register about the broadband projects under the umbrella of the framework and their key characteristics).

Backhaul network and access network

Some of the notified measures are focused on subsidising the backhaul part of broadband networks (e.g. Federal framework programme on duct support in Germany, High-speed Broadband Construction Aid in Sparsely Populated Areas of Finland, North Yorkshire NYNET Project) while others cover backhaul and access network likewise. A limitation to the backhaul network requires further investments in the access network in order to enhance the availability of broadband access to end-users. These investments may be borne by the end-users as complementary investments (like in Finland) or by network operators as additional investments.

If the further investments in the access network part could not be generated the granted State aid may lead to only limited effects, i.e. the intended impact on the availability of broadband access does not occur to the desired extent.

Guarantees

Particularly in cases where State aid is paid out only after the subsidized network is built (e.g. Finland), from the perspective of stakeholders guarantees granted by public authorities deem to be necessary as an additional aid instrument for the successful implementation of projects. In this regard public authorities see the need to address guarantees explicitly in the Guidelines, taking into account the relationship to the Commission Notice on guarantees.

3 Expert opinion on technical issues

This Chapter addresses three main topics. It provides a detailed analysis and assessment of (1) alternative technological solutions for NGA networks, (2) different approaches to grant wholesale access to competitors on the subsidized networks, and (3) separation requirements for State aid related ventures.

3.1 Alternative technological solutions for NGA networks

This section (1) provides an overview of different NGA definitions in the context of major EU documents, (2) presents an assessment of current and foreseeable developments regarding (potential) broadband technologies apart from xDSL and FTTB/H, (3) gives a short overview of recent relevant regulatory developments, and (4) provides some preliminary conclusions and recommendations regarding the Guidelines.

3.1.1 NGA definitions in the context of major EU documents

3.1.1.1 The State aid Guidelines

Taking into account the level of technological and market development at that time the Guidelines of 2009 defined Next Generation Access (NGA) networks as "wired access networks which consist wholly or in part of optical elements and which are capable of delivering broadband access services with enhanced characteristics (such as higher through-put) as compared to those provided over existing copper networks."[122] It is the understanding of the Guidelines that NGA networks are mainly fibre-based or advanced upgraded cable networks.[123] It is on the other hand also the understanding of the Guidelines that neither satellite nor mobile network technologies are capable of providing very high speed symmetrical broadband services.[124]

3.1.1.2 The NGA Recommendation

The NGA Recommendation makes use of the same definition of NGA as the Guidelines do.[125] The Recommendation, however, makes clear that not only FTTB/H networks generate NGA: "In most cases NGAs are the result of an upgrade of an already existing copper or co-axial access network."

122 See European Commission (2009a), para. 53.
123 See European Commission (2009a), para. 52.
124 See European Commission (2009a), para. 53, footnote 60.
125 See European Commission (2010d), Rec.11.

3.1.1.3 The Digital Agenda

The Digital Agenda for Europe[126], the guiding policy document for the European broadband policy, follows a slightly different path. The Digital Agenda formulates broadband targets for basic, fast, and ultra-fast broadband. Fast broadband access is identified with an Internet access speed of above 30 Mbps, and ultra-fast access with speeds above 100 Mbps. Only the latter one is regarded as NGA. Only to guarantee universal broadband coverage with Internet speeds of up to 30 Mbps and above the Digital Agenda expects contributions of wireless (terrestrial and satellite) networks besides the contribution of the fixed network.

3.1.2 Technological developments

Although the Guidelines of 2009 and other EU documents defined NGA networks solely as wired infrastructure (in particular fibre optic cables) and considered that other technological solutions were not yet capable to provide NGA services, it is, however, fair to state that technological progress may change or may already have changed or at least have challenged this assessment. Apart from xDSL and FTTB/H the most important technologies to mention here are:

- Hybrid fibre coax,
- Fixed Wireless access technologies,
- Mobile technologies,
- Powerline technologies,
- Satellite technologies.

Hybrid fibre coax

Traditionally, a cable network was a one-to-many unidirectional infrastructure, i.e. the same “content” (TV programmes) was conveyed over the infrastructure to each end-user hooked upon the network. The user was only able to watch the programmes (or not), however, he/she had no capabilities for interactivity. The transport network infrastructure of traditional cable networks mainly consisted of copper co-axial cables.

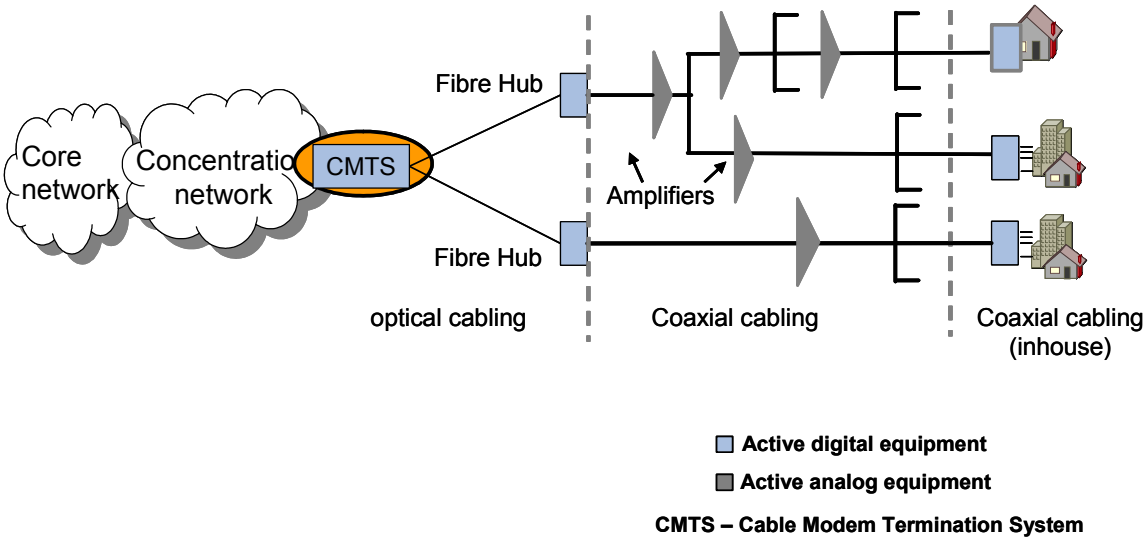
Today’s cable networks, however, are bidirectional and deliver interactivity and high speed broadband capabilities. The DOCSIS architecture allows separate communication channels besides the TV signals to communicate in both directions over the network. Cable networks by definition are a shared infrastructure, i.e. the resources are shared between all end-users connected. The “intelligence” for such a system is located in the so called CMTS (Cable Modem Termination System) at the central site which addresses the receiving party of an individual message and administers the sending rights in order to prevent collisions.

126 See European Commission (2010e).

In order to reduce the number of competing end-customers in this shared medium and to increase the available bandwidth for each customer, cable operators more and more replace some of their co-axial infrastructure by a fibre network (with a fibre hub closer to the end-customers; hybrid fibre coax (HFC) network infrastructures) and thus reduce the amount of customers per fibre hub or per given total bandwidth.

Figure 3-1 provides a stylized overview of the main characteristics of a HFC/DOCSIS "modern" cable infrastructure.

Figure 3-1: Main characteristics of a HFC/DOCSIS cable infrastructure (stylized view)



Source: WIK-Consult

The figure shows that in broadband cable (CA-TV/DOCSIS) architectures fibre is the prevalent infrastructure between the concentration network and the drop cable segment (where the "network side" is equipped with the fibre hubs). The drop cable segment still consists of coaxial cabling.

The bandwidth provided by the latest standard DOCSIS 3.0 is 160 Mbps downstream and 120 Mbps upstream. This capacity can be increased with bundling techniques but capacity remains shared by all connected customers. By pushing fibre closer to end-users and thereby reducing the number of customers per fibre hub cable operators can increase the bandwidth that is available to an individual user. Like for all shared media performance per end-customer has a wide spread, offering at maximum the whole channel capacity to one single user if nobody else competes for it at the same time, or at minimum the channel capacity divided by the amount of users connected. In any case this user interaction causes delay and jitter for the data packets.

It is obvious that today's cable-TV based access networks are able to support fast broadband speeds only to a limited degree. This disadvantage may be overcome when the fibre nodes are migrated to the homes, thus requiring a FTTB point-to-point fibre topology and in addition opening the opportunity for additional communication channels outside the DOCSIS 3.0 architecture. In this way hybrid fibre coax networks offer the option of a smooth migration path by extending transmission capacity according to end-customer demand, resulting in a FTTB fibre access network over time.

Fixed Wireless access technologies

Regarding mass market there are two different standardized wireless access technologies in use today on the basis of which broadband Internet access can be implemented: Wireless LAN approaches and WiMAX (Worldwide Interoperability for Microwave Access).

Wireless LAN encompasses technologies standardized in the IEEE 802.11 standard family. The technology has been planned as wireless access technology for end-customers in a limited (primarily indoor and campus) surrounding, but can also be used for wireless backhaul connections, e.g. to connect the WLAN access points to fixed network access points.

A Wireless LAN access point serves as a central base station to connect end-customers in an area with a radius of approximately 30 – 100 m as a shared medium. The "feasible" distance between end-customer and access point depends on the specific local circumstances, e.g. regarding line of sight, indoor conditions, construction materials, etc. Over time the 802.11 standards have been improved; today they cover a range between 2 Mbps and appr. 300 Mbps (802.11n) in the shared channel. The available transmission speeds depend on the specific standard deployed, on the amount of users being active simultaneously, and on the distance and quality of the radio connection. Since many of the access points are backward compatible to older standards the oldest end system connected to it determines the maximum speed of the access point at a given time. Real speeds which can be achieved always are below half of the theoretical maximum (0.5 – 150 Mbps). Thus, WLAN cannot offer homogenous access speeds and a dedicated QoS to the end-customers connected.

WLAN is an access technology ideally suited for hot spots like railway stations, trains, airports and planes, restaurants and event locations, where nomadic end-customers stay for a while (because they are waiting, travelling, …) and can use their terminal systems, which all have been designed and equipped as a WLAN end system. In larger locations there may be several access points, together covering the area, supporting moving end-customers, but not seamlessly, usually with a short interruption when switching over to another access point.

WiMAX encompasses technologies standardized in the IEEE 802.16 standard family. The technology can be used for Point-to-Point backhaul connections and for Point-to-

Multipoint customer access networks. Used as an access network technology, central base stations serve the surrounding area in a shared manner. Thus, a bandwidth of up to 75 Mbps (over short distances) is shared between the customers. The available customer bandwidth also depends on the distance to the central base station. While in theory a coverage radius of 50 km is possible, requiring line of sight between the endpoints, in reality radio transmission is affected by buildings, trees etc. and restricts coverage to a radius of appr. 3 km. Indoor coverage is even harder to achieve, if at all, thus, restricting the applicability of WiMAX in dense populated areas. In many cases the antennas have to be placed at a window and directed to the base station. The transmission capacity per customer depends on the number of customers active at the same time (shared medium) and is reported to be at 1 – 6 Mbps maximum, on average around 3 Mbps in medium distance to the base station. Accordingly, capacity and indoor penetration requirements may lead to the need for many base stations with small cells, potentially making it expensive. WiMAX therefore is an access technology that does not offer homogenous services in its coverage areas. Ensuring coverage of all customer locations, especially in urban areas, can become expensive.

WiMAX is designed with short latency times and additional features to offer guaranteed bandwidth, thus, the technology is in principle able to offer QoS features for a limited number of end-customers at the same time. WiMAX standards have also been expanded to serve mobile end-customers. The technology therefore could be viewed as a competitive technology to LTE, see below. But it seems that WiMAX has further weakened its competitive position when Cisco in spring 2010 announced to stop its WiMAX development.

The ability to also operate WiMAX as a backhaul technology allows to use it to connect (several) base stations of the same technology or different technologies in order to build meshed networks of base stations.

WLAN and WiMAX are wireless technologies with a common communication channel delivering bandwidths of up to 300 Mbps, being shared by all users communicating over the network at the same time. While in principle these networks can offer ultra-fast broadband speeds, they then are only suited to a handful of customers working in parallel, not for the mass market. Even fast broadband cannot be supported for a relevant amount of customers. For mass market usage and in dense populated areas these technologies also require a dense network of base stations, thus exhibiting severe challenges for profitability.

Mobile technologies

Since about the year 2000, when the UMTS frequencies were auctioned off in many European countries, mobile networks are able to deliver at least to some extent “broadband” speeds. UMTS in its original form was only providing 384 kbps. However, the further technical developments based on the UMTS standard, i.e. the “3.5 G technolo-

gies" HSDPA/HSUPA (High Speed Downlink (Uplink) Packet Access), deliver much higher bandwidths. Many mobile carriers in Europe today have implemented HSPA networks delivering up to 14.4 Mbps downstream and up to 5.7 Mbps upstream. Evolved HSPA technology allows for 42 Mbps downstream as a shared medium. From a technical perspective, the available bandwidths of HSPA technology will, however, remain limited. In all likelihood, it will not deliver 30 Mbps, but remain clearly below 10 Mbps per user.

The "standard" technology for mobile broadband access "tomorrow" apparently will be LTE (Long Term Evolution). LTE will be a major technological move of mobile carriers to serve growing customer needs requiring higher network speeds. LTE base stations could in theory and under special laboratory conditions provide 300 Mbps downstream and up to 100 Mbps upstream. Under real conditions, however, they are likely to provide a nominal download speed of up to 100 Mbps and an upload speed of up to 50 Mbps. Due to the cell based characteristic of this technology the effective access speed for the individual user therefore only is a fraction of the speed mentioned above. The effective speed for the individual user furthermore depends on the propagation characteristics of the frequencies and the topology. The effective speed at the edge of a radio cell only is a fraction of the access speed close to the base station. LTE will definitely support basic broadband access and to some extent also fast Internet access. It will, however, not support ultra-fast NGA. This assessment is supported by the marketing policy of mobile operators in Germany which is ahead in Europe in deploying LTE. While Deutsche Telekom is selling LTE for access speeds of up to 3 Mbps, Vodafone is offering LTE for "up to" 50 Mbps.

Summing up, any of the aforementioned mobile technologies by definition are cellular technologies. Like all radio technologies they use a shared medium, thus bandwidth is shared between the active users in a cell in a controlled manner. The more active users there are in a given cell the less bandwidth is available for each user. The available bandwidth for each user moreover depends on the length (distance between the base station and the end-customer) of the radio connection. For mobile users it also may depend on the speed of the moving user and it may vary from radio cell to radio cell.

Powerline technologies

Electric power lines are a physically shared medium for power transmission between the last transformer and the end-customer homes. Consequently powerline technology provides a shared communication medium on utility power lines. The bandwidths of the newest technologies are limited to approximately 85 up to 200 Mbps shared between all customers.

Electric power cables serve as emitting antennas for the high frequencies transmitted over it for powerline communication use, thus it may be required not to use all of the theoretically usable frequency spectrum in order not to disturb other radio based appli-

cations (e.g. broadcast, TV, microphones, private radio, aircraft radio, …), resulting in lower transmission capacity than its theoretic maximum. Powerline bandwidth also depends on line length and its performance can potentially also be affected by other electric equipment. The technology never reached maturity as an access network substitute and many experts today see the future of powerline as a technology solely for in-house networking or potentially as an access technology for smart electric grids. Due to shared capacity limitations, accompanied by high costs, lack of standards and defined processes for interaction with power utilities, powerline cannot be regarded as a relevant technology to support ultra-fast broadband access.

Satellite technologies

Satellite technology has been designed as a broadcast medium: the respective transponders deliver a portfolio of TV programmes in principle to all households in the area on earth that is covered, called a footprint. A further satellite application already in use since decades is the provision of transcontinental and transoceanic (large distance) leased lines and telephony connections in point-to-point topology. Due to large signal run times, however, these applications have been replaced by terrestrial or submarine fibre optic cables to a large extent.

Satellite technology providing two-way communications via low price Very Small Aperture Antennas (VSAT) in a point-to-multipoint topology is available since more than two decades. It also provides a shared medium communication.

Satellite as an Internet access medium never got off the ground at least in Europe: Astra claims to have about 60,000 subscribers and Eutelsat claims to have 25,000 subscribers. Eutelsat just recently introduced a new technology (“Ka-Sat”) and announced that the technology is able to deliver 10 Mbps downstream and 4 Mbps upstream for a limited number of end-customers in parallel per footprint. Even when the satellite is able to serve several footprints for Europe and thus increases the number of customers to serve in total, its service only is suited for sparse populated (white) areas without any basic broadband telecommunication alternative.

Yet, to use satellite technology for two-way and real time applications like video conferencing or interactive gaming is a challenge because (twice) the distance between earth and satellite (i.e. about 70,000 km) causes relatively high signal delay times (several 100 ms to 1.5 s).

Satellite broadband offerings in all likelihood are considerably higher-priced as regular broadband services. This can be seen from Table 3-1 which gives an exemplary overview of Internet access services for private end-users based on satellite technology in Germany.

Table 3-1: Internet access services based on satellite technology in Germany

ISP/satellite	Access product	Bandwidth (download/ upload)	Activation fee	Monthly fee
Filiago/Astra	Filiago Sat 4000	up to 4 Mbps up to 1 Mbps	99.95 €	39.95 €
	Filiago Sat 10000	up to 10 Mbps up to 2 Mbps	99.95 €	49.95 €
Sosat/Astra	dsDSLcompact 256 VoIP	up to 256 Kbps up to 64 Kbps	89.00 €	29.90 €
	dsDSLcompact 512 VoIP	up to 512 Kbps up to 96 Kbps	89.00 €	39.90 €
	dsDSLcompact 1024 VoIP	up to 1 Mbps up to 128 Kbps	89.00 €	49.90 €
	dsDSLcompact 2048 VoIP	up to 2 Mbps up to 256 Kbps	89.00 €	79.90 €
StarDSL/Astra	Start	up to 256 Kbps up to 64 Kbps	99.95 €	29.95 €
	Premium	up to 1 Mbps up to 128 Kbps	99.95 €	49.95 €
	Pro	up to 2 Mbps up to 256 Kbps	99.95 €	69.95 €
	Speed	up to 3 Mbps up to 256 Kbps	99.95 €	79.95 €
	Highspeed	up to 4 Mbps up to 256 Kbps	99.95 €	99.95 €
Deutsche Tele-kom/Astra	DSL via Satellit	up to 2 Mbps up to 256 Kbps	incl.	39.95 €
tooway Sat/Eutelsat	tooway 6000	up to 6 Mbps up to 1 Mbps	199.95 €	29.95 €
	tooway 8000	up to 8 Mbps up to 2 Mbps	199.95 €	45.95 €
	tooway 10000	up to 10 Mbps up to 2 Mbps	199.95 €	59.95 €
	tooway 10000+	up to 10 Mbps up to 4 Mbps	199.95 €	99.95 €
skyDSL/Eutelsat	skyDSL2+ 2000 UL	up to 2 Mbps up to 192 Kbps	99.00 €	19.90 €
	skyDSL2+ 3500 UL	up to 3,5 Mbps up to 384 Kbps	99.00 €	39.90 €
	skyDSL2+ 10000 UL	up to 10 Mbps up to 2 Mbps	99.00 €	49.90 €
Internetagentur Schott/Eutelsat	Basic	up to 6 Mbps up to 1 Mbps	incl.	28.90 €
	Family	up to 8 Mbps up to 2 Mbps	incl.	44.90 €
	Office	up to 10 Mbps up to 2 Mbps	incl.	59.90 €
	Premium	up to 10 Mbps up to 4 Mbps	incl.	109.90 €

Source: Company websites, August 2011.

As Table 3-1 shows activation fees as well as monthly fees are generally higher for satellite based Internet access than for comparable DSL-offers. The differences are not that big with regard to lower bandwidths but they increase with higher downstream bandwidths and even more with higher upstream bandwidths. Moreover, the end-user has to buy specific hardware for satellite based Internet access which may cost up to several hundred Euros and which is not included in the price elements of Table 3-1.

Summary of technological developments

Despite the progress in non-wired technologies, these technologies are not capable to provide the capacities and speeds needed for NGA services in the near future. From the point of view of technological developments there is no justification and no need to update and change the definition of NGA in the Guidelines.

3.1.3 Regulatory developments

Most NRAs have already dealt with or are currently preparing decisions on access to NGA. In the basic market analysis regarding the relevant Markets 4 and 5 none of the NRAs have included mobile and satellite into the relevant markets. The only exception is Austria where the NRA regarded mobile as a relevant substitute to DSL for broadband access for residential users and included mobile into the definition of Market 5. The mobile broadband access products, however, only compete for basic and fast Internet access. That is one of the reasons why the Austrian NRA did not identify a substitution between business broadband access products provided over fixed and mobile networks. The most comprehensive summary of the recent NRA decisions regarding NGA is provided in a recently published BEREC (2011b) report.

3.1.4 Conclusions and recommendations regarding the Guidelines

Neither technological nor regulatory developments in the Member States indicate the need or the justification of a change in the definition of NGA networks as wired infrastructure. Other technological solutions are neither today nor in the foreseeable future capable to provide NGA services. Any change in the definition of NGA networks would, furthermore, generate inconsistencies with the NGA Recommendation and even more specifically with the broadband targets as formulated in the Digital Agenda.

3.2 Granting wholesale access to competitors on the subsidized networks

3.2.1 Open Access requirement of the Guidelines

The Guidelines recognize that State aid in the field of broadband may distort competition. The possibility of distortion of competition is not a reason to reject a State aid request per se. The Guidelines, however, define principles to ensure that State aid does not crowd out market initiatives in the broadband sector, they require a design of State

aid measures such that the distortions of competition are limited and they try to ensure that the positive effects of aid (in terms of a higher level of broadband coverage and penetration) outweigh its negative effects in terms of distortion of competition.

As one of the requirements to minimise potential distortions of competition, the Guidelines require in para. 51 f that a network operator should provide effective wholesale access to a subsidised broadband infrastructure to third party operators. Wholesale access should enable third party operators to compete with the subsidised bidder. Effective wholesale access should be offered for a period of at least 7 years. If at the end of the 7 years' period the subsidised operator is designated as having SMP in the specific market concerned, the access obligation should be extended accordingly.

According to the Guidelines (para. 79) access in the case of NGA should be provided at all possible levels and to passive as well as to active infrastructure. This includes (but is not limited to) access to ducts and street cabinets, unbundled access to fibre loops, and bitstream access. The Guidelines implicitly reflect that not all NGA architectures support the access concept of unbundling. Here, the Guidelines give a clear orientation in the sense that any subsidised NGA network architecture should support effective and full unbundling. Furthermore, the Guidelines point out potential competitive benefits of a multiple fibre architecture: It allows for full independence between access seekers and is therefore conducive to long-term sustainable competition. In addition, it is technology neutral[127] in the sense that it supports both P2P and P2MP topologies. In contrast to unbundling, the Guidelines, however, do not require but only promote a multiple fibre architecture.

3.2.2 Access requirements of the NGA Recommendation

The NGA Recommendation aims at promoting efficient investment and innovation in NGA. Like all European initiatives regarding regulation it also aims at supporting and requesting consistency of regulatory approaches taken by NRAs to avoid distortions of the Single Market and to create legal certainty for all investors in the relevant field. The Recommendation therefore provides guidance to the NRAs how to formulate and impose regulatory remedies regarding Market 4 and Market 5.

The conceptual competitive framework of the Recommendation also is characterised by applying the ladder of investment principle where the achievement of infrastructure competition is the preferred regulatory option. Although the Recommendation primarily covers - in the tradition of the European Regulatory Framework - remedies imposed on SMP operators, it also justifies obligations of reciprocal sharing of facilities to overcome bottlenecks in the civil engineering infrastructure and terminating segments.

127 See Section 3.2.3.1.4.

The Recommendation specifies the following NGA access remedies:

(1) Access to civil engineering infrastructure

Access to ducts, civil engineering and other networks elements which are not active shall be provided where capacity is available. Access should be provided in accordance with the principle of equivalence and at cost-oriented prices. NRAs should aim at establishing a data-base containing information on location and available capacity of civil engineering infrastructure.

(2) Access to the terminating segment of an FTTH network

Such access shall be provided at economically viable access points (Distribution Points) and include access to in-house wiring and at cost-oriented prices.

(3) Unbundled access to the fibre loop in the case of FTTH

Unbundled access should be a general obligation which can only be exempted if there is effective competition on the basis of several alternative infrastructures. Unbundled access to the fibre loop should be provided at the MPoP[128] and be accompanied by measures assuring co-location and backhaul. Unbundled access to the fibre loop should be mandated irrespective of the network architecture and technology implemented.

(4) Access obligations in the case of FTTN (FTTC)

For this architecture NRAs should impose unbundled access to the copper sub-loop. This remedy should be supplemented by measures regarding backhaul and co-location.

(5) Wholesale broadband access

Bitstream access should be provided over VDSL and for other network topologies.

3.2.3 NGA topologies, technologies and wholesale access

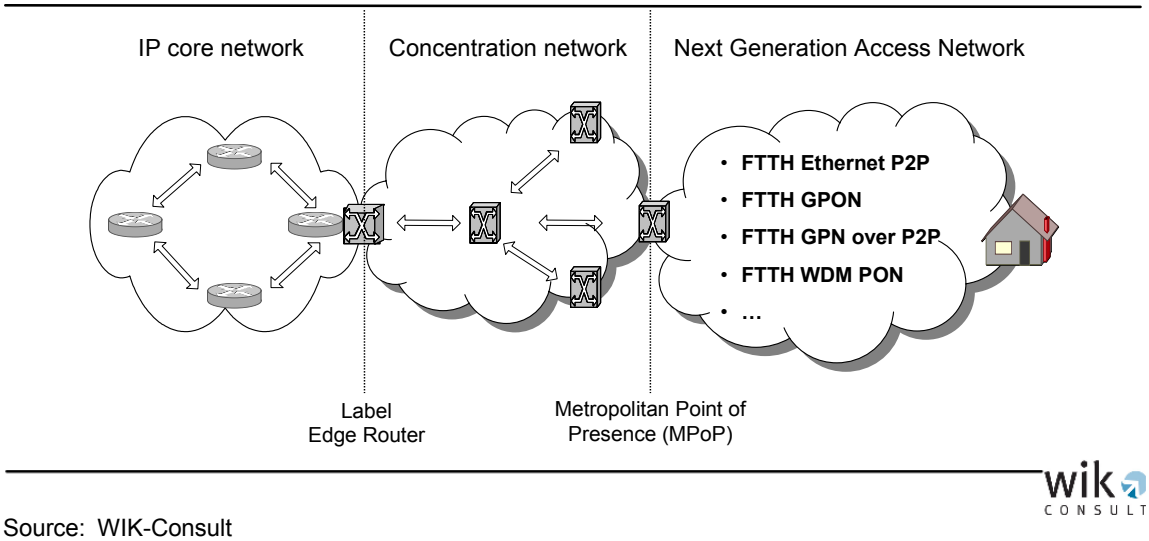
3.2.3.1 Basic NGA topologies

Until a few years ago almost all wireline access lines between the MDF and the end-user were based on twisted pair copper (respectively metal) loops. The sub-loop connecting the end-user premises to the street cabinet is an integral part of this copper loop. To provide DSL services the MDFs were already connected to the core network through optical fibres to overcome capacity constraints (FTTN). In this network architecture the available bandwidth to the end-user is limited by the length and the quality of the copper loop. Increasing the bandwidth to the end-user can be achieved in such a

128 See Section 3.2.3.1.

wireline fixed network by (1) shortening the copper loop and bringing the DSLAM closer to the customer (to the cabinet or even to the building), (2) using more advanced DSL technologies from the MDF or from the cabinet (e. g. VDSL, vectoring etc.) or (3) by installing a fibre loop with an optical network termination very close or at the end-user premises. All FTTx architectures are characterised by bringing the fibre closer to the end-user. The various FTTx architectures have different investment requirements, can make use of existing infrastructure (ducts, fibre) at a different extent and support advanced technologies at a different degree. Beside that vectoring requires access to all copper access lines in a cable in order to achieve highest capacity increase.

Figure 3-2: NGN/NGA general architecture



Source: WIK-Consult

The overall NGN/NGA architecture has three major segments, the IP core network, the nowadays typically Ethernet based concentration network and the access network. In the IP core network the IP-traffic is routed between network nodes or exchanged with other networks and application servers located in the same network or in other networks. The concentration network collects the traffic from the endpoints of the access network and transports and concentrates it to the core network nodes. The access network of today still is primarily based on copper lines between the Main Distribution Frame locations and the end-customer locations. Their replacement by fibre lines has already started. Many different technologies are available and implemented. Before we describe them we define some general access network related terminology used in this study.

Regarding access network topology we use the terms of the NGA Recommendation:

- It defines the *Metropolitan Point of Presence* (MPoP) as equivalent to the Main Distribution Frame (MDF). The MPoP is the first location where, depending on the NGA architectures and looking from the end-user, an Ethernet Switch of the concentration network is located.

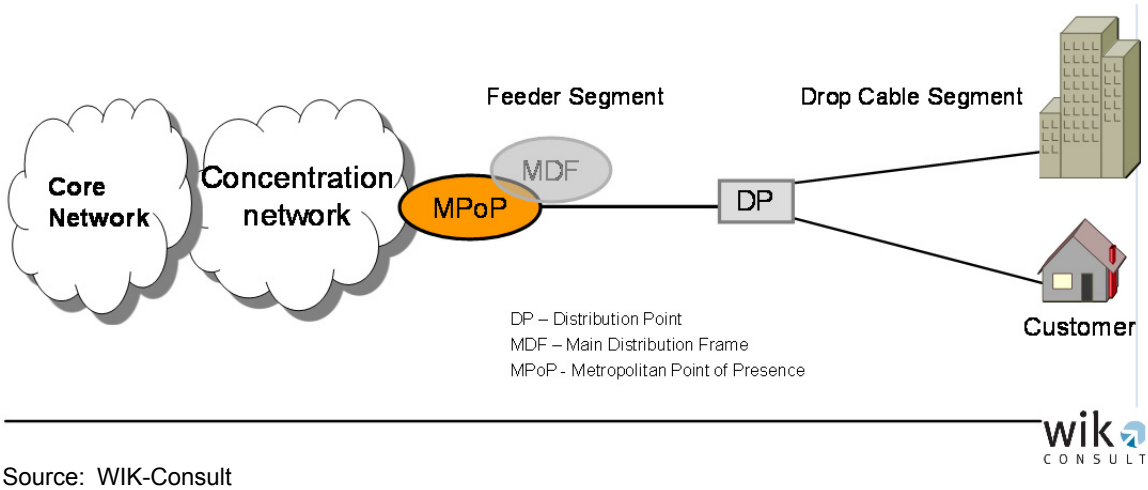
- The *Distribution Point* (DP) is an intermediate node within the NGA, from which fibres from the MPoP can be divided/accessed before running them to the customer building (or in the case of FTTC from which access is realised through copper sub-loops).
- The segment between MPoP and Distribution Point is called *Feeder (Cable) Segment*.
- The segment from Distribution Point to the customer location we call *Drop (Cable) Segment*[129].

There may be fewer MPoPs than MDFs, since fibre overcomes the line length restrictions of copper connections. Thus MPoP locations may be a subset of the existing MDF locations.

- In this case we will use the term *"backhaul"* to refer to the segment between an abandoned MDF location and the new MPoP.

Figure 3-3 visualizes the aforementioned segments of the network.

Figure 3-3: Network topology: Terms and definitions



Source: WIK-Consult

There are three general approaches to reduce the copper line length in the access network: Fibre to the Curb (FTTC)[130], Fibre to the Building (FTTB) and Fibre to the Home (FTTH).

129 The NGA Recommendation calls this network segment terminating segment, but for reasons of consistency with recent WIK studies we continue to use the term drop cable segment in this study. Both terminologies characterise the same network element.

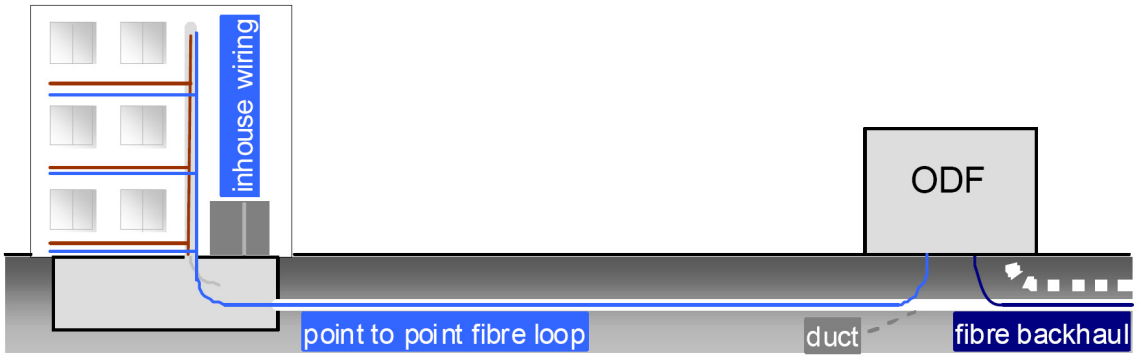
130 The NGA Recommendation names this architecture FTTN. We prefer, however, the wording of FTTC, because otherwise there can be confusion with locating the electronic equipment at the MDF which is also some real market approach towards VDSL and reserve the term FTTN for this architecture.

With FTTC there are fibre lines between the MPoP and the Distribution Point (DP - a street cabinet) only. The DP hosts electronic (VDSL) equipment which transmits the broadband signal over the existing copper pairs between the DP and the end-user homes. With FTTB the fibre lines cover the segment between MPoP and end-customer buildings, where electronic equipment[131] in the basement of the building transmits the broadband signals, using the existing in-house copper cabling, to the end-customer home (e.g. apartment). With FTTH the entire network segments between MPoP and end-customer home is bridged by fibre lines. Here no remaining copper segments reduce the bandwidth. In single dwelling buildings FTTB and FTTH fall together, while in multi-dwelling buildings FTTH requires a fibre in-house infrastructure which also has to be deployed during fibre roll out.

3.2.3.1.1 FTTH vs. FTTB

FTTH is a fully optical network architecture, where fibre cables are installed all the way from the ODF (located at the MPoP) to the home of the residential user or premises of the business user. The entire copper loop (including the in-house wiring) is replaced by an optical fibre infrastructure. Figure 3-4 represents a FTTH design in a P2P architecture.

Figure 3-4: P2P FTTH design



Source: BEREC (2010), p. 15

Some or all of the network node locations of the copper network (MDF locations, Street Cabinets) might be of use for the ODF and/or optical splitters. A FTTH network depending on its technology and the active electronics used generates potential speeds up to several Gbps for each end-user on its individual demand.

FTTH networks may be deployed in different topological structures, either as a P2P topology or as a P2MP topology usually as a passive optical network. Potentially a FTTH network allows a much greater distance between the end-user and the location of

131 See Section 3.2.3.1.2.

the active network equipment (fibre loop). While broadband services based on xDSL limit the copper loop to (significantly) less than 10 kilometres, fibre access links can have lengths of 20 km (GPON technology), more than 40 km (P2P Ethernet technology) or even 100 km (WDM PON technology). This characteristic allows for architectures of the fibre access network with potentially (much) less network nodes (MPoPs) than central offices (MDF) in the copper network. Current fibre deployments of incumbent operators, however, still build the fibre access network around the current network nodes.

In FTTB architectures the complete copper loop from the MDF location down to the basement of the end-customer buildings is replaced with fibre but the in-house cabling remains the already existing copper or coax-based infrastructure. Figure 3-5 presents a generic FTTB design.

Figure 3-5: Generic FTTB design

Source: BEREC (2010), p. 16

Mini-DSLAMs or ONUs can serve as fibre termination nodes in the building basement. Each building therefore only requires one fibre in the generic FTTB architecture, thus reducing the fibre count strongly not only in the feeder but also in the drop segment.

FTTB can be deployed on top of a P2P or P2MP fibre plant, resulting in different savings of the fibre count in the feeder segment. Based on a P2MP fibre plant the savings are higher, but require a GPON technology to administer the traffic. FTTB P2P has individual fibres per building, thus allowing one to connect each building with an individual connection, as requested by the potential customers inside, and enabling a higher degree of flexibility for future upgrades.

FTTB limits the bandwidth per end-customer first of all by the capacity the in-house copper connection supports, which today typically is 100 Mbps downstream and 50 Mbps upstream (in-house VDSL equipment and the copper telephony infrastructure assumed).

FTTB also means that the maximum capacity of each user is limited by the bandwidth provided to the building, which then is shared by the number of other subscribers in the same building. In the near future 1 Gbps, 2.5 Gbps or 10 Gbps links may still be sufficient for common European Multi-Dwelling-Unit buildings. However, as the number of tenants per building increases, the access link bandwidth per user that can be guaranteed decreases. In the long term FTTB architectures might need to be migrated to FTTH to allow sufficient bandwidths. Therefore, FTTB could be considered as an alternative to FTTC when migrating from copper based loops to FTTH, already now allowing for higher bandwidth and more stable product quality. Upgrading to FTTH, however, can only be efficiently done when considering at least ducts in the drop segment with sufficient space for further fibres, to connect each of the potential customers.

FTTB is a hybrid fibre solution (similar to FTTC) because there still is a copper-based cabling element. The fibre connection from the ODF to the building is shared by multiple customers. From this perspective, as BEREC (2010, p. 16) points out, the fibre link can be seen as a backhaul and an access seeker will then have to collocate at each individual building to access the in-house wiring. The main difference between FTTH and FTTB is that in the latter case the fibre link extends up to an optical networking unit (ONU) shared by multiple users, thus avoiding the cost of deploying optical fibre cable to each individual home.

3.2.3.1.2 P2P vs. P2MP topologies for FTTB/H

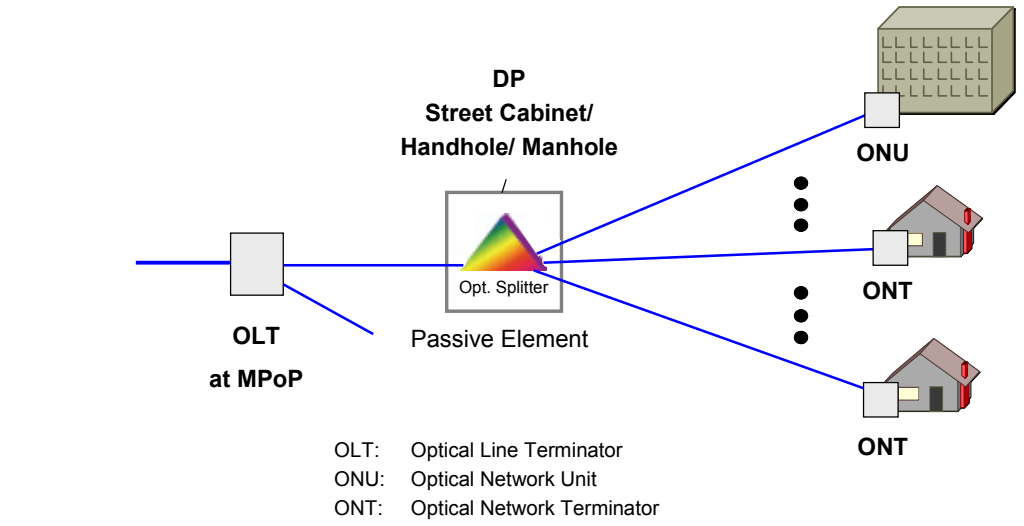
In a P2P FTTH topology a dedicated fibre is provided from the ODF (MPoP) to every single end-user. This topology thus is similar to the traditional copper access network. Only the MDF is replaced by the ODF.

FTTH P2P requires one fibre per home in the feeder and the drop cable segment as well as in the in-house cable segment. Thus FTTH P2P is the topology with the highest fibre count in the feeder cable segment, which may cause cost differences. In a P2P topology there is no capacity or traffic sharing in the access network among end-users. Each user has access to the potentially unlimited capacity of the (“his”) fibre line. Therefore, this topology often is regarded as the most future proof and most flexible one. A P2P fibre deployment allows virtually unlimited bandwidth for each end-user. Technical progress and innovation can simply be implemented by changing the easily accessible optical and electronic equipment of the network, if appropriate individually per access line. The physical fibre plant remains unaffected.

A Point-to-Multipoint topology concentrates the optical signals conveyed over several fibres onto one single fibre by a passive component called splitter (Figure 3-6). Viewed from the perspective of the ODF (MPoP) a splitter splits the light emitted at the ODF over several outgoing fibres. This topology thus reduces the number of fibres in the feeder segment compared to the Point-to-Point fibre topology described above. A single fibre line at the ODF is therefore shared by several end-users. This topology is also

called PON (passive optical network[132]). The degree of fibre reduction depends on the splitting factor a splitter supports[133]. Only one fibre per splitter is needed between MPoP and splitter location (e.g. a DP). However, one fibre per home (FTTH) or per building (FTTB) is still required in the drop segment. Accordingly the drop cable segment in a P2MP topology has the same fibre count as in a P2P topology.

Figure 3-6: Point-to-Multipoint fibre architecture



Source: WIK-Consult

Due to the fact that multiple end-customers can send their upstream information at the same time, some administration is necessary in order to manage conflicts and also in order to manage the downstream traffic. The systems used for this function are the Optical Line Terminators (OLT) at the central site and Optical Network Units (ONU) for several end-customers (e.g. FTTB) or Optical Network Terminators (ONT) for one single end-customer (e.g. FTTH). All customers connected to the same splitter share the same communication channel and its bandwidth. There are many different PON systems or technologies used to administer the P2MP fibre topologies. The most commonly one used in Europe is GPON. PON systems (MPoP equipment and CPE) have to interact and be compatible; in order to fully support all functionalities PON components often have to be supplied by the same vendor.

132 The use of PON for a P2MP fibre topology is misleading, since a P2P topology also is based on a passive optical network, not requiring active elements inside. Furthermore, PON or GPON is also used as description for a technology administering P2MP fibre topologies. This often is mixed up.

133 A splitter spreads the optical downstream signal onto many fibres and in this way distributes the power of the downstream beam also. Therefore the splitting factor not only is limited by construction constraints, but by the total optical budget of the system, too. Typically current splitting factors are between 1:8 and 1:32.

Another, more advanced Point-to-Multipoint fibre technology is under development, which allows one to use different colours (optical wavelengths) of the optical signal to address different customers over a single fibre. The technology of using different colours to separate individual communication streams on a single fibre is called Wave Division Multiplex (WDM). While the fibre plant does not differ compared to PON, the WDM-splitters need not necessarily distribute all colours to all end-customers, but may be configured to provide individual colours to each of the end-customers.[134] Each end-customer may then use its own colour beam individually, not sharing its bandwidth with the neighbours at the same splitter.

In FTTH architectures based on a P2P fibre plant, physical access to the fibre lines occurs at the MPoP, where all access lines are concentrated at the Optical Distribution Frame (ODF) and where the competitors may collocate their own equipment in order to get access to an unbundled fibre access line. This is very closely comparable to the well-known copper Local Loop Unbundling with all its proven processes and skills. In Point-to-Multipoint fibre plants the fibre access point is at the splitter site, thus the competitors have to collocate there – with accessible cabinets and Optical Street Distribution Frames (OSDF), making these locations significantly more expensive compared to buried underground splitters. In cases of cascaded splitters it is the splitter location closest to the end-customer locations where unbundling would take place. The closer the splitter location to the end-customer, the more locations are needed and the more expensive the own infrastructure of the competitors will become. In addition, the less customers are concentrated per splitter and the less customers a competitor can therefore acquire per location, the less attractive it is for competitors to collocate there. Studies by WIK-Consult and others have demonstrated the unattractiveness of Sub-loop Unbundling at the DP[135] compared to Local Loop Unbundling at the MPoP.

3.2.3.1.3 FTTC

Figure 3-7 presents the generic Fibre to the Cabinet (FTTC) design. The NGA Recommendation refers to this architecture as Fibre to the Node (FTTN). We regard this term as misleading insofar as operators can either install advanced DSLAM equipment at the MDF (“Node”) or at the cabinet. In such case the two concepts become no longer distinguishable.

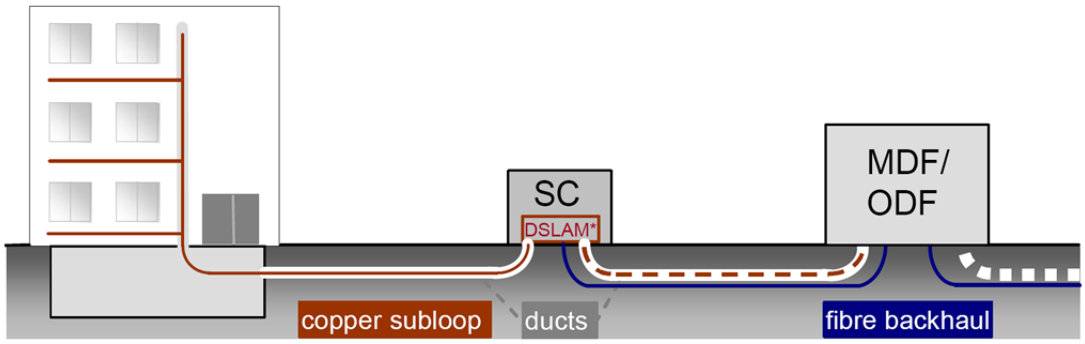
In a FTTC scenario, optical fibres are extended to street cabinets. From this location, traditional copper (sub-)loops provide the connection to the end-user. The street cabinet contains a cable distributor, the Sub-loop Distribution Frame (SDF). Due to the shorter copper loop higher bandwidths are possible. Active (DSLAM/MSAN) equipment is in-

134 This in general improves the optical budget and the length over which the signals can be transmitted. In NGOA systems still under development the colours are splitted to all customers and the ONU/ ONT automatically synchronizes to one colour. These systems are designed to serve up to 1000 customers/ colour over up to 100 km access line length.

135 See e.g. Elixmann et al. (2008), Ilic et al. (2009a), Ilic et al. (2009b), Analysys (2007a), Analysys (2007b).

stalled in the cabinet, usually advanced VDSL(2) equipment. In essence, FTTC shortens the traditional local loop and moves the technical functionalities located at the MDF to these street cabinets. The number of end-users connected to a street cabinet is considerably smaller than that connected at the MDF. In Germany, for instance, this reduction factor amounts to 1:40. This feature of FTTC already indicates and implies that larger market shares would be needed to support a business case for rolling out fibre to the street cabinet. This holds true of an incumbent operator and an access seeker alike.

Figure 3-7: FTTC generic design



SC: Street Cabinet. Note*: DSLAM or MSAN.

Source: BEREC (2010), p. 17

Due to the technical characteristics of the copper line, high transmission rates can only be offered to end-users over a distance of a few hundred meters (if at all). The available bit rates of VDSL are very much dependent on the length of the copper line, see Wulf (2007) or Williamson et al. (2008). The advantages of VDSL regarding bandwidth over ADSL disappear at sub-loop distances of more than 500 m.

The street cabinets have to be modified in order to be able to host outdoor-DSLAMs, which terminate the electrical copper signal and concentrate it in an Ethernet protocol over fibre up to the metro core location. Ethernet switches in the MPoP location further concentrate the traffic through the concentration network to the IP core network. Since the distance between the DSLAM in the street cabinet and the Ethernet switch in the metro core location is not limited by copper transmission characteristics it may be larger than before.

3.2.3.1.4 Single vs. multiple fibre deployment

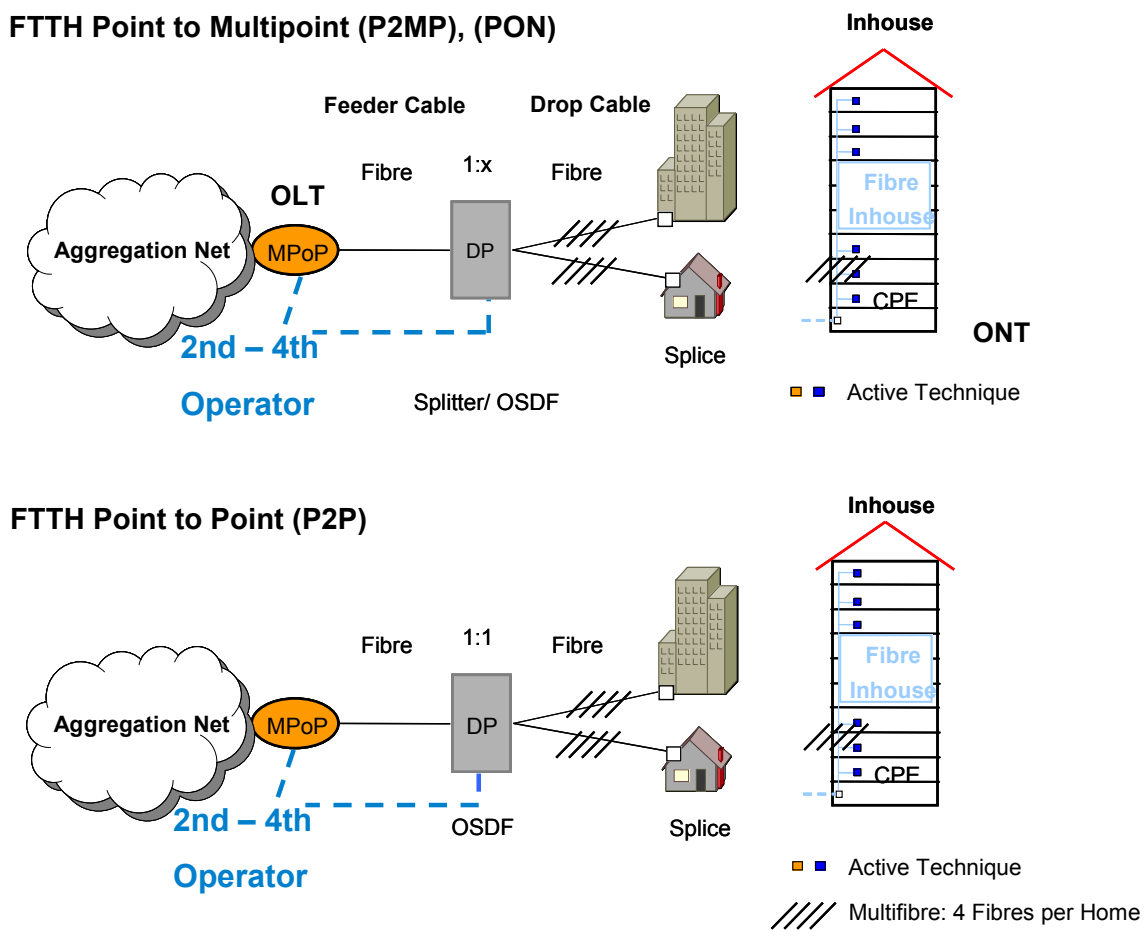
Fibre networks can be deployed in a single- or a multiple-fibre topology. In a single-fibre architecture an individual fibre connection from each home is either laid to the Distribution Point (P2MP architecture/GPON) or to the MPoP (P2P architecture). In the case of P2MP a certain amount of fibres (theoretically up to 1:128) is concentrated on one sin-

gle fibre using a splitter in the DP. Multiple-fibre architectures deploy more than one single fibre per home either (only) in the in-house cabling segment, the drop segment, or in the drop plus the feeder segment. Figure 3-8 describes these options in case of four fibres to each home.

Multi-fibre arrangements usually rest on a lead investor and one or more other market participant(s) acting as “partners” for the venture in question. The partners may e.g. act as co-investors or they may receive indefeasible rights of use regarding the fibre infrastructure.

In multiple-fibre architectures the lead investor deploys more than the required single fibre per home in the drop cable segment and (optionally) more fibres in the feeder segment and provides the surplus fibres to the co-investor(s). All co-investors hence have access to the same end-users through their own fibres. Co-investors could participate in the feeder segment of the lead investor or use other means to backhaul from the DP.

Figure 3-8: FTTH multi-fibre architectures



Source: WIK-Consult

A multi-fibre architecture enables several operators in parallel to get access to the same end-customer, thus offering the end-customer a wider choice. Theoretically (potentially limited by contractual arrangements) each customer has the choice between all access operators being part of a multi-fibre arrangement at each moment in time. Changing the access operator becomes an easy task. It is also possible to demand access services from different operators at the same time. A certain subset of services (e.g. internet access) may be demanded from one access operator and another subset of services (e.g. TV) may be demanded from a different access operator. In a single-fibre architecture the user can also switch the access operator if unbundling is available but he cannot subscribe to different access operators at the same time. This option is only available at the level of service provision.

The investing operator may or may not use one (or more) of the fibres to the home for his own retail business depending on whether he will integrate into (wholesale and/or retail) service provision. The access seeker shares the network segments with the investing operator (and potentially other access seekers) which are deployed as multi-fibres. In case access occurs at the MPoP he has to roll-out his own infrastructure up to the MPoP. This structure of own infrastructure and access to infrastructure of a third party is similar to the full fibre unbundling case. If the access is provided or demanded (only) at the DP, the access seeker has to roll-out its network further up to the relevant DPs. This structure is similar to the case of concentration point (sub-loop) unbundling. If multi-fibre is (only) deployed for the in-house cabling segment, the access seeker has to roll-out its own network further up to the building.

Potentially a multi-fibre architecture is compatible with an independent choice of the investing operator and the access seeker(s) of their own network topology and technology. This flexibility for all market participants, however, requires that multi-fibres have to be deployed up to the MPoP (drop and feeder segment) and access has to be provided both at the MPoP and the DP level. If that is the case, the investing operator may prefer a P2P architecture and use Ethernet technology. The access seeker may either make use of the same technological choice or apply a P2MP architecture using a GPON technology. The same applies if the investing operator chooses a P2MP architecture relying on the GPON technology.

3.2.3.2 Basic NGA technologies

3.2.3.2.1 VDSL

The VDSL technology offers download speeds to users of typically 20 Mbps up to a theoretical maximum of 100 Mbps downstream. The upstream speed reaches 5 Mbps. Both down- and upload speeds are depending on the copper sub-loop length and its quality.

3.2.3.2.2 P2P Ethernet

FTTH P2P deploys fibre access lines from the MPoP to each of the customers' homes (apartments, dwellings). The complete fibre capacity is available for each customer in the subscriber access network since every customer has a dedicated fibre from his home to the MPoP, thus one fibre per home in both the feeder and the drop cable segment is required. Because of the uncertainties of the future bandwidth need of residential and business customers this Point-to-Point fibre plant appears to be the most future proof solution, because the use of the full optical spectrum per fibre is not restricted by any intermediate technology.

The maximum length a fibre local loop may have is determined by the optical budget of the fibre connection and the power of the interface cards at the MPoP and end-customer location (respectively their lasers and receivers). Without intermediate repeaters today's interface cards may reach up to 40 - 80 km. But the longer the distance bridged, the more expensive the interfaces will become. In NGA networks we talk about mass market deployments, thus expensive interface cards could have a significant impact on total cost.

In the P2P architecture the network operator terminates the access fibres on an Optical Distribution Frame located in each of the MPoPs. Thus an ODF has as many customer sided ports as potential customers are in the field and as many homes have been passed by the fibre plant. The ODF is used to connect the single fibres to the ports of the traffic concentrating Ethernet equipment by patching only the access fibres of the subscribers to the network sided ports of the ODF, which then are connected to the ports of the Ethernet switches. This arrangement also allows to connect each end-customer individually to ports of different speed (0.1 to 10 Gbps) or to separate dedicated equipment. Ethernet links provide this capacity in a symmetric manner for both up- and downstream.

3.2.3.2.3 GPON

The GPON technology was designed to manage Point-to-Multipoint fibre plants. It concentrates the traffic of a significant number of customer access fibres at an intermediate optical splitter location (DP) onto a single backhaul fibre. Optical splitters may be cascaded in order to optimize the fiber count and to adapt it to the end-customer distribution. But each splitter adds some additional attenuation by getting spliced into the cable and because it has to distribute the power of the downstream signal to all fibres connected. Thus the fibre plant strongly depends on the optical power budget and the maximum splitting factor. ITU-T G.984 standardizes GPON in its limitation of 20 km reach at a 1:32 maximum splitting factor. New standards and better interfaces allow a splitting factor of up to 64 or even 128. The fibres from the splitters are connected to the client side of the ODF in the MPoP, patched over from there to the appropriate OLTs. The OLTs are connected to an Ethernet switch which is the interface to the concentration network.

In order to coordinate communication of end-users with the active electronics at the MPoP, admission rights are administered by a central component (the Optical Line Terminator – OLT) which has to interact with decentralised components at the end-customer sites, called ONU (Optical Network Unit, in case of several customers) or ONT (Optical Network Terminal, in case of one customer). Accordingly, OLT and ONU/ONT must be able to communicate with each other. International standards generally only offer a basic, minimal level of interoperability, thus in practice there is a supplier dependency between OLTs and ONUs/ONTs. By contrast, the degree of supplier dependency for P2P solutions is not significant, because current solutions for active equipment are all based on standard Ethernet interfaces that interoperate in a worldwide mass market.

GPON systems offer a downstream bandwidth of 2.5 Gbps and an upstream bandwidth of 1.25 Gbps, shared between all customers connected to the same splitter (respectively splitter chain) or OLT port. In the case of 64 end-customers per splitter it would result in approximately 40 Mbps down- and 20 Mbps upstream per customer as a fixed bottom line capacity, which can be used in a shared manner if the system is configured appropriately, so that the users may achieve the total sum of bandwidth as a peak capacity. Also if the splitters are not completely filled with active subscribers the spare capacity may be shared between the subscribers.

GPON with its central administration of sending rights in the OLT in principle allows to allocate a fixed bandwidth or more dynamic bandwidth for an end-customer and thus it enables to serve end-customers in an individual manner. But this is limited to the degree the other customers are not harmed or restricted in their principle capacity demand. Reducing the number of customers connected to a splitter is another method to increase bandwidth per customer, and of course both methods may be combined. But reducing the number of customers for a splitter requires a change in the fibre plant. Since customer demand cannot be planned in advance, spare splitters could be foreseen during fibre roll out for future use. As all fibres are administered by the same interface cards, individual solutions to single, dedicated (business or wholesale) customers requiring an Ethernet interface above 1 Gbps or requiring access to the optical spectrum (WDM band) cannot be supported by GPON, rather, they require additional fibres in the feeder and drop cable segment.[136]

Each ONU/ONT has to listen to the downstream messages of all connected customers and filter them for its own end-user. The downstream messages are encrypted, but broadcasted to all neighbours at the same splitter, which may listen. This inherently makes the system more vulnerable to illegal interception and/or generates higher costs for encryption to secure communications. The upstream messages between end-customer and OLT are not encrypted and may be reflected by imperfect splices in the

136 With sub-loop access at the DP and an OSDF additional feeder fibres could be flexibly connected to the drop segment without any additional fibre count.

feeder cable, thus enabling clear text interception with very sensitive (special) receivers. Denial of service attacks may be started with a strong optical beam ignoring the administration of the OLT, or by affecting the OLT's administration messages, and there is also a certain risk that faults in one ONU/ONT may affect all the other endpoints of the same splitter/OLT. Determination of fault locations in such a spread environment is harder to achieve than in a P2P system where only single lines fail under these circumstances. Thus we assume GPON systems to be more vulnerable to illegal interception, denial of service attacks and under certain fault conditions more time consuming to repair.

GPON architectures concentrate the traffic onto fewer interfaces at the MPoP compared to P2P Ethernet approaches. These active components are more complex and more expensive than P2P components. The same holds true of end-user devices. As long as a GPON architecture cannot make use of the concentration of the splitters, because users have not yet subscribed or new buildings[137] are not yet constructed, many splitter locations are likely to stand empty for a significant period of time. This situation could be improved with intermediate distribution frames at splitter locations. Nevertheless, this complexity does not occur with P2P architectures, where ports are only installed and operated to connect active customers.

GPON technology is well suited to asymmetric traffic, inasmuch upstream and downstream bandwidth differs due to the inherent characteristic of upstream communication collision. A preponderance of downstream traffic over upstream has so far been a typical residential communication behaviour, and GPON is well suited to residential customers who have substantial downstream and limited upstream communication demand. However, already today business customer demand is symmetrical. And even for residential customers, there is a strong progressive trend towards more symmetric broadband communication (e.g. video conferences/telephony, gaming, Peer-to-Peer[138] communication). Therefore, one might question whether the GPON architectures are really future proof in the long-term concerning traffic patterns, given that fibre-based infrastructures could have economic lifetimes of as much as 40 years.

If GPON had to deal with a bandwidth demand increase by a factor of 10, then the planned GPON evolution to 10G-PON would not suffice; either new GPON evolutions come forth or WDM PON concepts are required to increase bandwidth on a Point-To-Multipoint topology.[139] Migration to systems where the optical frequencies used overlap each other (e.g. GPON and DWDM) require the complete exchange of the components in the fibre strings (tree) of a splitter/OLT in one step with all ONUs connected (e.g. 64)

137 Homes which may be constructed later.

138 Peer-to-Peer is in many cases also referred to by the acronym "P2P". In this study we only use the term P2P for the fibre architecture, not for the logical communication relation in the layers above.

139 For migration from GPON to 10GPON the optical windows of the frequency plan are synchronized and allow for overlay installations and smooth migration. With XG-PON2 of FSAN (Full Service Access Network, the member companies drive standards into products and contribute to the standardization process via ITU-T) 10GPON will offer 10 Gbps symmetrical shared bandwidth. From 10GPON to WDM PON overlay and frequency plans are not coordinated and will cause conflicts; see Figure 3-9 below.

or a redesign of the fibre plant. Migration to technologies requiring a Point-to-Point fibre plant would require additional ducts and fibres in the feeder cable segment, thus should be avoided if possible.

Most GPON systems allow to distribute a separate cable-TV signal (RF signal)[140] as a separate wavelength in a broadcast manner from OLT to ONU/ONT[141]. This signal is terminated on a coax plug and can be fed into the existing cable-TV cabling at the end-customer's home. If enough frequency space is set aside for the RF signal (e.g. 2.5 GHz frequency space of this additional RF signal) the RF channel may be shared between several cable-TV signals (e.g. 3 x 800 MHz) and thus is open for unbundling and wholesale offers also. This feature adds new options of market approaches.

Providing 40 Mbps per customer on average could cause bottlenecks if many of these customers use high quality IPTV and Video on Demand (VoD) in parallel, e.g. during evening hours, if they use several receivers per home. Thus IPTV in a GPON environment often is implemented as dynamic multicast where only those TV-programs are broadcasted in an OLT string which are requested by the end-users of that string. This may cause switch-over delays. This may happen in GPON architectures more often than in architectures with higher bandwidth per end-customer, where more programs may be broadcasted at the same time. Thus, we qualify the IPTV capability of GPON to be poorer than that of P2P Ethernet.

GPON can also be implemented on top of a Point-to-Point fibre architecture by "moving the splitters back" into the central MPoP location and having dedicated fibres in both drop and feeder section. The reason why we consider this hybrid P2P/GPON architecture is the potential to combine advantages of both worlds. All fibres are terminated on the ODF and are accessible per patch cables. So every customer still has a dedicated fibre line to the MPoP, thus opening all future fibre and optical spectrum uses one may imagine and also allowing individual use of a single fibre as described in the previous P2P scenario (see Section 3.2.3.2.2). If not connected to the splitters and OLTs at the MPoP but to other transmission systems, individual customers could be served with special products beyond the broadband mass market GPON products (e.g. 1 Gbps symmetrical traffic, 10 G or even optical frequency space based transmission). Beside this additional option individual customer demand may be served on the basis of the GPON features as described above, whereby the reduction of the splitting ratio could be achieved in an easy way by installing new splitters at the central site (MPoP) without affecting the fibre plant in the field.

Locating the splitters at a central site allows a more efficient use of the splitters and the OLTs during the roll out of the services. This not only generates positive cash flow effects but also reduces some risk of investment. Only active subscribers would be

140 RF – Radio Frequency.

141 There are also Ethernet switches supporting RF signals in a separate wavelength to the end-customer, thus offering similar advantages.

patched from the main ODF via a network sided ODF port onto a splitter and from there to the OLT. This assures a very high degree of splitter and OLT efficiency (contrary to the standard GPON case with splitters in the field, OLTs will have a very high utilisation rate because only active subscribers are patched through).[142]

The use of longer access lines between splitters and end-customers has no impact on the total optical budget of the GPON system since the feeder cable is shortened by the same length. Compared to cascaded splitters a larger splitter at a central site also means less fibre splits and therefore lower attenuation and potentially an improved optical budget due to less splitter attenuations.

There is also no change concerning the exchangeability and interoperability of GPON OLTs and ONU/ONT. But the flexibility of the Point-to-Point fibre plant allows one to exchange the transmission systems smoothly over time, one customer at a time, if that looks favourable, and thus reduces the supplier dependency of the operator. This is an economic value per se[143].

Since the active equipment connecting to the customers still is GPON-based, the security and availability considerations for GPON described in the section above remain the same. But the underlying Point-to-Point fibre architecture allows individual services with improved features for dedicated customers in parallel without any additional fibre count. It would also allow a smooth migration to other architectures like Ethernet P2P, if that looks favourable at one point in the future or for a subset of customers.

The space and the associated cost required at the MPoP sites will be higher than with GPON with distributed splitters, because the ODF network and customer sided port counts are significantly higher (by the splitting factor) and the splitters themselves must be located at the MPoP sites, too. On the other hand, the distributed splitters and their associated cost in the field will be saved. The demand of electrical power consumption during ramp-up will be lower in a GPON topology with centralized splitters, since the OLTs will only be installed according to demand and subscriber increase. Concerning outband RF-TV signal transmission there is no difference between the two GPON approaches.

3.2.3.2.4 WDM PON

Using a single optical fibre for several customers can be done in technologically different ways. GPON technologies use the same single optical beams and assign transmission rights to end-users by a central administration (the OLT at the central site), so that each user can send his upstream information exclusively and without interference with other

142 At least in the beginning of a roll-out, GPON OLTs would suffer from low take-up while GPON over P2P OLTs could always be operated at their capacity limit.

143 The ability to switch suppliers without loss of service quality for the end-user improves supplier competition and reduces equipment cost when new generations of systems have to be introduced. It also reduces migration cost and the risk of supplier insolvency etc.

users in the same system in different time slots (TDM, Time Division Multiplex). WDM (Wave Division Multiplex) systems, however, use optical beams of different wavelengths (different colours) to separate the transmitted information from each other (optical FDM, Frequency Division Multiplex). Hence, WDM is essentially a means of capacity expansion by reusing the physical medium optical fibre with more than just one wavelength.

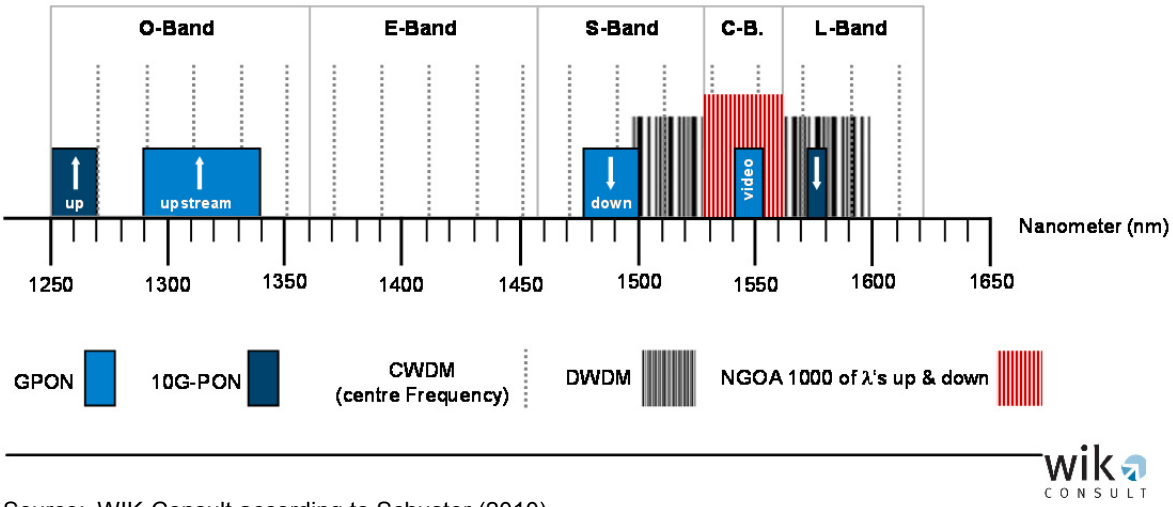
GPON already multiplexes two (three if additionally analogue (RF) TV is being considered) wavelengths on the fibre. The Coarse WDM standard enables 18 separately distinguishable wavelengths and the Dense WDM standard enables 162 wavelengths with a much smaller frequency space for each transmission channel. GPON and C/DWDM as such cannot coexist on the same fibre (at least not without sacrificing some of the defined WDM wavelengths). The more wavelengths are enabled, the smaller the spacing between two wavelengths becomes. Smaller channel bandwidth and spacing requirements mean that lasers must be increasingly accurate. This has made the use of DWDM in the access network up to now expensive.

Yet, system development proceeds and DWDM costs have significantly decreased over the last decade and will continue to decrease. Already today there are DWDM PON systems in the market that allow using up to 80 different colours of the DWDM grid in order to address customers individually[144] – or as customers grouped on a GPON overlay network. WDM also allows for splitters allocating the individual colours to the appropriate fibre access lines connected to the splitters. Each colour is capable of transporting a 10 Gbps Ethernet signal. Tuneable transponders allow to use “grey light” standard end-customer equipment.[145] In multi-dwelling buildings this large capacity may be shared in a FTTB manner by an Ethernet aggregation switch in the basement. At the central site the OLT routes the optical beams to different directions and thus allows to unbundle single optical beams. Overall, the DWDM approach is not well suited to address the mass market already now, because it is oversized and still rather expensive, so it better suits for business customers and large multi-dwellings in a FTTB manner.

144 E.g. ADVA Systems, Munich, Germany.

145 “Grey light” means light of a specific wavelength allowing all end user equipment to be based on the same wavelength whereby the transponder transforms this light onto a single dedicated colour.

Figure 3-9: Use of the optical wavelength grid in a WDM system



Source: WIK-Consult according to Schuster (2010)

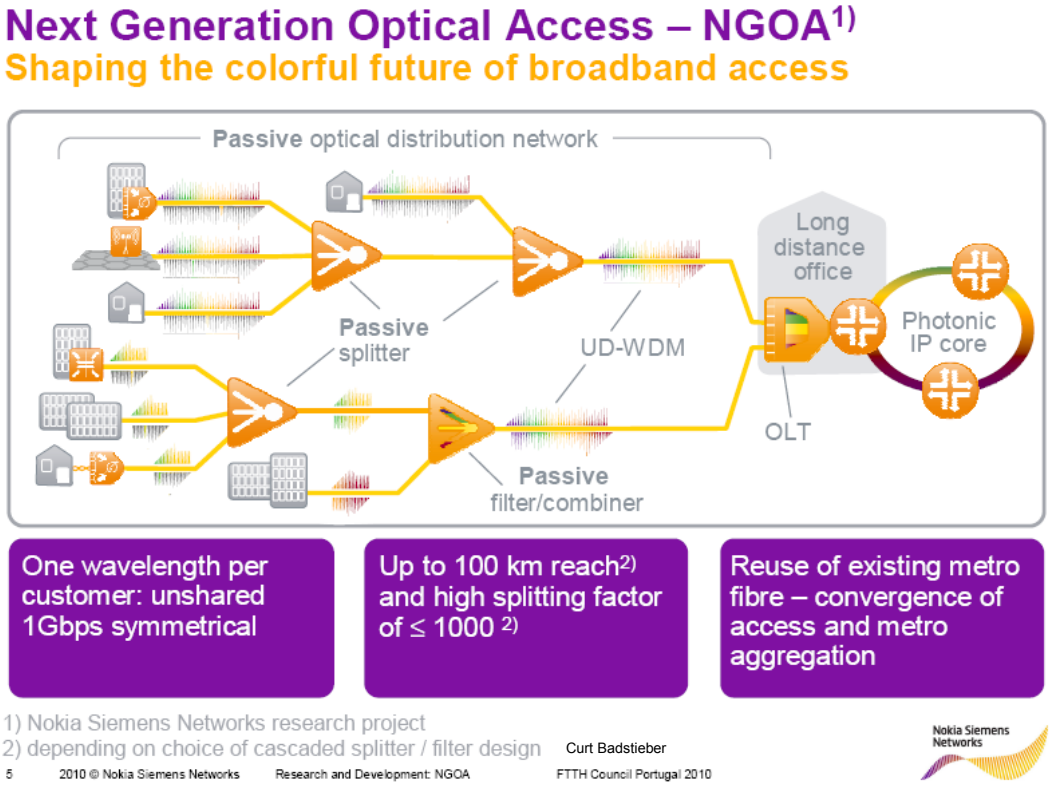
Recent research by Nokia Siemens Networks and other companies organized in the Open Lambda Initiative aims at enabling an enormous increase of wavelengths on the same fibre by facilitating technological progress in signal processing, tuneable lasers and photonic integration. This would allow high wavelength density and requires high receiver sensitivity, thereby enabling approximately one thousand individual wavelengths in the C-Band of the spectrum alone (Next Generation Optical Access – NGOA). Such a solution would, however, affect the GPON downstream channel bandwidth, the RF video wavelength of the GPON standard and the 10G-PON downstream channel wavelength, see Figure 3-9. In this way, only coexistence between GPON and 10G GPON would be enabled. At the moment we see no option for a coexistence between GPON and NGOA.

Such a WDM PON technology (Figure 3-10) would allow dedicated wavelengths for each customer, resulting in higher bandwidths compared to GPON. Each of these WDM PON wavelengths is expected to support 1 Gbps bandwidth, which can be administered by one or more WDM PON OLTs, operated by different carriers, thus allowing to unbundle the wavelength.

To be precise, the aim of using WDM in this context is not to multiplex multiple GPON overlays on the same fibre but rather to enhance the capacity of the system by providing every customer with a separate wavelength of higher capacity which e.g. may be “unbundled”, too.

So far, this is ongoing research and development, and it remains to be seen whether this technology can be commercialized. Suppliers forecast the market availability within approximately three years from now.

Figure 3-10: Outlook: WDM PON in future use



Source: Badstieber (2010)

In a WDM PON system a single OLT supports up to 1000 wavelengths with 1 Gbps capacity each in a symmetric manner. The fibre plant may bridge a distance of up to 100 km. This allows to close all of the existing MDF locations except those used for the core network. The MDF will be replaced by larger manholes which host additional splitters (1:16)[146] in order to further concentrate the fibres. Up to 1000 drop cable access lines would then be concentrated per backhaul fibre between the old MDF and the remaining MPoP at the core layer nodes. Up to the old MDF locations the fibre plant can be the same compared to GPON (with splitters in the field), from there to the MPoP the existing concentration network will be replaced by backhaul fibres, hence by a passive optical network.

With this type of WDM PON architecture we have a dramatic increase of dedicated bandwidth per end-customer (from 40 Mbps to 1 Gbps) but the bandwidth peak per customer is reduced to 1 Gbps compared to 2.5 Gbps in the shared GPON case. This solution only allows to serve the end-customers individually in the bandwidth frame the opti-

146 A splitting ratio of 1:64 is assumed up to the old MDF according to the GPON standard, 16x64 = 1,024.

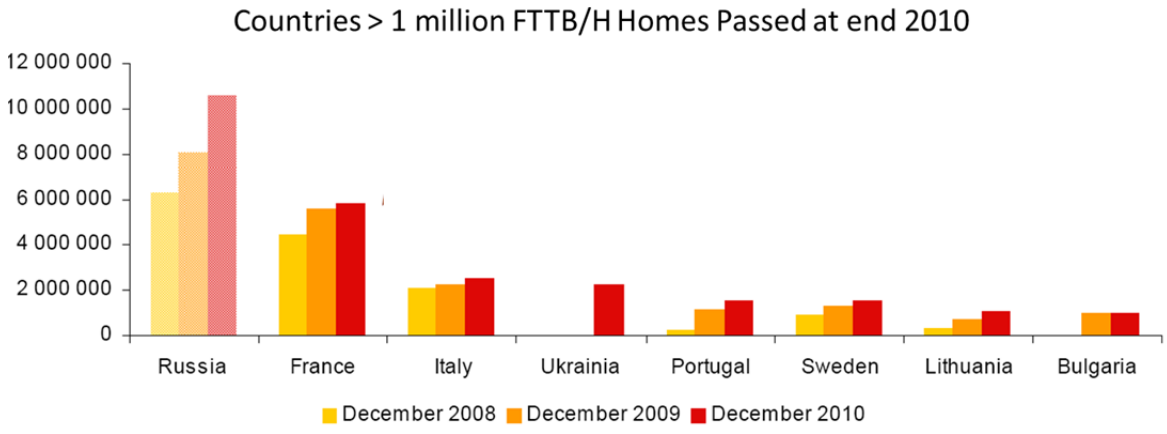
cal beam offers (1 Gbps). Higher bandwidth can only be offered by bundling colours. Dark fibre optical frequency bands for dedicated customers cannot be served and require additional fibres in the backhaul, feeder and drop segment. Supplier dependency and inflexibility for future system upgrade may remain the same as with GPON since the system is also based on a Point-to-Multipoint fibre plant.

To the best of our knowledge the WDM PON solutions do not implement the RF-TV approaches of GPON and Ethernet P2P, but in principle we see no technical hurdles to add an additional optical beam for this purpose, if there is demand for it. Thus we see no competitive differences between the architectures considered regarding RF-TV.

3.2.3.3 Actual roll-out and roll-out announcements

Compared to other regions of the world the NGA deployment based on FTTB/H is still at a relatively low level in Europe. In December 2010 22.3 million homes were passed by FTTB/H in Europe.[147] Just 3.9 million subscribers actually make use of this supra-fast technology which makes an average penetration rate of 17.5%. There is a significant spread of deployment within Europe. Figure 3-11 provides a snapshot of countries where the number of FTTB/H homes passed exceeds 1 million.

Figure 3-11: FTTB/H Homes Passed in selected European countries



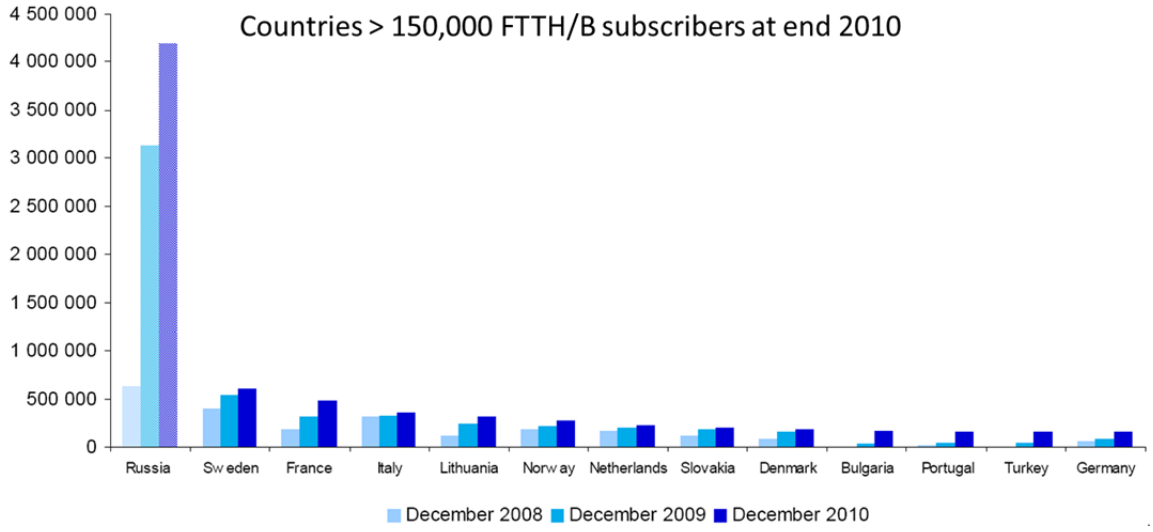
Source: Montagne (2011b)

It is not the large but the small countries which are the leaders in FTTB/H coverage. The top 5 countries in terms of homes passed as a percentage of total households are Latvia (41%), Portugal (40%), Andorra (100%), Slovenia (44%) and Lithuania (78%).

147 See Montagne (2011b).

The economics and profitability of FTTB/H is mainly driven by penetration. It is not the largest countries in Europe which exhibit a high degree of actual penetration. Rather, Norway (68.3%), Sweden (39.5%) and Lithuania (29%) exhibit the highest values.[148] As a contrast, French operators could only motivate 8% of potential FTTB/H subscribers so far to actually subscribe and to use available fibre networks.

Figure 3-12: FTTB/H subscribers in Europe



Source: Montagne (2011b)

As Figure 3-13 shows the main architecture deployed in Europe still is FTTB and the share or FTTH is only slightly increasing. Operators have mainly chosen the Ethernet technology to operate their network and therefore deployed a P2P topology. Only 27% of all homes passed are connected to a GPON technology and the corresponding topology is deployed in a P2MP architecture. As the economics of FTTH dictate, Multi-Dwelling Units (MDU) are still the principle target for fibre deployments in Europe.

148 See Montagne (2011b), p. 31.

Figure 3-13: FTTB/H technologies applied in Europe

Main architecture deployed (homes passed segmentation)	Dec 2010	June 2010	Dec 09
FTTH	37%	34%	33%
FTTB	63%	66%	67%

Main technology deployed (homes passed segmentation)	Dec 2010	June 2010	Dec 09
PON	27%	26%	24%
Ethernet	73%	74%	76%

Dwellings deployed (homes passed segmentation)	Dec 2010	June 2010	Dec 2009
MDU	77%	76%	75%
SDU	23%	24%	25%

Source: Montagne (2011b)

European incumbents are getting more concerned by FTTH, nearly all of them have plans for FTTH or are already deploying it. They are, however, currently not the leaders in deployment. Indeed, they are representing only 19% of the homes passed in Europe, while alternative operators and cable companies represent 73% of fibre deployment and the remaining 8% are deployed by municipalities and utilities (end of 2010).[149] Many incumbents currently use VDSL(2)-technology in a FTTC approach. Current deployment of FTTB/H differs ranging from small scale pilot projects to deployment at a broader scale.[150] In the majority of countries where the incumbent deploys FTTH the focus is on GPON technology. In the survey conducted by BEREC (2011a) almost all incumbents have announced that they plan to roll-out NGA networks in the near future. But such announcements are not always reliable. In 2010, for instance, Deutsche Telekom announced to roll-out fibre to 10% of all German households by the end of 2012 which would have implied the tremendous number of 4 million homes passed. In the meantime, however, these plans have been reduced to 160,000 lines in 2011 and 100,000 lines in 2012, which makes only about 7% of the originally announced plans.

The major part of fibre based access lines is deployed by competitors of the incumbent, namely cable companies, utilities/municipalities and other telcos. In several countries regional or even local ISPs deploy these networks often on a small scale. In Italy, Fastweb's NGA network passes 2 million homes and connects 300,000 customers. In a recent co-investment project the three Italian operators Fastweb, WIND and Vodafone deployed a P2P access network in an area of Rome, giving unbundled fibre loop access to each of

149 See Montagne (2011a), p. 9.
150 See BEREC (2011a), p. 2.

the partners, while the incumbent Telecom Italia promotes GPON over a P2MP fibre topology, thus not joining the other market players. In Slovenia where 11% of households are connected with FTTH, the main competitor has a market share of approximately 62% of the FTTH connections.[151] The competitors mainly deploy Ethernet technology based on a P2P topology. In countries like Belgium, the Netherlands and the UK the cable operators are the main competitors of the incumbents' NGA deployments. In the Netherlands, for example, DOCSIS 3 networks cover 95% of the population.

3.2.3.4 Classification of access products

There are various ways to classify access products:

(1) Layer level classification.

(2) Active vs. passive access products.

(3) Classification according to where the access point is located in the network.

(4) (Primary) wholesale products vs. (ancillary) wholesale products to reach access points.

A reasonable differentiation of access products might be given by classifying different layers:

- Layer 0 products (defined for specific endpoints) consist of duct access and access to dark fibre (i.e. including fibre unbundling) or copper pairs.
- A Layer 1 product is given by WDM-PON in combination with active components, also leased lines of fixed capacity could be classified as layer 1 access products[152].
- A Layer 2 access option (for different network segments and at different speeds) is given by a Ethernet bitstream service between Optical Network Terminations (ONT) of end-users and a specified PoI (perhaps plus additional backhaul service to connect the POI of the wholesale supplier and the PoP of the wholesale access seeker).
- Layer 3 services are characterised by (IP-) bitstream access at different locations.

Layer 2 and 3 services in a fibre based broadband environment are already available at least as concepts in several countries (e.g. in Australia and Singapore)[153]. Moreover, in the UK Ofcom has introduced a „virtual unbundled local access" (VULA) solution and the NRA in Austria has imposed a „virtual unbundled local loop" (vULL). solution. Albeit named as unbundled access options these concepts are bitstream access approaches.

151 See BEREC (2011a), p. 3.
152 Market 6, access segments of leased lines.
153 In these countries specified supplementary services like e.g. co-location, additional QoS services, and/or multicast services are available in addition to the Layer 2 and 3 services; see Doose and Elixmann (2011).

Passive wholesale products provide access to a transmission medium without any electronic component. Passive products include duct access; all unbundling products are located at Layer 0. Active wholesale products are including passive equipment and active transmission systems and take into account technical transmission protocols such as SDH, Ethernet etc. that are located at Layer 1 or Layer 2 of the ISO/OSI model. Wavelength unbundling (Layer 1) entails hybrid elements. In terms of unrestricted usability for the access seeker it comes close to an unbundling product. On the other hand, active electronics is needed to separate the various wavelength to which an access seeker would get access.

Access can be provided at various locations and protocol layers of the network:

- At the basement of a building in order to access the in-house wiring,
- at the street cabinet (FTTC architecture) or distribution point (FTTH),
- at the MDF (copper network) or MPoP (fibre network),
- at nodes of the core network.

Potentially, bitstream access can be provided at all (protocol) layers of the aforementioned locations of the network. At the core network nodes, only bitstream access is a technically feasible access product. The possibilities to provide unbundled access depends on the topology of the passive fibre network.

BEREC (2010) has introduced the distinction of (primary) wholesale products and (ancillary) wholesale products which are used to reach access points. Duct access, co-location and access to leased lines or dark fibre in the backhaul segment fall into the latter category of wholesale products.

3.2.3.5 Unbundling, topologies and technologies

3.2.3.5.1 Basic concept

Physical unbundling grants access to the end-customer access line and allows to connect the competitor's own transmission systems to directly transmit over it. On the one hand this gives a high flexibility for the competitor to determine its own access products. On the other hand this can only be implemented with the limitation not to disturb the other signals transmitted in the same cable. With fibre access lines the danger of interference with other fibres disappears, using wavelengths for unbundling it has to be taken into account. Physical unbundling reduces the dependency of the competitive operators to the quality with which the physically unbundled wholesale product is provided and operated. No active elements, adding additional constraints, are involved.

Using physical transmission media of a supplier offering unbundling by definition implies the access seeker to be dependent on the media's quality, which may in the case of copper dominate the transmittable bandwidth. Thus, for high bandwidths there may arise the need to access shorter lines than offered from the MDF, e.g. at the street cabinet. Thus, the access point for the unbundled lines may be determined by product quality. But also the access network topology may determine where the individual access lines start, thus determining where access is possible at all (e.g. FTTC at the Street Cabinet, GPON P2MP at the splitter closest to the end-customer). From an access seeker's point of view one can generally state, the closer the physical unbundled access point is located towards the core network or the more concentrated the number of access lines, the less own infrastructure is required and the more the access seeker can profit from the incumbent's economies of scale.

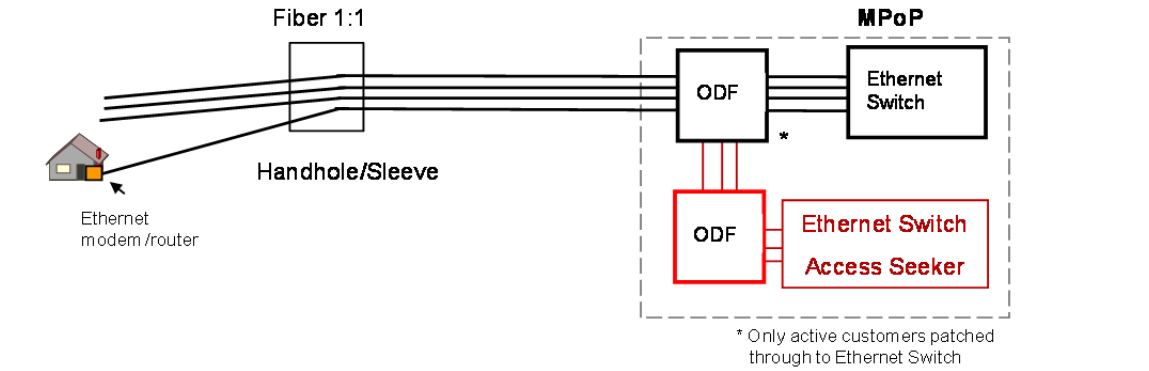
Physical unbundled access in any case requires co-location and in most cases backhaul (ancillary) services also, which have to be determined in parallel.

3.2.3.5.2 "Full" unbundling

A P2P architecture of the FTTH network provides the same approach of unbundling of the fibre loop at the MPoP as the architecture of a copper access network allows at the MDF, see Figure 3-14 below. The location of an MPoP can be the same as that of an MDF but this is not a necessary requirement. P2P architectures make unbundling "easy" as there is one distinct fibre per customer between MPoP and end-user. The "canonical" wholesale product to be offered is an unlit fibre. Unbundled access takes place at the MPoP. The bandwidths available for wholesale access seekers on a P2P architecture in principle are only limited by the physical limitations of the fibre as such.

The access seeker will terminate its fibre in the ODF location of the access supplier. It rents the unbundled fibre loop, places an additional Optical Distribution Frame of his own at rented co-location space in the MPoP and operates in addition his own Ethernet Switch (or other communication equipment). The access seeker's ODF is connected via a dedicated patch cable to dedicated customer sided ports of the access supplier's main ODF. The costs of all these elements are part of the access seeker's total cost. In addition, the access seeker has to bear the cost of the concentration and core network himself. The cost structure of a business model based on fibre unbundling is rather similar to the ULL business model widely applied in the EU today.

Figure 3-14: P2P with fibre LLU: Stylized view



Incumbent cost (relevant for LLU price)	**Competitor cost****
▪CPE	▪CPE
▪Access Network incl. Inhouse cabling	▪LLU charge
▪ODF + Patch cabling + floorspace	▪Competitor's ODF & Patch cabling + floorspace
▪Ethernet Switch + floorspace + energy	▪Ethernet Switch + floorspace + energy
▪Network sided Ethernet port (1 per MPoP)	▪Network sided Ethernet port (1 per MPoP)
▪Concentration Network	▪Concentration Network
▪Core Network	▪Core Network

** Assumption: Unbundler operates Ethernet P2P network

Source: WIK-Consult

For fibre unbundling at the ODF, the following ancillary products are necessary:[154]

- Co-location at the ODF location;
- Backhaul from ODF to a higher network level (depending on the status of competition for backhaul services, to be provided by the SMP-operator). Such ancillary services include duct access, dark fibre or leased lines (including Ethernet solutions) and should be made available to alternative operators to connect their network to the interconnection point.

3.2.3.5.3 Concentration point unbundling

The concentration point is an intermediate node in a fibre based NGA, where physical unbundling is feasible to the group of end-users connected to this point. The concentration point provides a physical interface between the drop and the feeder segments of the access network where a physical aggregation of fibres takes place. Aggregation may be materialized via splicing if the operator applies a P2MP architecture or by using a simple distribution frame.

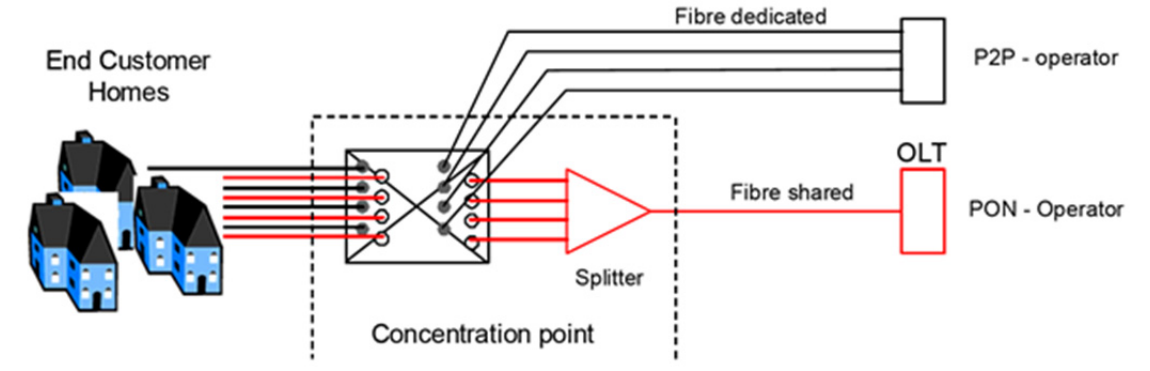
154 See BEREC (2010), p. 31.

The term and access concept of “concentration point unbundling” as used by BEREC (2010) is identical with the term and concept of “access to the terminating segment in the case of FTTH” as defined in the NGA Recommendation. This access concept and the corresponding access product is similar to the sub-loop unbundling concept in the copper access network.

Technically, a concentration point can geographically be located “anywhere” between the ODF (MPoP) and the end-users. The actual location determines the number of end-user connections to a concentration point. A sufficient number of end-user connections is a key factor for the commercial viability of this access concept. In most cases it is likely to be located no further from the end-user than the street cabinet in a copper network. Technically, a concentration point might also be located between the street cabinet and the ODF.

Figure 3-15 provides the general structure of concentration point unbundling. Concentration point unbundling is neutral with regard to the basic fibre architecture and of course the technology (active electronics) which the access provider as well as the access seeker applies. Under concentration point unbundling the access seeker gets access to a dedicated fibre (sub-) loop to each individual end-user of an FTTH network. For its own upstream network he is free to choose whether he aggregates fibres in a P2MP architecture or whether he deploys also in the feeder segment a dedicated P2P fibre architecture. The same holds true of the access provider. He can apply a PON technology based on a P2MP or P2P architecture or he can apply a P2P Ethernet technology.

Figure 3-15: Concentration point unbundling: Stylized view



Source: BEREC (2010), p. 23

Although concentration point unbundling is an attractive access option from the point of view of architectural and technological neutrality for access seeker and access provider it has relevant limitations from the point of view of economic viability. Several studies show that access seekers need large market shares for a viable business model on that basis which can be (significantly) above 20% for a relevant degree of network coverage.[155] Compared to full fibre unbundling at the MPoP access seekers have to replicate the whole feeder segment of the network, which generates significantly increased costs compared to full unbundling and therefore requires significantly higher critical market shares for running a viable business model. One indication can be provided by the analogy to the copper network: In the case of Germany an operator has to connect about 8,000 MDFs for nationwide coverage. If he interconnects at the street cabinets he has to connect about 300,000 access points. Concentration point unbundling generates business opportunities for perhaps one access seeker (if at all) only if he has access to fibre infrastructure in the feeder segment at lower opportunity cost than under a Greenfield deployment like some utilities might have. It is also BEREC's expectation that a significant demand for unbundling at a concentration point closer to the end-user is unlikely unless the operator seeking access has already rolled out fibre to the concentration point.[156]

3.2.3.5.4 Sub-loop unbundling

In an FTTC architecture the fibre is deployed up to the street cabinet.[157] A VDSL or VDSL2 DSLAM is then installed at the street cabinet. From that node downwards to the end-user's premise the copper sub-loop of the existing copper access network will be used. If an access seeker gets access to the copper sub-loop he can install its own VDSL DSLAM at or "close" to the street cabinet of the incumbent and can replicate VDSL services to the end-user. Practical implementation can either be by adding an additional street cabinet to host the competitor's active equipment next to the incumbent's cabinet or by placing new street cabinets over the existing ones. If the incumbents' street cabinet is sufficiently large, co-location inside the cabinet also is an option.

Sub-loop unbundling is access at the physical layer in the same way as unbundled access at the MDF. As the NGA Recommendation states, sub-loop unbundling should be supplemented by backhaul related remedies like fibre and Ethernet access as well as access to facilities for co-location (or equivalent).

Several studies show that the economic potential for viable business models of competitors based on sub-loop unbundling are rather limited.[158] Deploying the fibre up to the street cabinet requires a significant network investment and/or generates significant

155 See Elixmann et al. (2008), Analysys (2007a), Analysys (2007b).
156 See BEREC (2010), p.2.
157 This architecture often is abbreviated FTTN (node). This is misleading insofar as VDLS DSLAMs can be and actually are (for instance in Germany) also installed at the MDF (node), improving the transmission speeds for those loops which are directly connected to a MDF without an intermediate street cabinet node.
158 See for instance Analysys (2007a), Analysys (2007b), OVUM (2008), Elixmann et al. (2008).

scale even if backhaul products are available such that a high level of critical market share is needed. According to our calculations they are in the range of 20 to 40%.[159] This becomes obvious if one compares the number of end-users connected to a node. While 1,000 to 20,000 customers are connected to an MDF in Germany and with an average of 5,000, there are only 100 to 300 customers connected to a street cabinet with an average of 150.

3.2.3.5.5 Unbundling and multiple fibre

We have already formulated significant similarities between a multi-fibre based and an unbundling access regime.[160] One further identity is that under multi-fibre the access seeker has the same unrestricted access to the full capacity and capabilities of the (unlit) fibre line. Under both access regimes the access seeker is only restricted by its own topology and technology choice and can therefore produce the same service quality to the end-user as the investing operator. There is, however, a difference in the provision of wholesale services. In the multi-fibre case the access seeker can also in competition to the investing network operator provide unbundling as a wholesale service. In the unbundling case the access seeker may only act as a reseller of the incumbent's access lines.

Indirectly service quality may, however, be affected by the operating process under which unbundling effectively works operationally. If there is delay or uncertainty in the switch over of access lines, service quality may be affected. This is different in the multi-fibre regime. Here the access seekers will become physically linked to all access lines of an area via splicing of the fibres. There is no line by line switch over process of access lines which may affect service quality. Thus, there is no operational risk in this relationship. There remains, however, an identity when it comes to operation and maintenance. The operation of the fibre access network is carried out by the investor in the multi-fibre case and by the incumbent in the fibre unbundling case, thus normally by a third party from the view of an access seeker. In both cases, the process between the access seeker and the fibre operator for failure analysis and repair have to be synchronised and performed in the same manner and therefore does not differ from each other.

In both scenarios the access seeker can, of course, provide a competitive bitstream access wholesale service.

There is one major difference between unbundling and multi-fibre access representing an inherent feature of a multi-fibre architecture: In the unbundling case access usually is demanded and provided line by line. Usually the access seeker acquires a retail customer first and then acquires the access line from the incumbent on the basis of unbundling. In the multi-fibre case the access seeker usually acquires access to all access lines of an entire region, city or district while the access commitment in the unbundling case refers to just one single access line. This also means that the access seeker ac-

159 See Elixmann et al. (2008).
160 See Section 3.2.3.1.4.

quires a bulk of access lines before he acquires the corresponding customers. This means that the risk profile of this access concept is quite different.

So far we have considered the position of the access seeker and its relationship with the investing operator in both cases in the same way. Effectively their position, however, is different. While the unbundling relationship represents the “traditional” asymmetric incumbent/access seeker relationship, their relationship in the multi-fibre case is better described as a (more symmetrical) co-investor relationship. Both (or several) parties share the investment of a certain network element. Usually there is not joint ownership – which could also be an organisational model – of the shared investment, rather, the investor owns the infrastructure and provides indefeasible rights of use (IRUs) to the access seeker(s) which define the exclusive right to use a particular fibre capacity. The IRU concept is a well-established concept in the field of undersea and transnational cables. The IRU concept also underpins the long-term and effectively risk sharing nature of such cooperative arrangements. The investment cost of the shared part of the network also usually is shared in fixed proportions.

To get some more insight into the functioning of such cooperative arrangements we present (in the following) some details of the multi-fibre approach which has been established in Switzerland as a cooperation between the incumbent Swisscom and municipality owned electricity utilities and which we have analysed in detail in other studies.[161]

Switzerland seems to be at the moment the only European country where a concrete multi-fibre deployment model and an access model based on this network roll-out has been negotiated and implemented for some time.

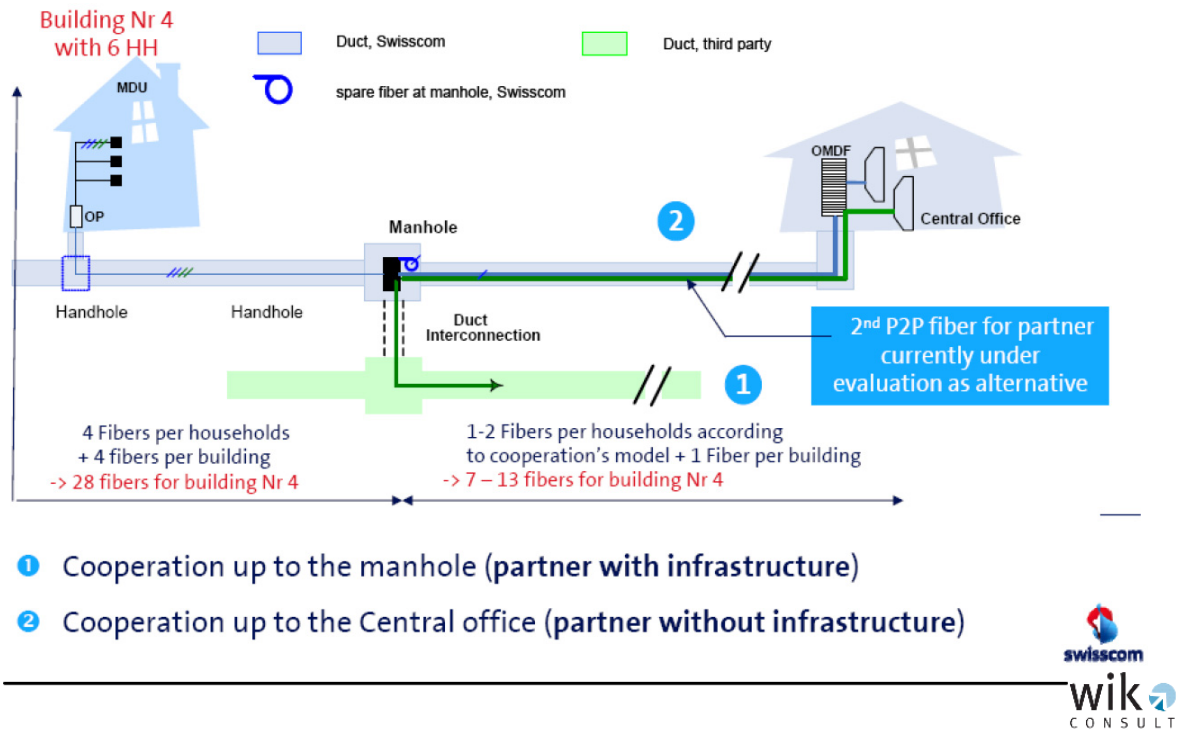
As a response to some local utility plans to roll-out fibre networks in some major cities, Swisscom stopped its own far reaching roll-out of VDSL in 2008 (already covering 75% of all households) and announced a far reaching FTTH network roll-out. 100,000 apartments (3% of all households) shall be connected through FTTH by the end of 2009 and 33% of population by 2015 at an investment of 2.8 billion CHF.[162] Swisscom deploys a FTTH P2P network architecture. Swisscom is connecting each home in a multi-fibre approach with four fibres from a manhole (concentration point) into each home. On the basis of cooperation models with other operators or utilities, Swisscom has negotiated co-investment arrangements to swap fibres and to share the terminating fibre segments with these partners in the major cities of Switzerland. Swisscom has signed the first letter of intent for a multi-fibre co-investment arrangement with the local utility Group E in Fribourg in March 2009.[163] In some cities both partners will deploy the network in different areas and swap the fibre capacity to each other. Each operator will lay four fibres from each apartment up to the manhole in each area. Fibres will then continue up to the constructing operator's ODF and through duct connection at the manhole to the

161 See Ilic et. al (2009a) and Ilic et. al (2009b).
162 See ERG (2009), p. 171.
163 See ERG (2009), p. 171 f.

partner's ODF, see Figure 3-16. This model is currently being tested before final and binding deployment agreements are being made. In other cities one partner (mostly the utilities) deploys the fibre network and provides IRU-based access. In cities where Swisscom has no cooperation agreement (yet), it is nevertheless laying four fibres in order to allow for possible further cooperations.

Technically, Swisscom's cooperation model is described in Figure 3-16. Each home in a building is connected with four separate fibres, all ending in a standardised plug. At the other side all fibres of a building end in a manhole close to the building. At this distribution point at least one fibre per home is directed through the distribution cable to the Optical Main Distribution Frame (OMDF) of Swisscom (resp. the constructing operator), the other fibres may be accessed by competitors running their own infrastructure down to the manhole, where they connect to the shared fibre end lines.

Figure 3-16: Build and share cooperation model of Swisscom



Source: Crausaz, Débieux (2009)

If alternative operators do not have ducts or fibre for their own feeder cable, Swisscom is willing to provide alternative operators access to the fibre at its ODF. This is the predominant cooperation model which has been negotiated. This type of cooperation model – depending on the unknown details – is or comes close to a fibre unbundling access model. The main difference, however, still is that the altnet has to commit itself for a comprehensive region, city or district whereas the commitment in the unbundling case only relates to one single line.

There are some more interesting details of the cooperation model important to be mentioned:

(1) The cooperation partner receives indefeasible rights of use (IRUs) which define the exclusive use of the particular fibre.

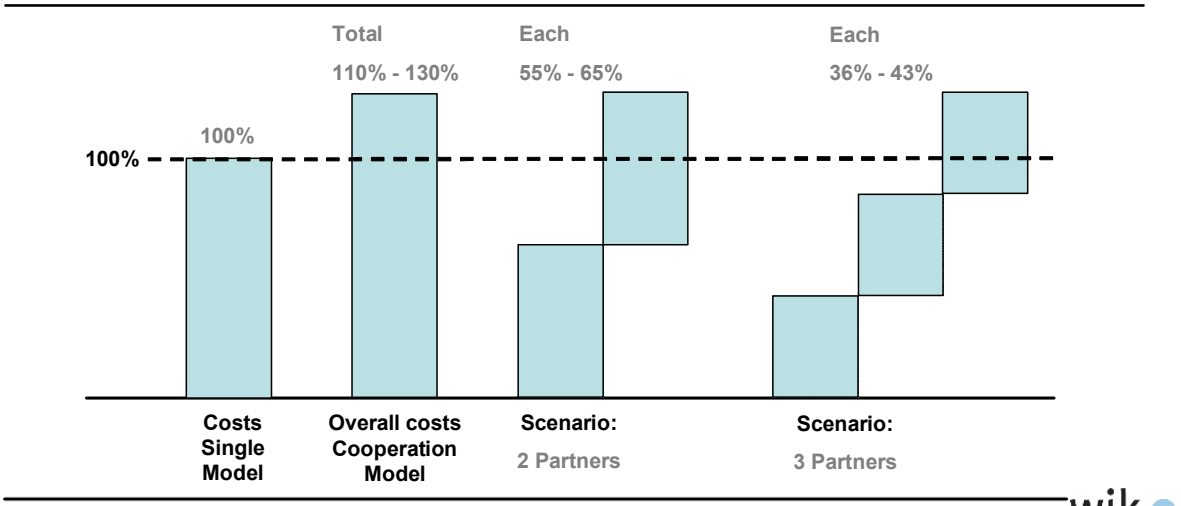
(2) The sharing of investment costs follows the model to be applied for international undersea cable contracts: The first partner pays the investor 50% of the investment cost plus a margin to cover the project-specific investment risk. A second partner has to pay 33% of the investment cost plus the margin mentioned above. The payment of the second partner will be shared between the investor and the first partner. This original model has been modified in the meantime such that Swisscom now usually bears a 60% share of the investment cost and the utility bears 40%.

(3) In the (symmetrical) swapping model there is no financial compensation, because both partners are investors. Instead, they grant each other IRUs for one fibre in their respective roll-out area.

(4) There is no example with more than one cooperation partner to Swisscom (in a specific geographical area).

Figure 3-17 shows the impact of the sharing assumptions on the distribution of investment cost. Swisscom assumes the total investment cost to increase by 10% to 30%.[164] Compared to the single fibre architecture, the investor has to bear only 55% to 65% of the total investment. The same holds true of his investment partner. Both partners can reach 100% of the potential customer base at a lower investment than in a stand-alone investment case.

Figure 3-17: Potential investment cost distribution in the multi-fibre model



Source: WIK-Consult according to Gromard (2009)

164 See Gromard (2009).

The Swisscom cooperation model reveals already some inherent problems of the multi-fibre approach:

(1) Total investment cost may increase by 10% to 30%. In a later study for the Swiss regulator Bakom we have calculated these cost differences in more detail.[165] The additional cost of multi-fibre depend, of course, on the network segments where this architecture is applied. Furthermore, the cost differences decrease with customer density. If access is provided at the DP they range from 2.2% to 11.6%. For the more realistic case of access at the MPoP the cost differences range from 11.5% to 26.3%.

(2) The demand commitment is always related to a whole region, city or district and not to an abstract number of fibre access lines.

(3) In case of duct connection the incumbent's architecture determines the location of the manhole access points to which the feeder cable of the altnet has to be connected. This may or may not fit with existing duct or fibre infrastructure of the altnet; insofar as it does not fit, the altnet's costs are higher than those of the incumbent.

(4) If the incumbent uses two fibres, a four fibre roll-out only gives access opportunities for two more alternative operators. The number of operators in the market is limited accordingly.

(5) If the incumbent uses two fibres, it has more technological options than the cooperation partner which only receives one fibre. E.g. the SMP operator could use two unidirectional fibre interfaces for bidirectional (duplex) communication, which are cheaper than single fibre interfaces, or the operator could use a separate fibre for the TV signal distribution – outside the triple-play IP stream and thus saving bandwidth in the IP network and not needing a multicast function.

(6) The asymmetries mentioned under (5) may even be increased if the uneven allocation of fibres has no influence on the allocation rule of investment costs.

(7) The cooperation model as such does not provide an incentive compatible approach to keep costs low. It is basically the investor who decides on the capital expenditure and the operating expenditure. Due to the sharing rule, the investor has an incentive to transfer (unjustified) parts of the cost to the altnet.

(8) The cooperation model as such does not provide an incentive compatible approach towards discrimination. The SMP operator has under the defined sharing rule a strong incentive to favour his own use of the infrastructure compared to that of the altnet by shifting costs and by imposing different conditions of use.

165 See Ilic et. al. (2009b).

(9) A cooperation model where two partners have equal rights to use the built capacity and share the costs of the built capacity equally, generates significant asymmetries, when only one partner decides on the technical details of the roll-out, the investment expenditure, OPEX and other day-to-day decisions. Such a cooperation model calls for joint ownership of the infrastructure company which deploys the shared capacity and at least a symmetrical decision making structure.

(10) Depending on the distribution of market shares, the cooperation model can lead to significant cost asymmetries. Only in case of an equal distribution of market shares, the cost sharing rule leads to symmetrical costs. Assume e.g. in case of two partners a market share distribution of 60% to 40%. In this case, the smaller operator will be facing costs per customer served which are 50% higher for the shared infrastructure. The shared infrastructure amounts to around 80% of total costs. In case of a market share distribution of 80% to 20%, the costs of the shared infrastructure differ by a factor of four or are 300% higher for the smaller operator.

The future of the multi-fibre model in Switzerland has become uncertain due to a recent decision of the Swiss competition authority.[166] The competition authority had to develop a legal opinion whether or not the cooperation agreements could contain an exclusivity clause in favour of the utilities. Under this clause the utilities wanted to reserve the exclusive right to provide unbundling on a wholesale basis to third party operators, thus restricting or even excluding this type of wholesale competition. The competition authority did not give a general exemption for the exclusivity clause but made it dependent on the effects on competition in each individual case. At least some cooperation agreements now have to be re-negotiated because some utilities made their (further) participation dependent on a “positive” outcome of the competition case. As a first response Swisscom stopped the negotiations on new cooperation agreements.[167]

In a former study of 2009[168] we came to the following conclusions regarding a multi-fibre approach which we still regard as valid today and therefore present them here:

The multi-fibre model has the following advantages:

(1) The multi-fibre model generates competition at the deepest level of the network and provides a relevant model of replicability of the fibre at lower costs than the end-to-end infrastructure duplication.

(2) If the SMP operator as the investor finds partners for this model, he may have a stronger investment incentive and may expand the scope of coverage of the FTTH roll-out.

(3) The altnet has a better end-to-end control over his network infrastructure.

166 See TeleGeography (2011b).
167 See Swisscom (2011).
168 See Ilic et.al. (2009a).

(4) The altnet(s) as well as the SMP operator has significant sunk cost investment and can therefore not engage in destructive hit-and-run competition. However, the complementary investment to be made by the altnet in the unbundling approach directly has a similar effect, but of course the overall amount and share of sunk investment becomes significantly larger under the multi-fibre model.

(5) The multi-fibre model allows for a competitive scenario where the user can get different services from different operators. In case of full unbundling (and no infrastructure competition) the user only has access to one single access line to his/her home and has to receive all line-based services from one operator, whom he/she might of course change from time to time

(6) The multi-fibre approach potentially can contribute to solve the termination monopoly problem. A user could for instance subscribe to different termination services from different operators.

(7) In cases or scenarios where the multi-fibre approach actually has achieved effective competition, regulation becomes obsolete.

Besides these advantages the multi-fibre approach is also characterised by a relevant number of disadvantages:

(1) The significant higher requirements of sunk investment generate a significantly higher barrier to entry for non SMP operators.

(2) The number of competitors is determined by the market in the unbundling model. In a multi-fibre model unconstrained by regulation, the maximum number of competitors is determined ex ante by the investor and his decision on the number of fibres to be deployed. It is fair to say, that this restriction may be overcome by a secondary market of fibre lines, e.g. on the basis of unbundling, if that is not excluded by contract.

(3) The overall investment costs are 13% to 23% higher in the multi-fibre approach compared to a single fibre approach. There are also some additional wholesale-specific investment costs related to the unbundling model (billing, reporting, …). But they are negligible compared to the incremental costs of the multi-fibre model.

(4) Depending on the distribution of market shares, the multi-fibre model can cause significant asymmetries in per customer costs and can therefore result in unsustainable competition.

(5) Although the multi-fibre model increases the replicability of the infrastructure, in most relevant cases the number of competitors is, however, limited to two, with the exception of co-investment by four operators with similar scale in dense areas. Our calculations on critical market shares needed for a profitable business model within a multi-fibre approach show that the coverage of multi-fibre is lower compared to the single fibre case regardless of the considered technology. The coverage reduction is higher for P2P than for PON which mainly results from the higher number of fibres in the feeder cable segment and at the MPoP.

(6) The dynamics of the multi-fibre model either tend to unsustainable competition or to a symmetrical market position with strong incentives for both partners to (explicitly or implicitly) collude.

In addition to the comparative aspects of the unbundling model mentioned so far, there are some specific strengths of the unbundling model which still need to be mentioned:

(1) The unbundling model has a proven track record in the EU as an effective access-based competition model.

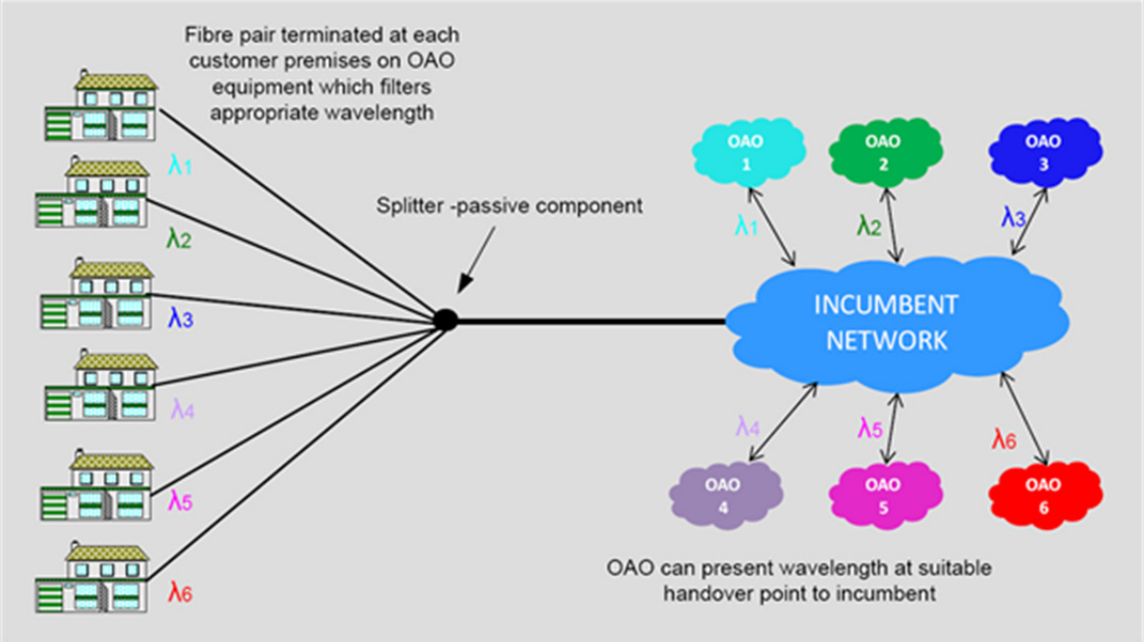
(2) The risk of market entry is lower. This is of particular relevance when a new entrant is entering the market or when the current market share in the broadband market is significantly lower than that of the SMP operator.

Summing up, we come to the conclusion that the additional investments of the multi-fibre deployment cannot be overcompensated by the marginal relative benefits of multi-fibre compared to unbundling and in addition they cannot overcompensate the relative disadvantages of the multi-fibre approach.

3.2.3.5.6 Wavelength unbundling

If the incumbent deploys a P2MP fibre topology, physical access to the fibre loop at the MPoP is technically not feasible. In such a scenario, unbundling at the MPoP is only possible through access at the wavelength level. In a WDM PON technology, a specific end-user is accessed by using a separate wavelength and transmitting data onto that wavelength. This wavelength is dedicated to the specific user and not shared by other users. Unbundling in this environment works such that an alternative operator gets access to the appropriate wavelengths at the ODF on a user by user basis in a similar way like full unbundling at the ODF works in a P2P architecture (see Figure 3-18). As the access seeker does not have access to the full capacity of an unlit fibre but “only” to a wavelength and to its physical bandwidth limitations this type of access sometimes is defined as a form of virtual unbundling because it represents an active line access.

Figure 3-18: Wavelength unbundling



Source: BEREC (2010), p. 33

WDM technology suitable for unbundling is currently used mainly in long distance or corporate networks. The vendor industry still needs a lot of developing and standardization work before commercially applicable systems will become available (see also Section 3.2.3.2.4). It seems to be industry consensus that WDM PON systems are not available before 2014. Solutions under development by vendors today plan to concentrate up to 1,000 customers by splitters onto one OLT. The maximum distance for the customer access line can increase from 20 km (GPON) to approximately 100 km allowing to close many of the existing MDF/MPoPs and substituting the concentration network. Access then can be granted at a few number of core network nodes. These characteristics of a WPM PON architecture can generate significant savings to a network operator and to an access seeker as well.

Similar to “full” unbundling, wavelength unbundling requires some ancillary wholesale products, namely co-location at the ODF location and in some circumstances backhaul from ODF to a higher network level respectively to different node locations of the core network of the competitors.

3.2.3.6 Bitstream access

The NGA Recommendation[169] asks for maintaining wholesale broadband access or amending it for existing services and their substitutes on the value chain. Bitstream access over VDSL is considered as such a substitute on the value chain to existing wholesale broadband access over copper-only loops. The Recommendation reinforces the general competitive principle of access provision also in an NGA environment[170]: Bitstream products should best reflect in terms of bandwidth and quality the technological capabilities inherent in the NGA infrastructure, so as to enable alternative operators to compete effectively.

Bitstream access is a wholesale product which combines an access link to the customer premises (over copper or fibre) and a transmission service (e.g. Ethernet or IP) to a defined set of handover or access points.[171] Depending on its technical and quality characteristics bitstream access may enable competitors to differentiate their services by altering a number of technical parameters. Because the provision of bitstream access relies on the electronics and technology of the access provider such variations are by definition only possible within the limitations and variance which this technology allows. Therefore, the potential of quality and service differentiation based on bitstream access are by definition more limited than the differentiation capabilities which are possible on the basis of passive access products like unbundling.

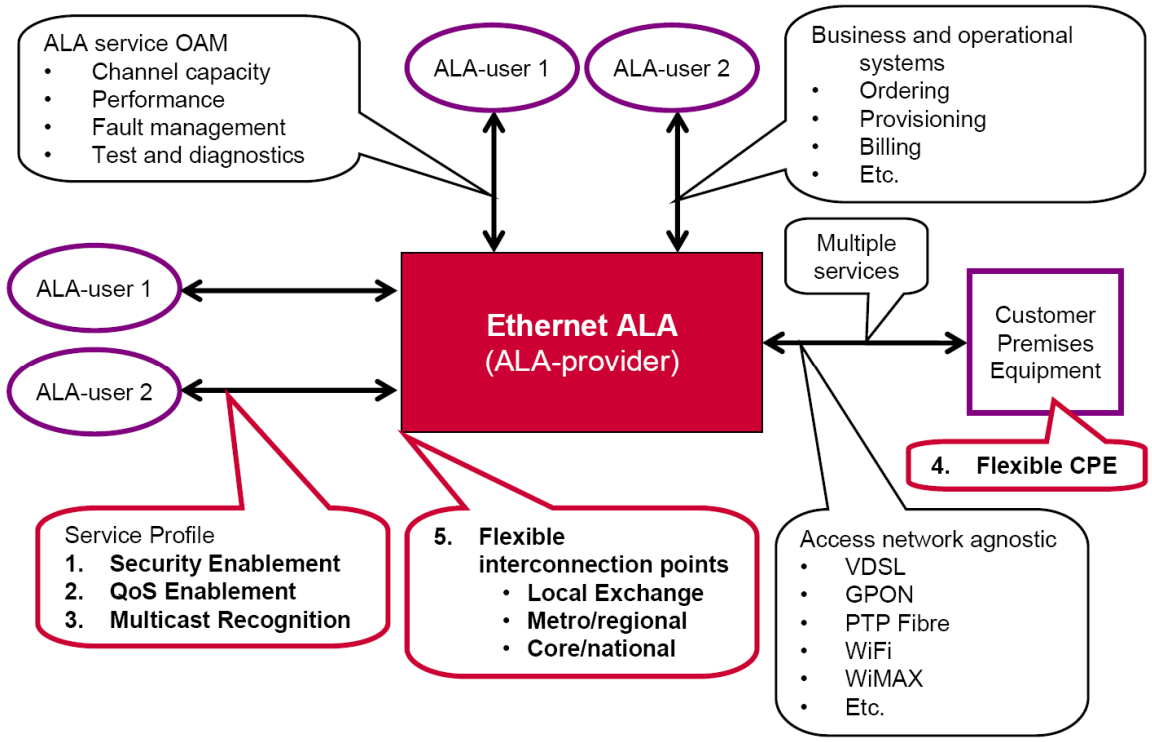
In the case of a copper-based access network, bitstream access consists of a xDSL link (ADSL, SHDSL/ SDSL, VDSL) from the CPE to the DSLAM/MSAN (located at the cabinet or MDF) and a backhaul transport link from the DSLAM/MSAN port to the competitor's access point. In theory there also would exist an option to access the bitstream at the MDF location, but in this case the competitor in the past would have chosen copper LLU instead of bitstream, provided it is available. In case of a fibre network, the fibre link connects from the CPE to the optical termination equipment like the OLT for GPON located at the ODF. The competitor can access the incumbent's network at the DSLAM/MSAN/OLT level or at a higher level, like in the copper case, before the parent node at Layer 2 or at the exit of the parent node and/or distant node level at Layer 3.[172] The competitor can access the incumbent's network at the location of the DSLAM/MSAN/OLT or at a higher level location, like in the copper case, before the last node of the concentration network at Layer 2 or at the exit of the concentration network or at the first node of the core network at Layer 3.

From a technology perspective bitstream access can be provided on Layer 2 of the OSI model (ATM, Ethernet) and/or on Layer 3 (IP). The higher the access layer, the more network functionalities are incorporated into the wholesale product and the less flexible the alternative operator becomes in its own quality and service differentiation potential.

169 See Rec. 33.
170 See Rec. 31.
171 See BEREC (2010), p. 36.
172 The NGA-Forum, a consultative body organized by the Bundesnetzagentur in Germany, e.g. has specified a layer 2 bitstream access product for fibre networks (see BNetzA (2011)).

Currently, incumbents are migrating their aggregation networks from the outdated ATM to Ethernet technology.[173] One form of enhanced bitstream access is Active Line Access, a Layer 2 Ethernet product. This wholesale product allows (more) flexibility to the access seeker because it provides CPE control. Figure 3-19 gives a comprehensive overview of key characteristics and operational requirements of Active Line Access (ALA).

Figure 3-19: Conceptual summary of ALA functionality



Source: BEREC (2010), p. 40

Because bitstream access in NGA environments should replace the existing copper LLU there are many ongoing discussions how to achieve a comparable functionality concerning network operations and access line provisioning. This includes to test the customer access for physical connectivity and electronic functionality and the ability to reset a customer access to a default configuration for basic tests. Also access to access line quality statistics are required and an early information about major faults, affecting an area or a major group of access lines. Thus there are requests for features requiring access to the line driving equipment of the wholesale entity, which if at all, should be provided in a manner that no other access lines of third operators are affected.

173 The reason for this is e.g. more scalability and cost advantages of Ethernet based solutions.

3.2.3.7 Access to in-house wiring

Access to in-house wiring can be inherently included in other access products or there may be specific access points in the building were an access seeker might obtain access to the in-house wiring, usually in the basement of a building. Access to in-house wiring might get a complex dimension when it is not the network owner who owns the in-house cables but the real estate owner. In case of unbundling, sub-loop and concentration point unbundling, as well as with bitstream access the in-house wiring is an inherent part of the access product which must not be considered separately. In case of FTTB, Layer 0 access can only be provided at an access point within the building. Also in a FTTH architecture access to in-house wiring may be provided as a sole or additional access point.

The fibre wiring topology inside the building might be single- or multi-fibre. In case of multi-fibre each operator accessing the building has access to all end-users in the building in parallel. In case of a single-fibre architecture it is only one operator who has access to an individual end-user at a certain moment in time. Customers can, however, be switched physically from one operator to another.

3.2.3.8 Wholesale products to reach access points

In order to reach access points, sometimes appropriate wholesale products are needed. This can be ducts, dark fibres, leased lines or other active backhaul products. Furthermore, most wholesale products can only be used efficiently if the active equipment of the access seeker is collocated at the premises of the network operator. These wholesale products are often also called and treated as ancillary products.

3.2.3.8.1 Duct access

Trenching and ducting constitutes a major cost factor for deploying a new access network, generally exceeding 70% to 80% of total investments.[174] Sharing such costs among several operators can significantly reduce the required investment and improve replicability of infrastructure. Such advantage may even increase if access to ducts is possible at incremental capacity cost or even more if access is possible for spare capacity of a legacy infrastructure which has no opportunity cost.

Duct access is a passive wholesale product which could in principle be used to reach any of the access points of the wholesale products mentioned in Sections 3.2.3.5 to 3.2.3.7 (buildings, street cabinets, manholes, ODFs, core nodes). Even vertical duct access inside buildings might be relevant in a FTTH scenario. Duct access can be relevant to install all types of cable: copper, fibre and coax cables. All these cables have different space requirements and generate limitations regarding available capacity. As-

174 See Jay et al. (2011).

sociated infrastructure to ducts may be manholes which are needed for cable installation, maintenance and repair purposes, or it may be poles, if aerial cables are used.

In case the capacity of ducts is limited compared to the potential demand of various operators, rules for allocating the limited space may have to be established. For that purpose information about spare capacity in ducts and manholes has to be provided[175].

Duct access is not only a requirement on how to provide access to existing (legacy) capacity. In an ex ante deployment e. g. for NGA it is also an issue of encouraging or mandating to install sufficient capacity for other operators in accordance with market demand. In particular when it comes to new deployments it should be self-evident that beneficiaries of State aid establish a data-base containing information on geographical location, available capacity and other physical characteristics of all civil engineering infrastructure which could be used for the deployment of optical fibre networks. Such a database should be accessible to all operators as the NGA Recommendation requires.[176]

3.2.3.8.2 Leased lines / dark fibre

Similar to ducts access to dark fibre provides in general passive wholesale access to reach any of the relevant access points. Instead of renting duct capacity and installing its own fibre optic cable the access seeker can lease the physical fibre optic infrastructure in the form of unlit fibre pairs. Like unbundling dark fibre is an unlit optical fibre wholesale product. Access seekers don't have to install their own fibre optic cable, they just rent one (or more) single fibre pairs. Compared to ducts there is more flexibility with dark fibre. Dark fibre capacity may be made available even if there is a lack of duct capacity. Access to dark fibre is of particular relevance in case of FTTC for connecting street cabinets from the MDF location and for making use of concentration point unbundling. Dark fibre access can significantly reduce the cost of backhauling and barriers to entry for such business models. Access to dark fibre requires less investment for an alternative operator than duct access. It also increases the chance for several operators to get backhaul infrastructure since empty ducts exhaust earlier than dark fibres.

Leased lines may be a close substitute to dark fibre which may again be used to reach potentially all relevant access points. In contrast to dark fibre leased lines, however, are used as an active and not a passive backhaul product. A leased line offers an active connection between two network access points using transparent technologies such as Ethernet or SDH. The leased line is a dedicated connection able to connect all kind of traffic and upper layer technologies. Any leased line solution, Ethernet more than SDH, influences the transmission quality of the signals transferred more than that of a dark fibre solution, since the transmission then is already under the responsibility of the access seeker.

175 Information about available duct space also has to be provided to competitors in order to enable adequate network planning.
176 See Rec. 17.

3.2.3.8.3 Co-location

Most access concepts as described in Sections 3.2.3.5 to 3.2.3.7 only make sense and are viable if co-location is provided as an ancillary service. By virtue of co-location alternative operators can host their own infrastructure and active electronics in the MPoPs and DPs of the incumbent. Co-location usually has to be defined by a set of physical conditions under which such joint use of facilities happens. This includes space for installation, energy feeding and uninterruptable power supply, cabling, air conditioning, functions of access control and fire alarm, etc.

In case physical co-location is not technically or economically feasible for one or all access seekers, terms and conditions for virtual co-location[177] have to be defined which generate equivalence of access.

3.2.3.9 Access to other network infrastructures

Typically access for third parties to all telecommunication platforms could be provided on a lower rung of the ladder of investment by providing managed bandwidth services. In mobile networks such access can be provided on the level of so-called Mobile Virtual Network Operators (MVNOs), which is typically an enhanced resale access option. In fixed networks like wireless, satellite or cable networks access can be provided as wholesale bitstream access. For the upper rungs of the ladder of investment, i.e. for access to physically unbundable network elements, the options have to be considered in a more detailed way, always assuming that the topology of the existing physical infrastructure fits to the topology of the access seeker.

Mobile networks

The physical infrastructure of mobile networks is characterized by a large number of radio stations with masts and antennas, which are connected to the fixed mobile core network by microwave or broadband (fibre) backhaul lines. Thus, there are options of sharing the radio stations in form of masts or even antennas, which also requires co-location at the station, and as far as possible sharing the backhaul infrastructure. In the case of microwave links we see the option of adding additional capacity in form of leased lines. In case of own fixed network infrastructure we also see the option of additional capacity in form of leased lines, but also in form of sharing fibre cables (dark fibre), ducts (empty subducts) or trenches. Sharing these infrastructures also requires a co-location facility (physical or customer sited) at the other end of the commonly used part of the infrastructure at higher level network node locations (or even somewhere between radio station and next higher level network node). The common use of trenches only can take place during the construction phase.

177 Virtual co-location or remote co-location enables an operator to acquire locations/space in the vicinity of the incumbent's location in order to host its equipment and to connect it to the incumbent's network.

Fixed wireless networks

The physical infrastructure of fixed wireless access networks is to some extent comparable to the mobile networks. They also consist of a large number of radio stations covering a dedicated area, being connected to the core network by microwave, WiMAX or other fixed network backhaul lines. Thus there may be options of sharing these infrastructure elements (radio stations with masts, backhaul infrastructure, including appropriate collocation at both ends) in a comparable manner to the mobile network. According to our knowledge there is no option to share WiMAX Backhaul in a leased line manner.

Satellite networks

Satellite networks in each cases feature one head station which provides access to the core network and covers a large area, e.g. Western Europe. Bidirectional transmission between the head station and the satellite as well as between the satellite and the satellite dishes at the end customer premises is based on radio frequencies. Thus, sharing physical infrastructure of satellite networks would require sharing the existing frequency spectrum of the operator, which is not feasible due to the existing access protocols. Therefore, access for third parties is restricted to bitstream access.

Cable networks

Since cable networks originally were intended to broadcast TV programs over a cable infrastructure[178], systems and access network topology had been optimized for broadcast transmission from one central source to any connected end customer in parallel. They have been upgraded to allow bidirectional communication of customer individual messages and conversations. Cable networks are in its access part characterized by central CMTS (Cable Modem Termination Systems), administering the transmission of telecommunication messages to and from the end-users of a dedicated area over a shared cable topology. The CMTS are connected to fibre nodes at the same central location or at locations closer to the end customers, there being connected to the existing coaxial cable network topology, which in most cases is connected in a bus (chain) or hierarchical tree manner. This results in one shared cable infrastructure, where the CMTS has to grant access rights for individual customer communication in exclusive time slots (TDM/Time Division Multiplex). Since CMTS in principle allow for providing leased lines for a restricted number of end-users, there may be an option to unbundle access segments of leased lines up to 2 Mbit/s in a restricted manner – in addition to provide bitstream access. But these lines would provide only low bandwidth and they are out of the regulatory scope.

Due to the coaxial cable topology there is no option to unbundle the coaxial cable. If the cables are not deployed in a ducted infrastructure there also is no option to unbundle ducts. The common use of trenches can only be granted during the construction phase.

178 See Section 3.1.2.

However, a potential option is to unbundle the frequency spectrum used in the cable infrastructure: If the cable access network is able to support a high frequency band of 2.5 GHz, this can be subdivided into 3 frequency bands of about 800 MHz, which typically meets the requirements of today's cable network operators. Thus, at least in theory there is an option for up to three independent cable network operators sharing the same access network infrastructure and being able to offer telecommunication services. This would require co-location at the central site. According to our information this unbundling concept has only little market relevance so far.

Although it is not yet a broad market reality, cable networks are capable of providing bitstream access at Layer 2 (under certain conditions) and in any case at Layer 3.

3.2.3.10 Summary of access products, topologies and technologies

1. In an NGA network access is possible at different locations of the network including
   - The basement of a building offering access to in-house wiring,
   - access at the concentration point,
   - access at the ODF/MPoP,
   - access at the core network nodes.
2. While active wholesale access products are in principle technically feasible at all these locations, there are restrictions with regard to passive wholesale access products depending on the network architecture deployed by the network operator or by the required access line quality (e.g. bandwidth).
3. The topologies of the passive fibre plant as well as active electronics implemented by the network operator have an influence on the technical feasibility of different access products.
4. Bitstream access is in principle a technically feasible option at all of the aforementioned access locations of the network. Bitstream loses, however, its potential economic advantages for an access seeker the closer the access point is located to the end-user.
5. Full unbundling of the fibre loop is only feasible under a P2P topology of the passive fibre network. A P2P topology also allows for sub-loop unbundling at a concentration point.
6. Under a P2MP topology of the passive network unbundling is only technically feasible at a concentration point which aggregates the single fibre sub-loops of the terminating segment to the feeder segment of the access network.
7. In a PON scenario using a P2MP topology unbundling is only feasible at the concentration point or at the MPoP with wavelength unbundling.

8. Implementing a GPON fibre technology does not necessarily require a P2MP fibre topology. GPON can also be implemented on top of a P2P topology by moving the splitters back into the central MPoP location and having dedicated fibres in both the drop and the feeder segment.
9. A P2P topology supports the principle of technological neutrality with regard to the active fibre network electronics while a P2MP topology does not.
10. The economic viability of the business model of an access seeker solely on the basis of concentration point access is rather limited if it exists at all. Deploying the own fibre network down to the concentration point of the access network generates significant costs and therefore requires rather high critical penetration rates for viability. They are in the range of 20% to 40% and only allow for one competitor if at all.
11. If an incumbent operator deploys the GPON technology, de facto only an enhanced Layer 2 bitstream access product at the MPoP is a viable access concept.
12. Access to a wavelength is an active line wholesale product which from the perspective of an access seeker comes close to an unbundling wholesale product ("virtual unbundling") with regard to technical flexibility and quality control.
13. A WDM PON technology which allows for wavelength unbundling does not seem to become a viable technological option in the next three years.
14. Fibre networks can be deployed by connecting end-users with only one fibre or with multiple fibres. Multiple fibres per end-user can be deployed only in the in-house segment, in the drop segment of the network or also in the feeder segment.
15. The use of a multiple fibre architecture does not necessarily require a cooperation agreement among two or more operators but usually is combined with co-operation agreements where the operators share the investment cost of the passive network for a specific area or city.
16. As the experience in Switzerland and our own model calculations[179] show, a multiple fibre approach only (if at all) seems to be economically viable if the access occurs at the MPoP and not at the concentration point. This result follows directly from the economics of sub-loop or concentration point unbundling.
17. Only if the access is provided at the MPoP the cooperation partners of a multi-fibre arrangement can compete for full unbundling wholesale products.
18. A multi-fibre model may have the following advantages:
    a. It generates competition at the deepest level of the network and provides a relevant model of replicability of the fibre at lower costs than the end-to-end infrastructure duplication.
    b. The altnet has a better end-to-end control over his network infrastructure.

179 See Ilic et. al. (2009b).

c. It allows for a competitive scenario where the user can get different services from different operators.

d. It potentially can contribute to solve the termination monopoly problem. A user could for instance use different termination services from different operators.

e. Inasmuch as the multi-fibre approach also generates competition at the wholesale level, regulation can be reduced or may even become obsolete.

19. Besides the additional investment a multi-fibre approach has, however, also relevant disadvantages:

    a. The significantly higher requirements of sunk investment generate a significantly higher barrier to entry and generate increased penetration risks for non SMP operators as compared to unbundling.

    b. The number of competitors is determined by the market in the unbundling model. In a multi-fibre model unconstrained by regulation the maximum number of competitors is determined ex ante by the investor and his decision on the number of fibres to be deployed. It is fair to say, that this restriction may be overcome by a secondary market of fibre lines, e.g. on the basis of unbundling, in particular, if unbundling is mandated.

    c. Depending on the distribution of market shares, the multi-fibre model can cause significant asymmetries in per line costs and therefore in competition which can result in unsustainability of competition.

20. A multiple fibre architecture leads to increased fibre deployment costs. Depending on the cluster density and the segments of the network where multiple fibres are deployed investment costs increase by 10% to 25% of the total invest compared to a single fibre deployment.

21. Most but not all of the benefits of a multiple fibre architecture can be materialised by an unbundling approach. It remains questionable whether the remaining advantages can compensate for the additional investment cost.

22. Apart from fibre-based infrastructures access for third parties is also possible regarding other network technologies.

    a. Wireless, mobile and satellite networks generally allow for a bitstream service access. Mobile networks in addition allow for an MVNO (reselling) access approach. All networks mentioned in principle can share the use of backhaul services (leased lines, dark fibre, ducts, trenches). Furthermore, wireless and mobile networks could share infrastructure like masts and locations and therefore could provide access to such network elements.

    b. Cable networks can provide a theoretical option for unbundling by access to the frequency spectrum used in the cable infrastructure. From this perspective there is an option for up to three independent cable network operators. Due to the coaxial cable topology there is no option to unbundle the coaxial cable like in copper or fibre networks.

3.2.4 Access remedies regarding Markets 4 and 5

The wholesale access remedies which are of relevance in the context of State aid measures are mainly assigned to Market 4 (wholesale access for physical network infrastructure at a fixed location) or Market 5 (wholesale broadband access) of the SMP-focussed regulatory framework. The following overview relies on a BEREC (2011a) document, where BEREC has collected factual information of NGA roll-out from NRAs. BEREC has distributed a questionnaire to the NRAs in September 2010. With a few exemptions (Cyprus, Luxembourg, Bulgaria) all NRAs in the Member States have provided answers. The factual information was provided for the status at 30 June 2010.[180]

Duct access as a passive access product is mainly included in Market 4. As of 30 June 2010 duct access was not available in several countries (Czech Republic, Finland, Hungary (planned, about to be notified), Latvia, Malta, Romania, the Slovak Republic, Sweden, UK).[181] In the other Member States duct access is available on a mandated basis. Duct access on a symmetrical basis is available in Lithuania. In Belgium and the Netherlands duct access is available but not used. In some Member States duct access is regarded as an ancillary service as part of Market 4 (Austria, Belgium, Germany, Spain). NRAs typically impose transparency, a reference offer, non-discrimination and some type of cost orientation as additional remedies regarding duct access. Some Member States have reported further duct related measures for SMP-operator regulation:

- Denmark: Third party access, incumbent's responsibility for securing space for other operators.
- Portugal: Improvements as to the access (and QoS) to the "duct database" (on an Extranet), access to poles and other PT infrastructures, an IT system for handling requests and more strict QoS parameters and compensations to be paid to operators (in case of non-compliance with the SLA).
- France is planning to extend the access to civil engineering infrastructures by including an obligation regarding the poles (in the next Market 4 review).
- Italy has mandated Telecom Italia to provide enough space in cables for the fibre of other operators in case of realisation of new ducts. In addition, Telecom Italia (as SMP operator) has to provide a database of its passive infrastructures, including ducts and dark fibre. Timely communications to Agcom and OLOs of its NGA development technical plans is also imposed to Telecom Italia.

Besides duct access, access to dark fibre in the access network is included as a further passive access product in Market 4. Dark fibre is a backhaul access product consisting of unlit optical fibres. In the access network it can cover the network segment between the cabinet and the MDF or between a concentration point and the ODF. In some Mem-

180 This means that the actual status of access remedies regarding Markets 4 and 5 may be somewhat different due to some recent decisions of NRAs.

181 See BEREC (2011a), p. 5.

ber States (Austria, Belgium, Netherlands) dark fibre access is regarded as an ancillary service. In more than a third of the EU 27 countries (Austria, Belgium, Denmark, Germany, Hungary, Italy, Netherlands, Poland, Slovenia, Spain, Sweden) access to dark fibre is mandated. In Estonia and Portugal it is available on a voluntary basis. Mandated dark fibre access usually has to be provided under some form of cost orientation. Dark fibre access usually is mandated together with a transparency, a reference offer and a non-discrimination obligation. In Italy access to the unbundled fibre local loop is intended to be mandatory even if a P2MP fibre topology is deployed by the incumbent.

Access to in-house wiring is mandated in some Member States (Austria, Germany, Poland, Slovenia) as part of the Market 4 regulation. In Hungary the obligation is covered by obligations for sub-loop unbundling. In France and Portugal access to in-house wiring is mandated through symmetrical regulation. Spain applies a symmetrical obligation (only) for operators deploying FTTH. Usually a transparency and a non-discrimination obligation are imposed for in-house wiring.

Concentration point unbundling contains another remedy related to Market 4. Concentration point unbundling[182] is mandated in Estonia, Poland and Slovenia; in Hungary, Germany and the UK the obligation is covered by obligations for sub-loop unbundling. In Italy concentration point unbundling will be available from 2013 on in specific areas. In Spain there is a symmetric obligation for operators deploying FTTH. NRAs typically impose a transparency, a reference offer, a non-discrimination and a cost orientation remedy to the access obligation.

Approximately 60% of the EU 27 countries have mandated cabinet unbundling by 30 June 2010. In Estonia cabinet unbundling is available on a voluntary basis. NRAs typically impose in conformity with the NGA Recommendation a transparency, a reference offer, a non-discrimination and a cost orientation remedy. According to BEREC (2011a) four countries referred to other SMP regulatory measures:

- Denmark: Measure on the incumbent not to take actions which have a negative effect on copper lines used by alternative operators.
- Poland: Access to fibre loops via LLU service is granted if no access to ducts or dark fibre is possible in a given local loop.
- Portugal: Maintenance of the obligation to grant access to local loops and sub-loops and associated resources.
- Italy: Such a remedy is also foreseen in the case of FTTC NGA network topology.

Access to fibre at the ODF is also included in Market 4. In the Netherlands, Poland, Slovenia, Sweden, Germany and Hungary ODF unbundling is available on a mandated basis. In Italy the remedy is under discussion. As foreseen in the NGA Recommenda-

182 According to BEREC (2011a) sometimes also called “manhole unbundling”.

tion, NRAs typically impose a transparency, a non-discrimination, a reference offer and a cost-orientation remedy on this access obligation. In the Netherlands the obligation to provide ODF unbundling is supplemented with the obligation to provide co-location and backhaul as ancillary services. In Poland access to fibre loops is granted if no access to ducts or dark fibres is possible for a certain loop. The Swedish regulator makes sure that access to fibre has to be provided between the ODF locations (if the distance between customer and access ODF is less than 10 km access in a neighbouring ODF location is required).

Member States differ concerning the Market 4 related remedies in place with regard to FTTB/H and FTTN:

- Denmark: For FTTN all remedies are in place; for FTTH no remedies are in place.
- Hungary: All remedies will be imposed.
- Italy: Access to ducts and dark fibre are in place and under discussion for fibre ULL and access to in-house wiring.
- Portugal: No remedies.
- Romania: FTTN/FTTB: All remedies are in place; for FTTH no remedies included in Market 4.
- Slovenia: All remedies will be imposed.
- Spain: FTTN/FTTB: All remedies are in place. For FTTH access to civil engineering infrastructure is in place; access to the terminating segment is imposed as a symmetric obligation.
- Sweden: No remedies.
- UK: No remedies.

Mandated bitstream products are usually included in Market 5 (Wholesale Broadband Access). There are two exceptions to this classification of NRAs: Austria and the UK have included a Layer 2 bitstream access product in Market 4. In many Member States enhanced bitstream products are available on a mandated basis. These countries include Belgium, Denmark, Estonia, Germany, Hungary, Italy, Poland, Portugal, Slovenia, Spain, Sweden, Netherlands, UK. In Lithuania enhanced bitstream products are provided on a voluntary basis. Access typically is provided at regional and national level. At a regional level bitstream access products are available in Germany (regulated IP-bitstream), Spain, Netherlands, Hungary, Italy, Portugal. In some countries (Germany, Hungary, Poland, Portugal, Slovenia, Spain) there are also national points of bitstream access available. A local point of access is provided in Estonia, Italy and the UK.

Enhanced bitstream access in summary is provided on quite a variety of OSI layers and at a significantly different number of access points across the Member States:

- Austria: Up to 9 regional concentration points.
- Belgium: 54 access points for ATM and 10 access points for Ethernet (Layer 2).
- Estonia: Access at the DSLAM at local and national level.
- Germany: Layer 2 and Layer 3 bitstream both are available at national and regional access points.
- Hungary: Layer 2 and Layer 3 bitstream available at national and aggregation point level.
- Italy: Access at local exchange parent and distant node.
- Poland: Access at DSLAM location; ATM and IP-bitstream.
- Portugal: ATM and Ethernet bitstream (Layer 2), IP (Layer 3), 28 regional and 2 national points of access.
- Slovenia: Access to MSAN or DSLAM location at the local level; transmission access to BRAS (broadband remote access server) at the regional level; access in administrated networks through IP/MPLS at the national level.
- Spain: ATM access at Layer 2 (109 points); IP access at Layer 3 at 40 points and a single national access point; Ethernet Layer 2 access at 40 access points.
- Sweden: Access at Level 2a (100+ access points providing national coverage) and Level 2b (27 metro Ethernet rings with 27 access points providing national coverage).
- UK: Access at local NGA exchange (MPoP).

Quality differentiation based on bitstream access is possible in several countries (Belgium, Hungary, Italy, Poland, Portugal, Spain). Guaranteed bandwidths are available e.g. in Belgium, Italy, Poland and Portugal. Other countries (like Austria, Denmark, UK) do not foresee quality differentiation (yet). In most countries multi-cast technology is not available for alternative operators via bitstream access. Multi-cast is available in Denmark, Italy, Slovenia, Sweden. In Germany multi-cast is foreseen for Ethernet- and IP-bitstream. In the UK BT may provide a multi-cast product on a (voluntary) commercial basis.

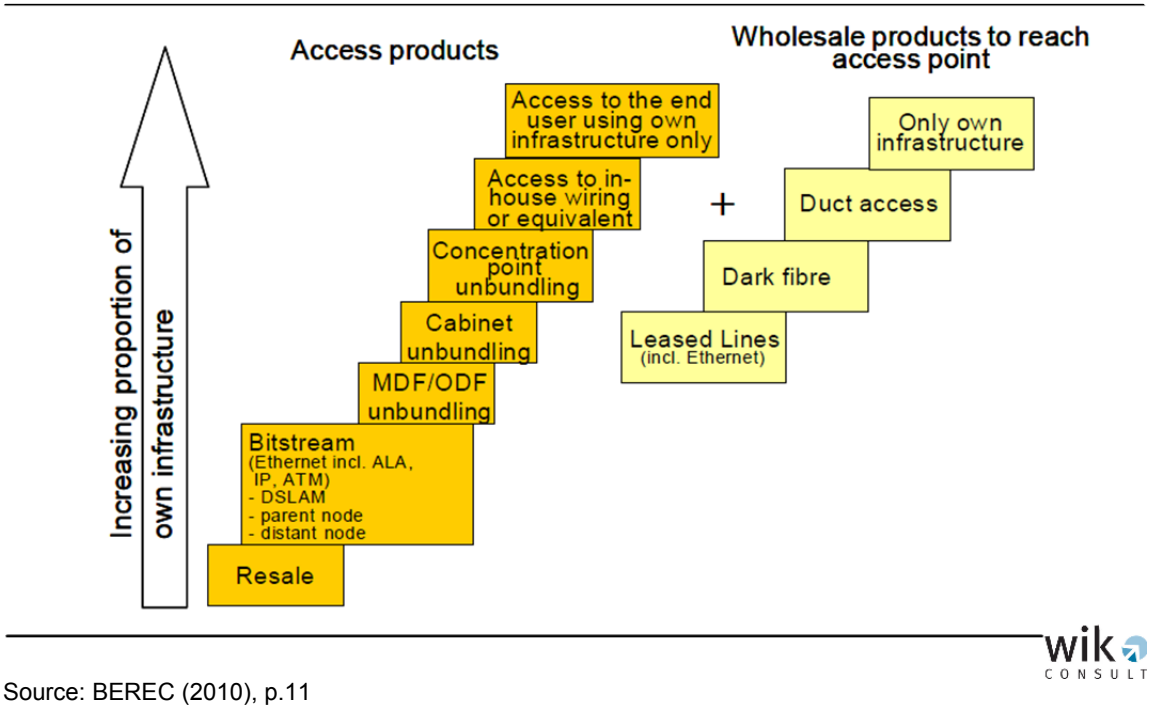
Regulatory remedies in most countries include transparency, non-discrimination, reference offers. Some NRAs mandate accounting separation and other accounting obligations. Pricing for bitstream access is controlled by applying cost-orientation, price-capping or retail-minus wholesale pricing.

3.2.5 Access and competition

One of the major analytical and conceptual guideline for defining and imposing access remedies within the European regulatory framework is the ladder of investment concept. The basic logic of this concept is that competition should be promoted at the deepest level of the network where it is likely to be effective and sustainable. Competition is expected to be most intense and sustainable if all network elements are replicated by competitors, and competitors are independent from the incumbent operator at the highest degree. At the low end of the intensity of competition ranks a service competition which purely is based on the simple resale of the incumbent's retail product(s). All relevant access products are located in between these two extremes. If one structures the available access products according to an increasing level of own value added of the alternative operator or an increasing portion of own infrastructure the picture of a ladder of access products emerges. A higher rung of the ladder implies that the access point is located closer to the end-user and is requiring a higher degree of own network investment by the access seeker. Where and when an alternative operator climbs up the ladder, it will have to progressively invest more in its own infrastructure. This effect may be limited to some extent if wholesale products to reach access points become available. Their importance will grow in an NGA environment.

In its common position on NGA the ERG (2007) has in principle confirmed that the ladder of investment concept remains valid in an NGA environment. This position has been confirmed in a BEREC (2010) report on wholesale products for NGA. As shown in Figure 3-20 the ladder consists of the following access products in an NGA environment: resale, bitstream, MDF/ODF unbundling, cabinet unbundling, concentration point unbundling, access to in-house wiring, access to the end-user on the basis of own infrastructure only. These access products are complemented with several wholesale products necessary to reach the respective access point: leased lines, dark fibre and duct access. Various combinations of access products on the left hand side and backhaul products on the right hand side are possible depending on the access scenario and network architecture.

Figure 3-20: Ladder of investment



Source: BEREC (2010), p.11

Although the concept still is valid as a policy framework in an NGA environment, the ladder becomes more sophisticated with changes in the relative importance of their rungs and different dynamics as a consequence of a shift in the structure of economies of scale and economic bottlenecks. Furthermore, the technical feasibility and availability of certain access products depends on the architecture and technology deployed by the fibre investor.

If, for instance, fibre unbundling at the ODF is not available because of the technology choice of the fibre network operator, unbundling may become less important and may imply to step back to the bitstream access rung, so that it becomes more important and should get more attention by the regulator. Such a technology choice may also imply that access seekers prefer a direct jump to sub-loop unbundling or even access to in-house wiring. Bitstream access in an NGA environment may require more access points than before ranging from the beginning of the concentration network (DSLAM, OLT or equivalent) to the aggregation level in the middle of the concentration network up the core network node in the Ethernet/IP backbone. Different degrees of own network infrastructure may be needed to reach such access points with the potential implication that bitstream access in an NGA environment may become more similar to unbundling at least with regard to this dimension.

Despite the fact that the degree of competition increases with the degree of own investment of the competitor, the economics of NGA may set limits and may make the achievement of the top level of the ladder a wishful thinking of the regulator. Several

studies[183] show that the degree of replicability of a FTTH network is extremely limited. If this option is feasible, it is definitely limited to the most densest parts of a country where the costs to deploy a fibre network are lowest.[184] Similarly to replicate a FTTC/VDSL network or to build an own fibre network up to the street cabinet/concentration point level also requires significant critical market shares in order to make up a viable business model. They are in the range of 20% to 40%, thus, limiting the market entry opportunities to one competitor in the densest clusters of a country (if at all). The move towards NGA seems to reinforce the importance of scale and scope economies, generally reducing the degree of replicability. This may result in a change of the access points most suitable for the promotion of competition. At the current stage of deployment it is, however, difficult to draw final conclusions. This is in particular true because the conditions and prerequisites for NGA roll-out seem to differ greatly across Member States, definitely within different regions. Furthermore, currently it is less the incumbents than other market players like alternative operators and utilities which carry most of the NGA investment.[185] This change as to the major investors may have a relevant impact on the market structure, which will definitely become more heterogeneous[186].

The ladder of investment concept already implicitly entails an assessment of the various access concepts: Access products which generate more value added for the access seeker lead to more intensive competition. Besides value added and sunk cost there is also the flexibility, ability and autonomy of the access seeker to determine its own product and service quality which makes the competitive difference. The more flexibility an access product allows the more it contributes to the intensity of competition. These general principles already seem to suggest that the access concept of unbundling should support a higher intensity of competition than access concepts like bitstream access and resale. In the context of NGA the reality is, however, more complex. Two major aspects of complexity are related to cost: (1) Different access products and the corresponding business models of access seekers may be associated with a different degree of fixed costs or economies of scale for the competitors and therefore requiring different market shares to operate at minimum efficient scale and to run a viable business model. (2) The various NGA architectures do not provide all relevant access products and at the same time may have different cost characteristics. These aspects indicate that there might be trade-offs between costs and benefits of certain access concepts which need to be evaluated in a complex welfare analysis.

183 See for instance Elixmann et al. (2008) or Ilic et al. (2009b).

184 In a recent study by WIK for Germany the authors show that even in the two most densely populated clusters (10% of all access lines) the operator already needs a critical market share of 50% making it effectively impossible to replicate a fibre access infrastructure (see Jay et al. (2011)).

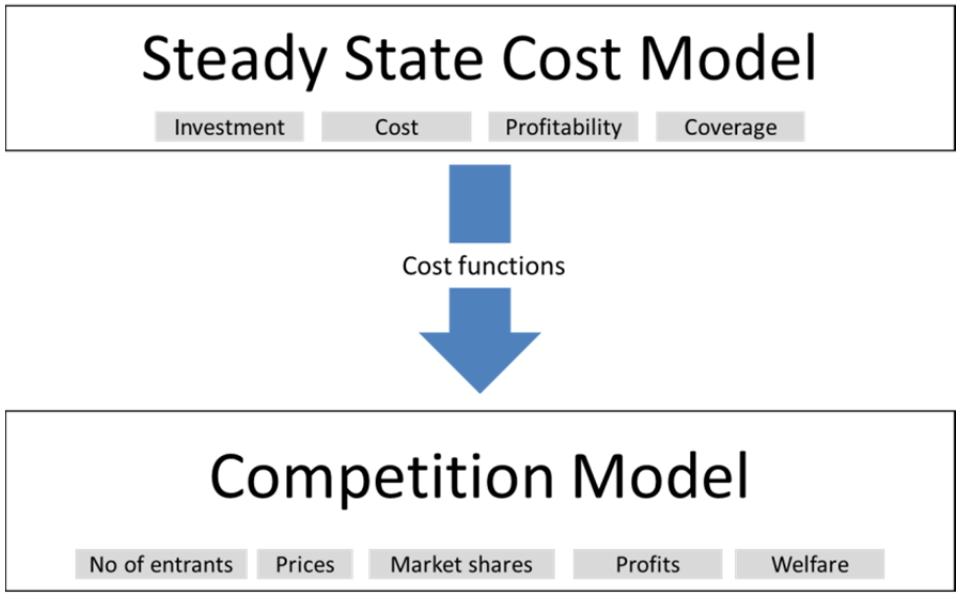
185 See Holden et al. (2011), pp. 15.

186 Increased heterogeneity make it harder to produce a nationwide homogeneous product set for end-customers. A non-homogeneous product set, however, is harder to communicate and to provide in the market for a national or even Europe wide operator. It may also harm larger nationwide or Europe-wide business customers in deploying a homogenous IT-solution or IT-based organisation, thus, resulting in competitive disadvantages compared to more homogenous telecommunication environments.

Modeling welfare effects

In a recently published study[187] a novel approach has been developed including the cost benefit evaluation of different FTTH architectures, various access products provided over these fibre network architectures and different business models of competitors. For that purpose we have combined an engineering cost model with a differentiated multi-player oligopoly model subject to wholesale access regulation. The modeling approach aimed at identifying the impact of various FTTH architectures and technologies on the one hand and regulatory choices with regard to access on the other hand on costs, prices, market entry, penetration and market shares over time. For that purpose we have developed two partly interlinked modeling approaches. We have used a steady state cost model that feeds cost functions into a strategic competition model. Figure 3-21 shows the relationship between the models and their primary outputs (grey).

Figure 3-21: Overview of modeling framework



Source: Hoernig et al. (2010)

The analysis concentrates on the two most relevant FTTH architectures in Europe, Ethernet P2P and GPON. In order to overcome some restrictions and weaknesses being discussed for GPON two (G)PON variants, namely (1) implementing GPON on top of a passive Point-to-Point fibre plant and (2) WDM PON, were also included.

187 See Hoernig et.al. (2010).

Modeling approach

In this approach we assume the incumbent to be the investor in the NGA network infrastructure. Competitors (new entrants) face the same (efficient) retail cost if they offer FTTH services on the basis of wholesale access to the incumbent's network, but may achieve a lower average revenue per user (ARPU). If the NGA architecture is based on a P2P fibre plant we have modeled the competitors as using unbundled fibre loops as the wholesale access service. If the architecture is based on a P2MP fibre plant, we consider an active wholesale access at the MPoP or at the core network node locations. In total we consider the architectures and wholesale scenarios as presented in Table 3-2.

Table 3-2: Architecture and wholesale services that characterise the different scenarios

Scenario name	Incumbent architecture	Competitor (Entrant) wholesale base
P2P unbundling	Ethernet P2P	Fibre LLU at MPoP
GPON over P2P unbundling	GPON over P2P	Fibre LLU at MPoP
WDM PON unbundling	WDM PON	WDM unbundling at Core Nodes
GPON bitstream core	GPON	Bitstream access at Core Nodes
GPON bitstream MPoP	GPON	Bitstream access at the MPoP

Source: Hoernig et al. (2010)

Regarding costs, the basic modeling relies upon an engineering bottom-up cost modeling approach. This means that we model the total cost of the services considered under efficient conditions, taking into account the cost of all network elements needed to produce these services in the specific architecture deployed. This approach is coherent with an LRIC approach as applied in regulatory economics.

In the static model we compare the costs of the specific NGA deployment from a steady state perspective. Thus, we assume a timeless world and a status in which the roll-out is completed and the FTTH network has (fully) substituted the copper access network.[188] By increasing the market share and comparing the resulting cost per customer with an assumed average revenue per customer (ARPU) we determine the point, where, if at all, the revenue equals the cost. This is the "critical market share" necessary to make the NGA business profitable and hence it determines the viability range of a network operator.

188 The different NGA architectures have a different time pattern of the investment regarding certain network elements. The steady state analysis is not able to cover this aspect. In Hoernig et al. (2010) we have therefore also developed a dynamic approach which takes into consideration a ramp-up period to deploy the FTTH network. Besides a network deployment period this approach also takes into consideration that demand will be growing over time to reach the target level of a 70% take-up. The model takes a 20 year perspective and therefore also takes replacement investment of the electronic equipment into consideration.

The critical market share may not exceed a dedicated percentage of the potential subscriber base. In the telecommunications market all fixed network operators together will never achieve 100% market share since there are always potential subscribers who are not willing to use a fixed NGA network, but instead favor the use of a mobile network only, the use of a cable-TV network or even do not use telecommunications access at all. Thus, we believe the maximum achievable market share of an FTTH network of all potential subscribers is in the range of 70%. To determine this level of penetration it has to be considered that it is a steady state level where the FTTH network is the only fixed-line infrastructure and the copper network has been switched off. Today, the market share of the (copper-based) fixed line network exceeds the level of 70% in most EU countries.

The access network is modeled in detail in a bottom-up approach. The cost model follows a Greenfield approach for all network elements.[189] Concentration and core network costs are approximated by a cost function consisting of fixed and variable costs. Besides scaling these cost functions they are the same for the incumbent and the entrant. For simplicity the core and concentration network is also assumed to be the same for all access architectures considered.

The viability of access networks strongly depends on the subscriber density (subscribers per km²) and on settlement structures. The denser the subscribers, the sooner the access network will become viable. Thus the modeling has to rely upon a concrete settlement structure, a given country, and the results derived depend on that country.

We approximated typical European settlement structures and designed a hypothetical country for approximately 20 million households plus 2 million business customers or a population of around 40 million inhabitants. This country, referred to as “Euroland”, is composed of 8 different geo-types ("clusters") with typical structural access network parameters derived from detailed geo-modeling of access networks in several European countries on a nationwide basis. The geotype characteristics rely on exact data from several countries. In that sense, Euroland is a generically representative country.

Each of the 8 clusters is characterised by specific subscriber densities. The viability of a specific business model is calculated for each cluster separately, as for a separate profit center, i.e. the viability of a business model in Cluster 1 is independent from the viability in Cluster 2. In each of the clusters we assume the access network to be rolled out to 100% homes connected. For each of the clusters, the point where the NGA business may become viable is calculated individually and independently from the results of other clusters.

Wholesale prices for the competitor’s business case have been determined as monthly cost per line based on the long-run incremental cost (LRIC) of the network elements of the incumbent which are used for wholesale access, i.e. they directly are based on the

189 In reality there often is available infrastructure from legacy networks which may be reused to generate investment savings. This possibility could have an impact on the investment decision. For results on such a “Brownfield” approach see Hoernig et al. (2010).

costs determined for the incumbent. Wholesale prices are calculated at a take-up rate of 70% of the FTTH network. Since a significant part of costs is fix, the total cost per customer strongly depend on the number of customers on the incumbent's network. Wholesale prices have been determined under the assumption that the incumbent's network operates at a 70% take-up. This rate corresponds to the expected steady-state market share of the FTTH network taking into account the competing mobile and cable networks. This also means that these are the lowest possible wholesale prices under the LRIC assumptions. Depending on the scenario, they include active equipment in the MPoP (e.g. scenario GPON with bitstream access at MPoP) or even transport through the incumbent's concentration network (e.g. scenario GPON with bitstream access at core layer). The cost of the optical in-house cabling is also part of the wholesale charge. All initial analysis is cluster-specific, so the wholesale price in Cluster 1 is independent from the wholesale price in other clusters.[190]

The task of the economic model is to develop a steady-state picture of competition in an FTTH oligopoly, in order to determine and compare end-user prices, consumer surplus and producer surplus (for both network owner and other firms) for the five scenarios of NGA technology described above. Since we regard subscriptions as the units of sales, ULL and bitstream access in our approach only differ by costs, wholesale prices and QoS, but not by units. This allows us to use the same formal model for all scenarios; we only need to adjust parameter values appropriately.

The cost modelling results only generated a rough picture on the competitive conditions in the NGA market. It produced clear and definitive results on the replicability of FTTH fibre infrastructure. The critical market shares for viability indicated the potential number of competitors which could exist in the market on the basis of a certain business model. Furthermore, and most importantly, the cost modelling approach generated cost functions for the business models of the incumbent as the infrastructure investor and the access seeking competitors. These cost functions are developed for all architectural and all access scenarios we are considering. The cost modelling approach, however, does not deal with the strategic interaction between the wholesale provider and the competitors. Only if that is taken into account, it becomes possible to predict the "real" market outcome in terms of prices, market shares, profits and the actual number of competitors in the market.

The focus of the model will be on market outcomes for given investment decisions. The approach, however, also allows to quantify the gains from certain investment decisions. It can, thus, shed some light on investment incentives of the different market players. We can evaluate the effect of regulation on these gains from investment. The oligopoly model uses the output of the cost model, the cost functions of the various market players, as its basic and central input. Furthermore, the critical market shares are used to calibrate the initial number of operators in the oligopoly model.

190 In the competition model an average of the first 4 clusters has been chosen and discussed.

Our modelling approach is based on the pyramid model, which is closely related to the spokes model: For each pair of services, there is a set of consumers who choose between these two products and these consumers are (uniformly) distributed in their willingness to pay for one service rather than the other. Graphically this leads to a pyramid with each service located at one of the tips of the pyramid. Our approach captures essential aspects of competition in FTTH markets, both on the wholesale and retail side. One firm, the “incumbent”, owns and invests in an FTTH access network, to which other firms (“entrants”) must obtain access in order to provide NGA-based services. Entrants are assumed to be symmetric and need to make own investments in order to use NGA access. We consider models both with and without a second vertically integrated broadband infrastructure (“cable”), to which no other firms have access. The services that firms offer are both “horizontally” and “vertically” differentiated. The former means that consumers do not react strongly to small price differences because individual preferences for firms’ brands differ. In particular, assuming a uniform distribution of individual tastes in this horizontal dimension leads to linear demand functions. As a result of horizontal differentiation, the market is imperfectly competitive and firms will enjoy positive markups. Vertical differentiation expresses differences in service quality and goodwill or brand recognition as perceived by consumers, i.e., at equal prices a firm with higher service quality would attract more consumers. Service quality is assumed to affect all consumers similarly, i.e. we abstract from market segmentation in the service quality dimension.

To model that total FTTH subscription demand is variable, we considered two model variants. In both variants there is a group of “competitive” subscribers. Each competitive subscriber makes a first choice between two of the firms, and unless their offers are very unfavorable, he will choose one of the two. It is assumed that all pairs of preferred firms (before quality differences) are equally likely in the population, so that effectively each firm will compete with any other firm for consumers. Formally speaking, cross price elasticities are different from zero for all product pairs. Due to the assumption of uniform distributions of consumer tastes, the resulting demand function of each firm is linear in its own price and linear in the price of all other firms. This makes the analysis tractable and allows for explicit solutions. In spite of advances in empirical demand estimation that allow for more flexible demand specifications, the linear demand system remains popular in empirical research. Our underlying micro foundation permits us to compare markets with different numbers of firms in a meaningful way. If the firms on the market include the cable firm, our model has the feature that FTTH subscription demand is variable. However, total demand for subscription is fixed and assumed to be 100% of potential subscribers in the clusters considered. We call this the “No-Hinterland” model. In the absence of a non-FTTH-based competitor, we make subscription demand variable with the introduction of “captive” consumers who make a choice between one firm and not buying FTTH subscriptions at all (this is the “Hinterland” model). In line with the critical market share analysis we aim at FTTH subscriptions close to 70% of all potential subscribers in the clusters considered.

We treated the incumbent as if he were under vertical accounting separation into a NetCo that supplies FTTH infrastructure access and an OpCo that sells FTTH end-user services. The incumbent's NetCo sells access to other firms ("entrants") and to the OpCo. This does not affect pricing behavior and overall profits but it provides for an automatic price-squeeze test.

Depending on the scenario considered, first, firms make certain investments in networks and access, which determine their service quality levels and operating cost. Second, they compete in subscription fees at the retail level. The resulting market outcome is modelled as the Nash equilibrium outcome of the resulting pricing game, from which subscriber numbers, profits, market shares, consumer surplus and total welfare are derived. In the model with entry and exit, we first allow for a non-specified process of entry and exit with the feature that all active entrants make profits and that the entry of an additional entrant would lead to losses of all active entrants. Here we postulate that entrants foresee the effect of entry on the pricing decisions and, thus, on market outcome. Formally, and in line with the literature on industrial organization, this means that we consider subgame perfect Nash equilibria of the two-stage game in which entrants first make their participation decision and then all active firms make pricing decisions.

Results

From the many and comprehensive modelling results we will present here only those on consumer surplus (CS) and welfare (W) which is the sum of CS and profits of the firms in the market. The welfare results are basically driven by costs, prices, and number of competitors in the market.

There are three drivers of prices and price differences: Costs, willingness to pay (WtP) and competition (number of firms). Prices are directly driven by variable or, more precisely, marginal costs (MC), not by fixed costs. Fixed costs only influence the level of profits and are thus important for entry and exit of firms (which again indirectly affect prices).[191]

Under the basic parameterization in all scenarios only 3 or 4 entrants survive besides the integrated incumbent and a cable operator in equilibrium. While we had expected this for all the other scenarios, it has come as a surprise for GPON bitstream core[192], where our expectation based on the critical market shares was for a higher number of entrants. The main reason is that, already with a small number of entrants, the lower WtP for GPON leads to prices below the general ARPU assumed for the critical market share analysis. Further entry then leads to even lower prices and lower quantities per entrant, resulting in overall losses for all entrants.

191 The aggregate fixed costs of cable for the first four clusters are assumed to be € 20 million per month.
192 "GPON bitstream core" is to denote a GPON architecture variant in which a bitstream access is provided at the core network level.

Table 3-3 summarizes our basic model results for CS and W. It also puts the results on prices, profits and market shares in perspective. In this context it needs to be noted that CS is largely driven by the price/valuation relationships between the different technologies and firms rather than by the overall quantity of output, which is fixed.

Table 3-3: Basic model results on consumer surplus and welfare per month

Scenario	n-2	CS		W	
		Mio €	Rank	Mio €	Rank
P2P unbundling	4	466.9	**1**	490.3	2
GPON over P2P unbundling	3	434.0	2	493.8	**1**
WDM PON unbundling	4	431.2	3	473.9	3
GPON bitstream core	4	400.5	5	445.7	4.5
GPON bitstream MPoP	4	416.0	4	445.1	4.5

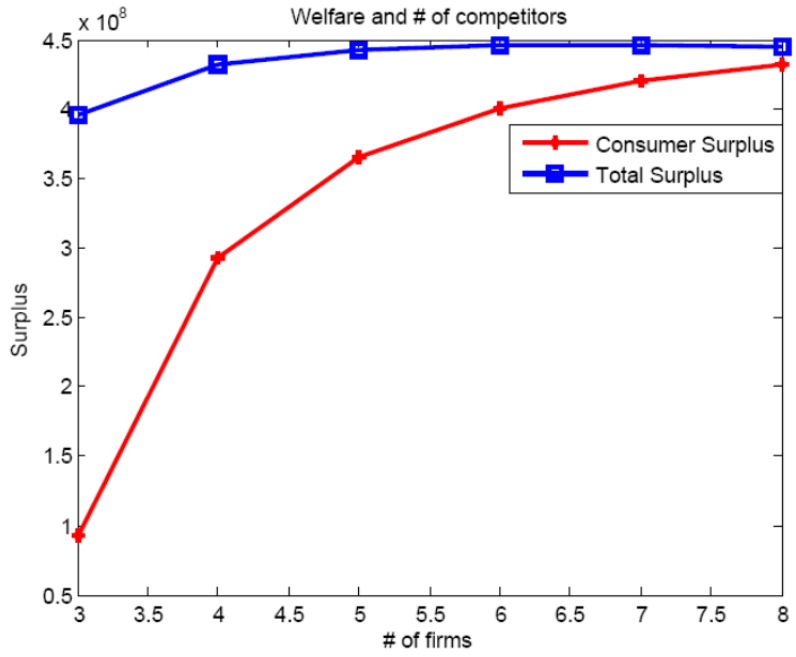
Source: Hoernig et al. (2010)

The CS rankings are rather evenly spread except for the very close GPON over P2P unbundling and WDM PON unbundling scenarios in places 2 and 3. In contrast, there is a roughly 4% difference in terms of W between the first (GPON over P2P unbundling) and the third (WDM PON unbundling) and a 6% difference between third and 4th/5th place. GPON over P2P unbundling ranks first and narrowly beats P2P unbundling, while WDM PON unbundling is third with a significant margin. The two GPON bitstream scenarios are in a dead heat for last place.

In terms of CS the ranking between the P2P topologies and between the GPON bitstream scenarios is influenced by the number of entrants. There are only three entrants under GPON over P2P unbundling and four entrants under P2P unbundling. This leads to higher prices and lower CS for GPON over P2P unbundling than P2P unbundling and for GPON bitstream MPoP than GPON bitstream core.

Figure 3-22 shows that, in contrast to CS, W is not much affected by entry, once the number of firms reaches 4. Thus, as a result of different numbers of entrants, the same rankings of scenarios in terms of W are as unsurprising as are different rankings of scenarios in terms of CS. The small effect of entry beyond 4 or 5 firms on W seems to be the result of the stable market share of the incumbent. The resulting cable's gain in market share relative to the entrants appears to be welfare neutral taking all other effects into account.

Figure 3-22: Welfare per month and number of competitors - GPON bitstream core according to Hoernig et al. (2010)



Source: Hoernig et al. (2010)

In contrast to W, CS continues to increase fairly strongly with the number of firms. Since the number of firms in equilibrium in some cases appears to be quite sensitive to small changes in model parameters, the results on welfare should be considered more stable than the results on consumer surplus.

Sensitivity of results

Besides the basic model runs we have done sensitivity analyses with respect to the wholesale access charges and to the QoS and WtP assumptions. They yielded the following results:[193]

Regarding the impact of the QoS and willingness to pay assumptions on the results we considered four alternative cases, (1) a smaller spread between the different WtP for incumbents, entrants and cable, (2) an increase in the goodwill advantage[194] for the incumbent, (3) a combination of (1) and (2), and (4) an increased WtP for WDM PON.

193 For detailed descriptions and numbers see Hoernig et al. (2010).
194 The goodwill advantage may arise from the familiarity of the incumbent and the unfamiliarity of the entrant. See Vogelsang (2003), p. 259.

A smaller spread between the different WtP for incumbents, entrants and cable shows that end-user prices, profits and market shares of the incumbent all generally decrease, while these variables increase for the entrants.

Increasing the goodwill advantages of the incumbent increases end-user prices, profits and market shares of the incumbent at the expense of those of entrants. This result shows that the incumbent can have incentives to deteriorate the quality of the wholesale product provided to entrants. An increase in the incumbency advantage leaves the rankings with respect to CS and W largely unaffected. CS and W generally decrease because of the lower WtP for entrants and cable services.

Combining increased goodwill advantage with smaller spread shows almost the same prices, profits and market shares as the basic model. However, levels of CS and W now almost even out between the scenarios. WDM PON comes out ahead.

An improved WtP for WDM PON relative to all the other scenarios leads to entry of an additional firm, implying substantially lower prices and profits. This outcome is associated with a changed ranking of the scenario by moving it ahead of P2P unbundling and GPON over P2P unbundling.

While the changes in the WtP assumptions can have substantial effects on the model results, those of the basic model are reemphasized for the most likely alternative to the basic model, which is to increase the incumbency advantage (2).

The next realistic alternative (3) provides very similar market outcomes to the basic model, but leads to different rankings in the valuations of CS and W. The least realistic alternative (1) changes many outcomes.

The sensitivities reveal that changes in the WtP assumptions can have relevant effects on the ranking of our competition scenarios in welfare terms. One central result, however, remains stable: Access technologies which can be unbundled dominate technologies which cannot be unbundled in terms of W and CS.

Summary of results

Our overall results reveal a clear distinction between technologies that can be physically unbundled and those bitstream-only technologies that cannot. Competition scenarios based on networks suitable for unbundling generate greater consumer surplus and total welfare than those based on GPON bitstream access. While our results are less clear on which technology suitable for unbundling should be preferred, our results suggest that the current trend in Europe – towards bitstream-only GPON – is inferior to any option that is suitable for unbundling. Such architectures would deliver greater consumer surplus and welfare.

Although GPON is the cheapest technology to roll-out fibre networks, the investment and cost advantage amounts to not more than 10% compared to Ethernet P2P, which is the more future-proof and capable technology. In our basic model, the benefits of Ethernet P2P, however, outweigh the additional investment costs and deliver higher consumer surplus and total welfare.

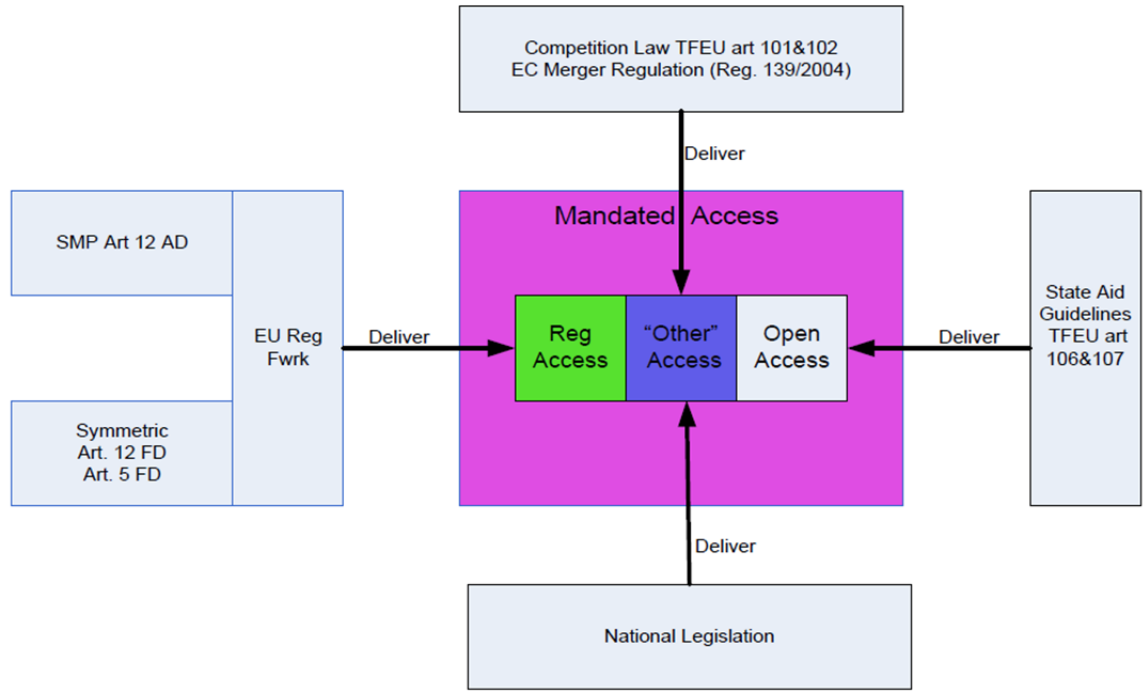
In light of our results, the principle of technological neutrality needs more careful consideration in European policy making regarding fibre networks. There should be public policy and regulatory concern over the passive architecture of a fibre network because not all architectures support technologically neutral access technologies in the market. While a P2P passive fibre plant topology can support all fibre access technologies for all market participants, a Point-to-Multipoint topology cannot. Thus, a P2P topology of the passive fibre plant is more compatible with the principle of technological neutrality.

3.2.6 Relationship between State aid and regulatory access obligations

Access obligations under the State aid Guidelines are addressed to all beneficiaries of State aid independent of their actual market position. Access obligations imposed under the Regulatory Framework are only addressed to operators which have a SMP market position. Despite these differences in the target group of access obligations there are good reasons that access obligations imposed under the State aid rules should be coherent to those imposed under the European Regulatory Framework. The physical nature and the characteristics of access products relate to certain features of the network infrastructure, the location of access points and to costs. Such features are mostly independent of the market position of the operator which is obliged to provide access. Under the Framework incumbent operators have been mandated to provide a variety of access products to competing alternative operators in order to lower barriers to entry and to promote the competitive provision of communication services for the benefit of European residential and business users. Beneficiaries of State aid measures may have a SMP position in the market, but usually they have not. For that reason access obligations under the State aid rules have more similarities to symmetric regulatory regimes which are put in place by some Member States for certain network segments like in-house wiring or concentration point access.

Besides regulated access under the European Regulatory Framework some Member States have introduced in the context of broadband and NGA deployment specific national legislations which often also address specific access obligations for broadband network operators. Further obligations may be imposed on the basis of national and European competition law. BEREC (2011b, p.8) has summarised all relevant forms of mandated access as presented in Figure 3-23.

Figure 3-23: Forms of Mandated Access



Source: BEREC (2011b), p.8

National legislation has been enacted in some Member States in order to take account of national circumstances and broaden the legal basis for mandating access with regard to NGA roll-out. By means of a questionnaire BEREC (2011b) has identified the following legislative examples:

1. Legislation which makes it easier for operators to carry out street works (UK).
2. Legislation providing operators with the ability to negotiate access to passive infrastructure already deployed (Ireland).
3. Legislation giving powers to the NRA to impose sharing obligations on passive infrastructure (Norway).
4. Wholesale access to ducts and dark fibre to be allowed by the owner of such infrastructure (Austria).
5. Projects relating to the building of new roads or railways must make provision for the installation of ducts that allow the deployment of electronic infrastructure to all operators under equal conditions (Spain).
6. "Open access" to passive infrastructure at a horizontal or vertical level and symmetrical regulation for in-house wiring (Portugal).
7. Legislation obliging facility sharing (Turkey).

8. Legislation regarding rules applicable to passive infrastructure owners regarding sharing of such infrastructure (Lithuania).

Some other Member States are planning to use national laws to impose obligations in the near future.

Competition Law has been applied in situations where joint ventures, mergers, or cooperation arrangements between competitors are affected. In such cases NCAs have used their authority under the Competition Law to ensure an appropriate level of wholesale access.

Besides mandated access operators which are not regulated under SMP regulation are negotiating or even offering voluntary access options. In particular for NGA networks there are strong incentives for non-SMP operators to provide access voluntarily. A single operating investor in a fibre network has not the initial critical market share to operate the fibre network viably. If this operator provides access to other operators to use his network platform on a wholesale basis it becomes easier to achieve the critical market share for profitability. As BEREC states[195] and as can be observed in Germany and some other Member States, voluntary access often is limited to active wholesale products in order to control a maximum of the value chain and to limit competition. Another reason for offering voluntary access might be to avoid formal regulatory requirements at least temporarily in the early years of deployment. A similar reason might be that voluntary access offerings might be granted in anticipation of formal regulatory requirements in the future. BEREC (2011b), however, concludes that voluntary access arrangements cannot be a substitute to mandatory SMP obligations because of the limitations of that concept which are observed in practice.

The harmonisation between the open access obligations under the State aid rules and the access remedies under the regulatory framework also has an institutional dimension. The Guidelines state that Member States should consult with the NRA in relation to State aid applications (para. 79). To ensure that access conditions are very similar if not uniform, the Guidelines are even suggesting that Member States may require that access conditions should be approved or set by the NRA. While some NRAs are actively participating in the design of State aid measures prior to their notification and their implementation, this is not common practice across the EU.[196] This is due to differences in national legislations. In many Member States NRAs lack the legal basis to provide a formal view or decision in State aid related matters. Furthermore, in some Member States NRAs do not have the capacity due to lack of resources to engage in a bulk of State aid measures and to overtake a monitoring role.

To materialise the role of NRAs as specified in the Guidelines, Member States should be encouraged to provide the proper legal basis for the requested involvement and monitoring of the NRAs.

195 See BEREC (2011b), p. 36.
196 See BEREC (2011b), p. 38.

3.3 Separation

3.3.1 Characteristics of the issue

"Separation" that has been imposed on market participants is by no means a new phenomenon in the telecommunications market. Examples are the divestiture of AT&T in 1984, the separation of cable activities from telecoms activities with the incumbents in several European countries (e.g. in Germany, the Netherlands, Portugal), and the functional separation in the UK imposed on BT by setting up the wholesale vehicle Openreach. These separation activities are, however, not specifically related to broadband. Separation in the context of broadband currently plays, however, a particular role in Australia, New Zealand and Singapore as an element of the respective national broadband policies.[197]

In the context of the present study the key issue is the following: Suppose a Member State or State resources (Art. 87 (1) Treaty) are involved in an NGA venture that constitutes State aid. What are the implications of "separation" imposed as a (pre-)condition for deployment, operation, and/or service provision from an ex-ante perspective? One form of separation has been already imposed in several MS, namely to demand that the wholesale operator of the network shall not provide retail services.

The current Guidelines address the issue of separation only once, i.e. in para. 27 in the context of SGEI : "….Where the provider of the SGEI mission is also a vertically integrated broadband operator, adequate safeguards should be put in place to avoid any conflict of interest, undue discrimination and any other hidden indirect advantages." The Guidelines conclude (see footnote 37): "Such safeguards may include, in particular, an obligation of accounting separation, and may also include the setting up of a structurally and legally separate entity from the vertically integrated operator. Such entity should have sole responsibility for complying with and delivering the SGEI mission assigned to it."

Separation and its implications for telecommunications markets in general and broadband in particular has been often addressed in the literature in recent times, see e.g. Haucap, Heimeshoff and Uhde (2008) providing a general discussion of the (dis)advantages of vertical separation; Doyle (2008) addressing the issue of structural separation and investment in particular in the context of the Australian National Broadband Network environment; and Zenhäusern, Vaterlaus and Worm (2008) focusing on a discussion of the functional separation of network and services and the implications for telecommunications markets.

197 See Doose, Elixmann (2011). This paper analyses both the UK case and the approaches in Australia, New Zealand and Singapore.

3.3.2 The concept of separation in the Access Directive

The Access Directive[198] addresses the issue of separation on four different dimensions:

- Accounting separation (Article 11 para. 1).
- Functional separation (Recital 61 and 62; Article 13 a).
- Structural separation (Article 11 para. 2).
- Voluntary separation by a vertically integrated undertaking (Article 13 b).

Accounting separation

According to Article 11, para. 1, a national regulatory authority may impose obligations for accounting separation in relation to specified activities related to interconnection and/or access.

Functional separation

Recital 61 of the Access Directive specifies functional separation as a means "to ensure the provision of fully equivalent access products to all downstream operators, including the operator's own vertically integrated downstream divisions". According to the European Commission, functional separation in principle "has the capacity to improve competition in several relevant markets by significantly reducing the incentive for discrimination and by making it easier to verify and enforce compliance with non-discrimination obligations."

Yet, the European Commission views functional separation to be a remedy which may be justified only in "exceptional cases", i.e. cases "where there has been persistent failure to achieve effective non-discrimination in several of the markets concerned, and where there is little or no prospect of infrastructure competition within a reasonable time frame after recourse to one or more remedies previously considered to be appropriate."[199]

198 See Directive of the European Parliament and of the Council amending Directives 2002/21/EC on a common regulatory framework for electronic communications networks and services, 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities, and 2002/20/EC on the authorisation of electronic communications networks and service; Brussels, 12 November 2009; 2007/0247 (COD); C7-0273/2009.

199 Article 13a para. 1 specifies: "Where the national regulatory authority concludes that the appropriate obligations imposed under Articles 9 to 13 have failed to achieve effective competition and that there are important and persisting competition problems and/or market failures identified in relation to the wholesale provision of certain access product markets, it may, as an exceptional measure … impose an obligation on vertically integrated undertakings to place activities related to the wholesale provision of relevant access products in an independently operating business entity. That business entity shall supply access products and services to all undertakings, including to other business entities within the parent company, on the same timescales, terms and conditions, including those relating to price and service levels, and by means of the same systems and processes."

According to Recital 61 and 62 the imposition of functional separation requires several conditions to be met:

- the incentives of the concerned undertaking to invest in its network are preserved;
- any potential negative effects on consumer welfare are avoided;
- particular attention is paid by NRAs - when undertaking the market analysis and designing the details of functional separation - to the products to be managed by the separate business entities, taking into account the extent of network roll-out and the degree of technological progress, which may affect the substitutability of fixed and wireless services;
- proposals for functional separation are approved in advance by the European Commission in order to avoid distortions of competition in the internal market;[200]
- the implementation of functional separation does not prevent appropriate coordination mechanisms between the different separate business entities in order to ensure that the economic and management supervision rights of the parent company are protected.

Structural separation

Article 11, para. 2 underlines that structural separation is an appropriate instrument in cases where public or local authorities retain ownership or control of undertakings operating public electronic communications networks and/or publicly available electronic communications services. In such cases MS "*shall ensure that … there is an effective structural separation of the function responsible for granting the rights referred to in paragraph 1 from the activities associated with ownership or control*."

Voluntary separation by a vertically integrated undertaking

Article 13 b addresses the case where a vertically integrated undertaking – that has been designated as having significant market power in one or several relevant markets - makes a voluntary decision in favor of (specific forms of) separation. These specific forms are defined as

- the transfer of the local access network assets or a substantial part thereof to a separate legal entity under different ownership, or
- the establishment of a separate business entity in order to provide to all retail providers, including its own retail divisions, fully equivalent access products.

Under these circumstances the respective undertakings "shall inform the national regulatory authority in advance and in a timely manner, in order to allow the national regulatory authority to assess the effect of the intended transaction".

200 Requirements for such a proposal are specified in more detail in Article 13a, para. 2 and 3.

3.3.3 Approaches of vertical separation

The aforementioned concepts of accounting, functional and structural separation are highlighted in Martin Cave's seminal paper[201] on different modes of separation in the telecommunications market. The following table provides an overview of the different "rungs on the Ladder of Separation".

Table 3-4: Different approaches of vertical separation in the telecommunications industry

Specification of separation options according to Cave (2006)	Essential characteristics
Accounting separation	Separate profit and loss statements and balance sheets for the separate entities
Creation of a wholesale division	Creation of a special wholesale (or otherwise named) unit, with a dedicated management
Virtual separation	Imposition by the regulator of an obligation to achieve full equivalence in the services offered to internal and external customers without any physical separation of networks, signaling systems, business premises etc.
Business separation	Segregation of particular assets and other inputs (regarding premises, operational support system, labour force, brand, management information systems, strategies) within a separate unit, which then trades using identical processes with both internal and external customers in a way that can be verified transparently
Business separation with localised incentives	Specific incentives for senior managers in the separated entity leading to an orientation solely at the profits of the latter
Business separation with separate governance arrangements	Creation of a divisional board with non- executive directors independent of the group
Legal separation	Separate legal entities under the same ownership (regime in which a separate board is created and separate statutory accounts are filed)
Ownership separation	Legal separation with a complete abolition of any links between the formerly integrated parts

Source: Cave (2006)

In this table the "weakest" form of intervention is at the top and the strictest one at the bottom. The "weakest" form of intervention into the property rights of an existing company encompasses accounting separation, creation of a wholesale business, and virtual separation. The strictest form of intervention would be given by an imposed structural separation (legal separation, ownership separation). In between there are different modes of

201 See Cave (2006). Notwithstanding the title that envisages six degrees of separation Cave actually differentiates between eight degrees of separation.

functional (sometimes also called operational) separation (business separation perhaps accompanied by localized incentives or separate governance arrangements).

In order to analyze adequately the issue of separation in the context of broadband it is pertinent to illuminate the case of Singapore and the implementation of its Next Gen NBN. In a nutshell, the approach in Singapore rests on separate entities which are responsible for specific tasks in the value chain, namely

- a passive infrastructure company (NetCo) responsible for designing, building and operating the "passive infrastructure layer" (to include wirelines and ducts on OSI Layer 1) of the Next Gen NBN.
- An active infrastructure company (OpCo) responsible for the design, build and operation of the active infrastructure layer (to include switches and routers on OSI-Layers 2 and 3) of the Next Gen NGN. The OpCo is to sell wholesale services to the SalesCos (retail service providers).
- Retail service providers (e.g. ISPs).[202]

The Singaporian approach rests on far reaching separation requirements:

- The NetCo must be *structurally separated* from other market parties. To this end, the terms of reference for the bidding process for the NetCo function had already specified that bidders also present in downstream markets must ensure the NetCo to be a separate entity with fully autonomous decision-making and with no effective control exercised by downstream companies on the NetCo or vice versa.
- The OpCo must be *operationally separated* from downstream parties. This is a less stringent separation than that of NetCo and allows OpCo to retain shares of downstream companies (i.e. retail services providers like ISPs). However, OpCo is obliged to be established as a separate legal entity. It must provide equivalence of inputs to all downstream operators (same prices and terms, same processes and information). Furthermore, OpCo must be independent from affiliated downstream operators.[203]

Subsequently, we use the terms NetCo, OpCo and SalesCo independently from the case of Singapore in order to differentiate between the key aspects of

- deployment of NGA passive ("unlit") infrastructure,
- operation of the lit infrastructure, and the
- provision of end-user services and applications.

202 From the perspective of NetCo we subsequently speak of downstream markets in the case of OpCos or retail service providers, respectively. From the perspective of OpCo we speak of downstream markets in the case of retail service providers and of upstream markets in the case of NetCo.

203 For more information see e.g. Elixmann et al. (2008).

3.3.4 Impact of separation on the broadband market

In order to highlight the potential implications of a separation condition imposed on an NGA venture which is subject to State aid, it is useful to differentiate between two different alternatives:

- National ventures focusing on the (more or less) ubiquitous deployment of NGA infrastructure throughout a MS;
- Regional or local ventures focusing on the deployment of NGA infrastructure in a certain part of the respective country.

3.3.4.1 (Ubiquitous) National NGA ventures

The first alternative is currently about to be implemented in Australia. Indeed, the policy of the Australian government regarding NGA (in Australia the acronym is "NBN", National Broadband Network) specifies to deploy fibre infrastructure throughout the country and to give access to more than 90% of the households allowing them to get up to 100 Mbps. The Australian government is the primary investor of this venture.[204]

Even though we think that such an approach in Europe is unlikely to become political and market reality[205], it might be useful to discuss it from the perspective of separation.

Let's suppose a national NGA plan in a MS. What is the likely activity profile of the MS vehicle along the lines of NetCo, OpCo and SalesCo? It is plausible to assume that the MS vehicle will not provide SalesCo services because this is distorting competition and devalues the assets of existing market participants. The same holds true of OpCo services: one might concede that there is a market failure in all MS regarding deployment of a nationwide NGA infrastructure (due to costs, in particular the costs of civil works). However, it can be anticipated that there is no market failure regarding the operation of the NGA network and therefore in a market economy the State should abstain from interfering with the market.

Thus, the only meaningful approach is that the MS NGA vehicle is (involved in) the NetCo. This NetCo provides the passive infrastructure. Two cases are in principle possible regarding separation:

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204 To implement the NBN a new company NBN Co has been established which is to construct and operate the broadband network. Actually, the implementation rests on a Public-Private-Partnership (PPP). Indeed, NBN Co initially is wholly Government-owned, however, private investment is encouraged and ultimately the Government intends to sell down its interest in NBN Co five years after the network is built. NBN Co will be a wholesale-only entity.

205 This assertion is based on the significant costs that are to be covered for a (near) nationwide deployment of NGA infrastructure and the financial pressure to downsize governmental budgets against the backdrop of the current economic debt problems in Europe. By most estimates, full coverage of the EU-27 at 30 Mbps by 2020, together with 50% coverage at 100 Mbps, requires an investment of two hundred to three hundred billion €. See for instance "NGA funding chasm revealed as Kroes meets industry CEOs", The European Broadband Portal, at http://www.broadband-europe.eu/Pages/NewsDetail.aspx?ItemID=833.

- It is intended to have one or several OpCo market player(s) which "light(s)" the NGA infrastructure (selected e.g. by a tender process) but the OpCo is not allowed to offer SalesCo (i.e. end-user) services. Rather, SalesCo services are provided by distinct entities that are separated (in a way to be specified by the MS) from the OpCo.
- The separation "interface" is at the NetCo level, i.e. there are integrated OpCos/SalesCos that purchase access to the passive infrastructure from the NetCo and that are providing end-user services.

Single (national) OpCo, many SalesCos which are separated

The crucial issue is: What is the market positioning of the existing market participants, in particular the telco incumbent in this environment?

There is a trade-off: On the one hand, from the perspective of an incumbent company it is highly likely that there is a viable business case for the OpCo function, i.e. for operating the (nationwide) NGA network. On the other hand, depending on the actual requirements due to fulfilling the separation clause the implementation of such an approach might mean a fundamental intervention into the existing property rights of the owners of the incumbent, inasmuch as there is a need to separate the end-user link from the OpCo entity.

At least for the time being we expect that European incumbents (and national integrated competitors alike) are not willing to separate network operation activities from providing end-user services, rather, the development of the business models still is oriented towards enlarging the service and application portfolio to end-users by virtue of a company internal transmission and control network.[206] Moreover, even if the owners of the incumbents agree on separation one can expect significant one-off reorganisation costs, ongoing costs of contracting, costs of operational and investment co-ordination, etc.. Such a process will be a matter of years.

In essence, such a separation approach in all likelihood would yield no feasible and stable outcome. On the one hand, there is the risk that none of the existing nationwide market participants are bidding for the OpCo function. In all likelihood this would make the business case for an OpCo pretty challenging if not impossible. On the other hand, existing regional market players, let alone new market entrants, lack the capital, expertise and resources to meet the requirements of becoming a nationwide OpCo.

206 It is true that migration to (ALL-)IP-based Next Generation Networks (NGN) is underway and, thus, the possibility of decoupling infrastructure operation and service provision arises. Implementation of an NGN – e.g. by virtue of IP Multimedia Subsystem (IMS) - in essence means that the network logically gets a new layered structure: (1) access and transport layer, (2) media layer, (3) control layer, and (4) service/application layer. However, we do not see any advances by facilities based telecommunications companies today and in the foreseeable future to change their integrated business model in an NGN world, i.e. the assertion is that they will keep their integrated activities at least on the aforementioned layers (1) – (3) and they aim at expanding on layer (4).

Integrated OpCos/SalesCos purchase access to the passive infrastructure from the NetCo, light their portion of the network and provide end-user services

What are the potential implications of such an approach?

- The public/private investment arrangement inherent in this approach means the MS can determine contract terms.
- Provided there are competition friendly conditions at the NetCo/OpCo interface the wholesale business with this kind of separation is straightforward.
- The likelihood of nationwide homogenous SalesCo product/ service-offerings is high, since these offerings can be based on nationwide homogenous wholesale products and processes.
- A crucial issue is: What happens with the existing network infrastructure in the market, in particular that of the incumbent? To what extent and under what conditions can the NetCo make use of the existing infrastructures? These issues have been discussed and sorted out just recently in Australia in the context of the implementation of the governmentally led NBN initiative.[207]
- This kind of separation a priori brings about different and perhaps contentious interests regarding (justification of) future NGA network investments. The challenge arises for a continuous and coordinated cooperation between the NetCo on the one hand and the integrated OpCos/SalesCos on the other hand regarding network upgrades and also vis-à-vis maintenance issues, etc..
- In all likelihood there will be fierce service competition, i.e. regarding prices, service/application innovations, Quality of Service, “value for money”, etc. This, in turn, increases take-up rates and increases consumer welfare.

Subsequently we focus on the second alternative, i.e. on regional or local NGA ventures.

207 In Australia the government has come to an agreement with the incumbent company Telstra specifying the following key components: Telstra agrees to disconnect, progressively, copper-based customer access network services and broadband services on its HFC cable network (but not Pay TV services on the HFC) that are provided to premises in the NBN fibre footprint. Telstra will migrate its services onto NBN-based services, over the expected 10 year build period of the NBN. Moreover, Telstra will provide NBN Co with large scale access to certain infrastructure – dark fibre, exchange space, lead-in-conduits and ducts - at prices based on committed large volume levels of usage and availability. The term of the infrastructure agreement will be between 35 and 40 years. The infrastructure will be taken over the course of the NBN rollout and payments made for an assumed average period of 30 years. In order to maximise the availability of this infrastructure, Telstra will undertake necessary work on the infrastructure. Telstra retains ownership of all infrastructure assets, except for those lead-in-conduits used by NBN Co which will become NBN Co property once used. The Government has agreed to a package which includes increased funding for the delivery of the Universal Service Obligation (USO), clarification of Telstra’s USO responsibilities for the supply of infrastructure in new developments in the NBN environment, and the avoidance of certain costs to Telstra through various funding measures such as funding of a public information campaign, and for employee retraining. Telstra and NBN Co have also agreed to key product feature and price commitments relating to NBN Co’s basic voice and data offering. These will be addressed in NBN Co’s full product terms, which remain subject to further development and industry consultation. See “Telstra signs NBN Definitive Agreements”, Media Release, 23 June 2011; http://www.telstra.com.au/abouttelstra/media-centre/announcements/telstra-signs-nbn-definitive-agreements-2.xml.

3.3.4.2 Regional or local NGA ventures

We assume a regional or local "State resource" which has decided to become involved in an NGA venture and the envisaged business model is not based on a fully integrated vehicle, i.e. incorporating NetCo, OpCo and SalesCo functions in a single entity. Rather, the activity focus of the "State resource" is supposed to be either on the NetCo function alone or on the integrated NetCo and OpCo function. We assume that the remaining functions are to be outsourced (e.g. by a tender process) and in addition that "separation" conditions are imposed on the successful bidder.

Several cases might occur:

1. "State resource" is (part of) the NetCo; OpCo and SalesCo functions are allowed to be carried out by an integrated "third party";
2. "State resource" is (part of) the NetCo; OpCo function is provided by a specific distinct entity; OpCo is, however, not entitled to offer SalesCo function, rather, end-user services are to be provided by "Service Providers";
3. "State resource" is (part of) the NetCo and OpCo; SalesCo function is provided by "Service Providers".

3.3.4.2.1 "State resource" (involved in) NetCo; OpCo and SalesCo functions carried out by an integrated "third party"

Implementation, business model

- NetCo provides the passive infrastructure; selection of one or more integrated market player(s) (OpCo/SalesCo) which "light(s)" the NGA infrastructure and provide(s) end-user services.
- Challenges: Deployment of a "separation-friendly" NGA network design (access to the passive NGA infrastructure); identification and making use of appropriate co-investment partners (existing infrastructures).
- Public/private investment means "State resource" can determine contract terms.

Competition issues

- In principle there is a potential for (non-) price discrimination at the NetCo interface. Appropriate "open access" rules specified on a national level might minimize this potential.
- The number of integrated OpCo/SalesCo players depends on the cost characteristics of the area in question where the "State resource" plans to deploy NGA infrastructure. A recent WIK study shows that in most cases the number of players in a given area is rather limited, i.e. not higher than 3 or 4.[208]

208 See Hoernig et al. (2010).

- From a pure economic perspective it might turn out that there is only room for a single provider for the OpCo and SalesCo function. In this case there is in particular a regional monopoly in the end-user market. A priori this brings about all the challenges of a monopoly situation (regarding e.g. pricing, innovation, etc.) and would require in all likelihood ex-ante market intervention.
- The challenge arises for a continuous and coordinated cooperation between NetCo on the one hand and integrated OpCos/SalesCos on the other hand regarding network upgrades, maintenance issues, etc. To the extent that the cooperation activities are not successful there might be negative effects on the speed of further deployments.

Take-up rates, consumer welfare

- A priori there are only limited incentives by the “State resource” NetCo to “beat the drums” for demand stimulation on the end-user side.
- The likely limited or even lack of choice for consumers regarding service provision induces lower take-up rates for the “new” NGA infrastructure. Thus, there might be an incentive to stay with the existing infrastructure and service provider regime.
- The consumer welfare of such a market outcome is relatively low.
- Negative effects on the speed of further deployments in all likelihood affect also take-up rates.
- Let’s assume that there are several or even “many” regions within a country in which entities set up such a NetCo approach. A priori it could be possible that the OpCo/SalesCo function is carried out in all of these regions by the same entity. In such a situation it is nonetheless hard for the OpCo/SalesCo to offer and sell nationwide homogenous products and services due to the patchwork of NetCo networks. In particular a nationwide sales market communication may be worthless.
- Against this backdrop it is also hard(er) to achieve nationwide homogenous products for larger business organizations. This, in turn, prevents them from realizing homogenous organizational solutions and, thus, harms their productivity.

3.3.4.2.2 “State resource” (involved in) NetCo; OpCo function provided by a distinct entity; OpCo is, however, not entitled to offer SalesCo function

Implementation, business model

- NetCo provides the passive infrastructure.
- Challenges: Deployment of a “separation-friendly” NGA network design (access to the passive NGA infrastructure); identification and making use of appropriate co-investment partners (existing infrastructures).

- Selection of an OpCo market player which “lights” the NGA infrastructure by a tender process.
- Public/private investment means “State resource” can determine contract terms.
- Formulation and imposition of separation clauses preventing OpCo from offering end-user services.
- Relationship between NetCo, OpCo and SalesCos
    - NetCo acts as the wholesale provider to OpCo;
    - Either OpCo is wholesale provider to SalesCos and SalesCos provide access and services to the end-user or OpCo provides physical access to the end-user and all services and applications are provided by service providers.
- Formulation and implementation of non-discriminatory access conditions.

Competition issues

- In principle there is a potential for (non-) price discrimination at the NetCo interface. The same holds true of the OpCo/SalesCo interface. Moreover, double marginalization might occur. One remedy limiting the potential detrimental effects for competition might be appropriate “open access” rules (specified on a national level).
- Crucial issue: It is likely that such an arrangement induces disincentives for existing market participants (incumbent and competitors alike) to bid for OpCo function; reasons:
    - For integrated market participants which operate a network and provide end-user services giving up the link to the end-user is not incentive compatible.
    - Depending on the specific separation conditions a feasible approach might be to set up a specific subsidiary fulfilling the OpCo function. However, this induces transaction costs already for a single venture. To the extent that such an approach is chosen by “State resources” in several regional/local circumstances the coordination costs are causing transactions costs to rise.
    - If an existing market participant is already active in the specific area in which NGA infrastructure is to be deployed by the “State resource” NetCo and the OpCo function in this area is to be carried out by a subsidiary then there is the challenge to set up a feasible and incentive compatible “division of labour” (network elements, staff, customers, marketing etc.) between the two parts.
- Overall, from the perspective of the “State resource” engaged in the NGA venture it is non-trivial to find a “suitable” player for the OpCo function.

- OpCo is by definition a regional monopoly (with regard to the wholesale market or with regard to the end-user market).[209] A priori this brings about all the challenges of a monopoly situation (regarding e.g. pricing, innovation, etc.) and would require in all likelihood ex-ante market intervention. Yet, regulating the OpCo entity might be easier than regulating an entirely vertically integrated entity.
- The requirement arises for a continuous division of labour (and cooperation) between OpCo and NetCo with regard to network upgrades, maintenance issues, etc.. As new services and applications might be developed by SalesCos over time requiring specific network characteristics (e.g. bandwidth), it is also indispensable to include SalesCos with regard to network upgrades. Thus, the likelihood for increasing transactions costs is high. To the extent that the cooperation activities are not successful there might be negative effects on the speed of further deployments.
- The intensity of service competition (ceteris paribus) rests on the actual access regime (physical interfaces, prices, efficiency of the division of labour between OpCo and SalesCos in case of QoS problems, etc.) implemented for the wholesale services to be provided by the OpCo to the service providers (if SalesCos deliver both access as well as services and applications to end-users).

Take-up rates, consumer welfare

- Negative effects on the speed of further deployments in all likelihood affect also take-up rates.
- There is a tendency towards an increase of transaction costs in case an end-user gets access from the OpCo and services/applications from the SalesCos.
    - End-user receives two bills.
    - If QoS problems arise at the end-user side there is the challenge for the end-user whom to approach (OpCo or Sales Co) because the end-user in all likelihood prefers to have one face to the customer for QoS problems.
    - In principle the end-user signs his/her contract for NGA access without having full information about the portfolio of services/applications available and the specific requirements (e.g. regarding bandwidth) of the services/applications.
- Take-up rates (ceteris paribus) are the higher the more services and applications are available delivering “value for money”, i.e. the fiercer the service competition.
- The same holds true for consumer welfare.
- Nationwide product/service offerings are even harder to achieve and therefore disadvantages for the business customers using telecommunications will even be larger (see above).

209 For technical and economic reasons it is hardly possible that there is more than a single entity that lights a given NGA infrastructure in a given area.

3.3.4.2.3 "State resource" is (involved in) NetCo and OpCo; SalesCo function is provided by "Service Providers"

Implementation, business model

- The approach rests on the deployment and operation of (passive and active) network infrastructure within a single entity.
- The challenge regarding the deployment of a "separation-friendly" NGA network design is lower compared to the previous cases.
- The challenge regarding identification and making use of appropriate co-investment partners (existing infrastructures) remains.
- Either the NetCo/OpCo is the wholesale provider to the SalesCos and the SalesCos provide access and services to the end-user or the NetCo/OpCo provides physical access to the end-user and all services and applications are provided by service providers.
- Non-discriminatory access conditions have to be formulated and implemented for SalesCos vis-à-vis the NetCo/OpCo. The public/private investment character of this approach means that the "State resource" can determine contract terms.

Competition issues

- The integrated NetCo/OpCo might have a strong market position. As mentioned above a priori it either has a regional monopoly status with regard to the wholesale market (i.e. vis-à-vis the SalesCos) or with regard to the end-user market. Thus, the overall competitive situation is crucially dependent of whether full unbundling and/or bitstream access is available. To the extent that these access services are not (sufficiently) available all the challenges of a monopoly situation (regarding e.g. pricing, innovation, etc.) might occur and would require in all likelihood ex-ante market intervention. Yet, regulating the integrated NetCo/OpCo entity might be easier than regulating an entirely vertically integrated one.
- This separation approach entails only a limited incentive for (non-) price discrimination.
- As new services and applications might be developed by SalesCos over time requiring specific network characteristics (e.g. bandwidth), it is indispensable that SalesCos and NetCo/OpCo cooperate with regard to network upgrades. Thus, the likelihood for increasing transactions costs is high. To the extent that the cooperation activities are not successful there might be negative effects on the speed of further deployments.
- The intensity of service competition (ceteris paribus) rests on the actual access regime (physical interfaces, prices, efficiency of the division of labour between OpCo and SalesCos in case of QoS problems, etc.) implemented for the wholesale services to be provided by the NetCo/OpCo to the service providers (if SalesCos deliver both access as well as services and applications to end-users).

Take-up rates, consumer welfare

- Negative effects on the speed of further deployments in all likelihood affect also take-up rates.
- There is a tendency towards an increase of transaction costs in case an end-user gets access from the NetCo/OpCo and services/applications from the SalesCos.
    - End-user receives two bills.
    - If QoS problems arise at the end-user side there is the challenge for the end-user whom to approach (OpCo or Sales Co) because the end-user in all likelihood prefers to have one face to the customer for QoS problems.
    - In principle the end-user signs his/her contract for NGA access without having full information about the portfolio of services/applications available and the specific requirements (e.g. regarding bandwidth) of the services/applications.
- Take-up rates (ceteris paribus) are the higher the more services and applications are available delivering "value for money", i.e. the fiercer the service competition.
- The same holds true of consumer welfare.
- Nationwide product/service offerings are even harder to achieve due to NetCo/OpCo patchwork networks and their potential monopoly. It is therefore likely that business customers using telecommunications will once again experience disadvantages if the state driven entities do not harmonize their fibre topology, and network technology, and service provisioning processes (see above).

3.3.4.3 Cost-benefit analysis

Two presentations at a recent WIK-Conference[210] have focused on general aspects regarding the costs and benefits of separation.[211] Both authors have analysed the pros and cons of a mandatory separation which can be condensed as follows.

There might be advantages by preventing a vertical integration of an entity deploying and operating fibre infrastructure into the end-user market:

- It is easier to enforce non-discrimination regarding competitors and the retail branch of the entity in question and, thus, solve the access problem. Otherwise stated, all market participants act on a level playing field regarding access products and services.

210 The "International Conference on Vertical Separation in Telecommunications" was organized by WIK on 22-23 November, 2010, in Brussels. The conference has addressed the issue of separation from different perspectives on the basis of session presentations, key notes, and panel discussions.

211 See Bohlin (2010) and Moselle (2010).

- There are large benefits from enhanced competition in telecommunications due to lower end-user prices, better quality, more choice for end-users, and increased innovation.

The potential positive effects of a separation have to be compared with the potential negative effects:

- The mandatory obligation of separation can be viewed as a more or less significant intervention into the property rights and managerial freedom of the entity in question.
- The separated entity might lose advantages from an internalisation of wholesale and retail activities in one single entity; this loss of economies of scope might lead to higher costs.
- Double marginalisation might occur; separation might cause inefficient input substitution.
- Separation of a company in many cases leads to non-negligible costs of restructuring (transaction costs).
- There is the non-trivial challenge regarding the coordination of investments between the network and retail arms; retailers might be under-incentivized to ensure success of new network investments.

Of course, the extent of the positive and negative implications of a mandated separation depend on the actual form of separation. The potential to secure non-discrimination increases from accounting separation to functional separation to structural separation. Likewise, the potential losses are highest in the case of structural separation.

3.3.5 Regional splitting as a special form of separation

Section 2.6 has presented the case study on New Zealand and its Ultra-Fast Broadband Initiative. An essential feature of this national broadband policy is a specific form of geographical regionalization. Otherwise stated, the country is divided into altogether 33 geographical lots in which the respective OpCo, NetCo and SalesCo functions are to be arranged. To be more precise, in each of the geographical regions a specific Local Fibre Company deploys the optical infrastructure and acts as a wholesale-only market participant, i.e. it provides dark fiber products and also wholesale Layer-2 active services.

A priori an approach to split an NGA venture on a national level into different regional lots (or a regional NGA venture into different sub-regional lots) might also be relevant in Europe. We assume therefore that a MS government aims at deploying a (near) national broadband infrastructure. To this end, the country is broken into regional pieces each of them mirroring a specific deployment lot. Thus, the issue at stake is: What are the potential implications for such a regional splitting which can be viewed as a special form of separation?

In order to make an appropriate assessment different dimensions can be distinguished:

- Bidding process and participation
    - A priori one might distinguish two approaches regarding the design of the bidding process: (1) a specific bidder is allowed only to bid in a restricted number of regional lots (the extreme case would be: only a single lot), i.e. there is a cap regarding multiple bids per bidder; (2) a specific bidder is allowed to bid in as many lots as he likes, i.e. there are no limitations as to the number of bids a specific bidder submits. It is obvious, that in terms of participation alternative (1) has disadvantages compared to alternative (2).
    - We therefore think the bidding process should be designed in a way to generate the highest possible number of national and regional bids. i.e. we favour an approach in which a priori each potential bidder has the freedom to submit as many bids as he likes. This should hold true of both domestic and foreign entities.
    - A regionally separated bidding approach allows "smaller" would-be bidders to participate in the bidding process that would not be able to participate in a single national bid due to lack of resources, economies of scale, organizational capabilities, etc.
    - However, even potential bidders that a priori dispose of the resources and skills to submit a bid on a national scale (e.g. the incumbent) might have an incentive to participate in the bidding process by concentrating on specific lots in order to reduce investment costs.
    - The crucial issue regarding participation is the following: Do the regional lots provide enough incentives to receive at least one (suitable) bid per lot? Otherwise stated: Is each regional lot demarcated in a way that – in view of the topographic, population density, etc. characteristics – allows a viable business case ("profitable" regional lot)?[212]
- Speed of deployment
    - Cost studies reveal that civil works are the most important cost component as to broadband deployment. It is plausible to assume that there are economies of scale regarding these civil works (digging, etc.; use of specific machines; skilled staff, etc.). But it seems to be also plausible to assume that the "minimum efficient scale" of a broadband deployment venture is not the country at large, rather one is able to be cost effective already on a more or less regionally limited scale. Taking this for granted, a regionally separated deployment scheme therefore might allow to be quicker in reaching the overall coverage targets compared to a single national deployment approach.

212 The case of Finland shows that this is by no means trivial. Indeed, as outlined in Section 2.7 there are regions (very sparsely populated) for which no bid was received.

- Efficiency of the approach
    - A regionally separated deployment scheme might allow that regional projects starting “later” can benefit from the experiences of projects that started “earlier”, i.e. it might allow some kind of “benchmarking”.
- Competition
    - In view of the aforementioned arguments it is apparent that a regionally separated approach increases competition in the bidding phase.
    - Supposed the deployment activities are finalized, i.e. the regional network infrastructure is deployed. What will be the implications with regard to competition in the market? If the design of the bidding process has been incentive compatible one can assume that broadband infrastructure has been rolled out in each regional slot.
    - The resulting competition intensity will depend very much on the specific fibre topologies deployed (e.g. P2P vs. P2MP), and the wholesale services that are available. Other things being equal, competition intensity is the higher the more “favourable” the wholesale services are for entrants. Wholesale services to generate such a favourable market environment are fiber unbundling and bitstream access. Competition intensity is also affected by the fact whether entrants dispose of integrated core and concentration network infrastructure. For more details and an assessment of these arguments see section 3.2.
    - This general statement virtually holds true, however, only for a specific regional lot. As to wholesale services the resulting market structure of a regionalized broadband deployment approach can be very different. The differences can be characterised along two dimensions: (1) Number of companies that are wholesale suppliers across the regional lots; this number may be in effect “low” because each wholesale supplier has (successfully) applied for several or perhaps for all regional lots, or it may be “high”, i.e. there is a multitude of different entities. (2) Number of market players that are demanders of wholesale services. Also this number may be “high” or “low”.
    - From the perspective of an access seeker that wants to provide end-user services on a supra-regional or national scale (by virtue of wholesale services provided in the respective regional lots) a crucial factor therefore is how “different” the access conditions are across the regional lots in question. In this context both technical and economic conditions are relevant. Supposed, “favourable” access services are available on a non-discriminatory basis across the regional lots. Under these circumstances (and other things being equal), market entry on the end-user market is the easier for an access seeker the lower the

transaction costs of getting access are. Factors that are increasing (lowering) transaction costs are e.g. different (harmonized) technical interfaces and standards and different (harmonized) contractual conditions across the regional lots. Against this backdrop, it is "easier" and probably also more efficient for an access seeker if he only has to negotiate the access terms with a single or at least a very limited number of operator(s) in the regional lots compared to a case in which there is a different access supplier in each regional lot. Summing up, one can state that the higher the ex ante perceived transactions costs to be covered the lower the likelihood of actual entry by a potential competitor and the lower therefore the intensity of competition.

- Interconnection (prices)
    - A regionalized broadband deployment approach might also affect interconnection. A crucial factor for interconnection costs is the number of interconnection points. Interconnection points a priori are carrier specific depending on its specific network topology. Other things being equal, it is plausible to assume that (pure LRIC) costs are lower the lower the number of interconnection points. Thus, the costs of interconnecting with a specific player from a particular regional lot might be "low". Across all regional lots the number of interconnection points might, however, be "high" depending on the number of "active" players in the regionalized broadband market. Thus, from the perspective of an entity seeking interconnection with the "relevant" market players[213] the overall number of interconnection points in a country might be higher than in a pure national case. Under these circumstances the costs are therefore likely to be "higher".

3.3.6 Assessment and potential implications for the amendment of the Broadband Guidelines

In view of the aforementioned analysis we come to the following assessment:

- Separation first and foremost is a regulatory instrument to prohibit or limit potential anti-competitive behavior of integrated firms, in particular those with SMP.
- Separation neither is a trigger for enlarging the scope of an envisaged NGA venture nor for speeding up broadband deployment. Moreover, it is no instrument to induce investments in NGA infrastructure that otherwise would not have been made.

213 Of course a market participant need not have interconnection with all other market participants in order to have ubiquitous reach. Rather, he might interconnect with a transit provider that cares for the respective upstream connectivity to the "rest of the world".

- There is no argument in favour of separation substantiating that such an approach would lead necessarily to a “Pareto improvement” for the market (participants). Rather, there are more or less severe pros and cons.
- In case a MS aims at setting up a broadband deployment program on a national (or supra-regional) scale it might nonetheless be efficient to implement a regionalized tender process. Indeed, it is a priori unclear which of the options “single national operator” vs. “several regional operators” provide a better outcome regarding efficiency and competition. In order to enable a pertinent and appropriate decision regarding the (dis)advantages of both options the Guidelines should encourage the MS to regionalize the tender process considering the following requirements: (1) Regional lots have to be demarcated whereby cost and profitability conditions should be taken into account regarding the size of the lots. (2) The tender terms should allow both bids for a single or only some of the regional lots and bids for all lots. (3) Despite the regionalized tender process a single operator should be awarded in case the advantages of this approach outweigh its disadvantages.
- The Guidelines should abstain from formulating specific conditions for imposing an obligation for structural separation. The European Framework provides the respective conditions specifying the feasibility and appropriateness of this instrument.
- The Guidelines should, however, consider a mandatory accounting separation obligation in case of State aid. This shall make it easier for NRAs or public authorities to control that subsidized network operators take subsidies into consideration when calculating wholesale prices.

4 Implications and recommendations

Based on the case studies and the expert opinion on technical issues we have identified several challenges associated with the Broadband Guidelines. As they refer to different aspects of the Guidelines we have classified these challenges to the following categories:

- Basic principles.
- State aid and broadband projects in general.
- State aid and NGA projects.
- Separation.

In the following we will shortly describe each challenge and give our assessment regarding relevance and importance, respectively. Moreover, we will sketch potential modifications or amendments of the Broadband Guidelines to overcome the identified challenges.

4.1 Basic principles

4.1.1 Definition of NGA

(1) The NGA definition of the Guidelines is developed from a technological point of view and it is the same as the NGA definition of the NGA Recommendation and it is in line with the broadband targets of the Digital Agenda.

(2) The Digital Agenda has defined a distinction between “basic broadband”, “fast broadband” and “ultra-fast broadband”. Only the latter one is regarded as NGA. The Guidelines should in principle follow this differentiation. If a thorough analysis proofs this approach to become too complex, then it makes sense to distinct between basic and fast broadband on the one hand and ultra-fast broadband on the other hand. In any case, the understanding of NGA as “ultra-fast broadband” has to be applied consistently throughout the complete text of the broadband Guidelines.

(3) The capabilities of LTE will be expanding over time. In the foreseeable future, however, LTE will only support basic up to fast broadband and not ultra-fast broadband. The same assessment holds true of broadband access via fixed wireless access and satellite technologies. Technological developments therefore do not justify updating the definition of NGA networks by including other technologies as wireless, mobile or satellite solutions.

4.1.2 Harmonisation of SMP regulation and State aid rules

(4) Open access obligations imposed under the State aid rules should be taken from the same portfolio of access obligations which are generally defined by the NGA Recommendation for SMP regulation. This will ensure that at the end of the 7 years validity period of the State aid based obligations (cf. para. 51 f) there are no discontinuities regarding the wholesale services on which access seekers have built their business models. This does not exclude that in a particular country the obligations imposed under SMP regulation are different to those which are imposed under State aid.

(5) The relationship between access obligations imposed under State aid rules and SMP access obligations following a market analysis should be clarified with regard to pricing issues. If there are no published or regulated prices available to benchmark against, the pricing should follow the principle of cost orientation.

(6) Even if the Guidelines state that MS should consult with the NRA in the case of providing State aid, in many countries the NRA lacks the legal basis to provide a formal view or decision on access conditions. Moreover it remains unclear, how far the public authorities adopt the views and recommendations of the NRAs. The Guidelines should encourage the MS to provide an appropriate legal basis for the involvement of the NRAs.

(7) In some MS NRAs are actively involved in State aid cases prior to notification (e.g. setting conditions for granting State aid). But there is no consistent approach about the role of the NRAs across all MS. The European Commission should encourage the MS to harmonize the national legislation in order to reach a common approach.

(8) The MS should encourage NRAs to transfer knowledge on access-related aspects of State aid to local authorities. A good practice instrument could be that the NRAs issue guidelines for local authorities which include recommendations on market analysis, wholesale access products and pricing.

4.2 State aid and broadband projects in general

4.2.1 Detailed mapping and coverage analysis (para. 51 a)

(9) State authorities seem to have problems to receive sound projections from private investors on their potential NGA roll-out activities in the near future. It seems that relevant planning projections for a 3 year horizon are difficult to be formulated or at least difficult to be communicated by operators to public authorities. The Commission may consider shortening the near future horizon from 3 to 2 years in order to get more reliable information about foreseeable broadband deployments.

(10) There are indications that operators in the market may provide information about their planned activities in a strategic way. They announce deployment within the near future and do not meet their commitments and thereby block potential State aid measures in favour of other operators. The Guidelines should allow public authorities to go ahead with a State aid measure if they have justified doubts on deployment commitments made by market participants for strategic reasons. Serious deployment commitments could be underlined by a corresponding contract between the public authority and the respective operator.

(11) Some market players and public authorities claim that they feel unable to meet the detailed mapping and consultation requirements because of lack of resources and know-how. In our view this critique against the Guidelines is not justified. It only raises the issue what the proper organisational structure within a MS is to deal with broadband State aid.

(12) In particular on lower administrative levels, there may be a potential conflict of interest in conducting the market analysis by public authorities due to their dual function (conducting market analysis as well as being involved in the intended broadband measure). The Guidelines should encourage MS to involve NRAs to prove the results of the market analysis.

(13) As a practical matter for the distinction between grey and black areas the question comes up whether two different broadband service offerings provided by the same operator via different network platforms (e.g. DSL and LTE) should be regarded as two different service providers. The classification of grey areas in para. 40 should make clear that two (or more) broadband service offerings by one operator still define a grey area.

(14) For matter of clarity the Guidelines should make clear that the actual coverage of an area should be assessed in terms of homes passed by a particular network infrastructure and not on the basis of the actual number of homes or customers connected as subscribers.

4.2.2 Open tender process (para. 51 b)

(15) In case of State aid projects which aim at the deployment of broadband infrastructures in small regional units there is a risk that these regions are defined too small and thus do not provide sufficient economic incentives for market players to participate in tender processes. The Guidelines should address this risk and encourage MS to take into account the assessment of economic incentives in the definition of relevant regions before launching their tender processes. If this leads to "leopard areas"[214] this would not generate over-compensation in case the tender

214 "Leopard area" is used as a term for a region which consists of geographic sub-units that are classified differently regarding the availability of broadband infrastructures (e.g. parts of the region are white areas while other parts are grey or black areas).

process is sufficiently competitive. On the other hand, target areas should not be defined too large to avoid negative implications on the intensity of the tender competition.

(16) Market players claim that the open tender process is not sufficiently transparent for all potential investors in case tenders are published only locally. The Guidelines should encourage MS to publish tender information on broadband State aid at least on a regional or national level or perhaps even set up a specific website at the national level.

(17) Market players claim that the tender requirements formulated at a decentralized local level vary significantly across the different regions within a MS, thereby increasing the transaction costs of tendering for potential investors. The Guidelines should encourage MS to harmonise tendering conditions at a national level.

4.2.3 Most economically advantageous offer (para. 51 c)

(18) Some public authorities express concerns about relevant criteria to identify the most economically advantageous offer besides the amount of aid requested. Notwithstanding the particular importance of the amount of aid requested the Guidelines should provide more guidance by specifying additional criteria for choosing the most economically advantageous offer. Relevant criteria in this context may be:

- User acceptance of a certain technological solution;
- Sustainability of the technological approach;
- Impact of the proposed solution on competition;
- Anticipated demand of foreseeable broadband access products;
- Chances for successful realisation.

4.2.4 Technology neutrality (para. 51 d)

(19) Depending on whether the State aid measure is intended to support basic, fast or ultra-fast broadband access the Guidelines should make clear that not all technological solutions support any of these broadband access categories. Technological neutrality to support basic broadband access may include a higher number of technological alternatives than in case of NGA.

4.2.5 Use of existing infrastructures (para. 51 e)

(20) The actual use of existing infrastructure does not seem to exploit its potential in many MS. The third party use of the incumbent's infrastructure often is limited because relevant and accurate information is missing and because of the lack of regulation with regard to access to this infrastructure. Therefore there is concern that incumbents may be favoured in tendering proceedings because they have access to their own infrastructure at no or lower opportunity costs compared to their competitors. The Guidelines may consider the option to oblige incumbents to provide access to their infrastructure at the same terms and conditions as they use it for their own tenders to potentially receive State aid. This obligation should be timed such that competitors know these terms and conditions in a relevant period before they have to deliver their tenders. Such an obligation is of particular relevance when access to existing infrastructure is not or not yet regulated.

(21) The Guidelines should make clear that the beneficiaries of State aid are obliged to provide entitled third parties comprehensive and non-discriminatory access to information on their infrastructure (ducts, fibre, …) deployed under a State aid contract such that other operators can easily establish access to such broadband infrastructure. If there is a central register of broadband infrastructures the beneficiaries should be obliged to include their relevant information into this database.

4.2.6 Open access (para. 51 f)

(22) The open access requirement in para. 51 f[215] as "effective wholesale access" does not seem to be sufficiently specified to market players and to public authorities. It may be impossible to define in the Guidelines all the possible types of wholesale access products that could potentially be requested under the State aid rules because the access conditions differ in the MS. The Guidelines can, however, specify the minimum access requirements of typical broadband access network constellations.

- If the State aid measure supports the deployment of passive network infrastructure, duct access, dark fibre and/or unbundled access to the local loop should be mandated.
- If the State aid measure supports the provision of ADSL-based broadband access unbundling and bitstream access should be mandated.
- If the State aid measure supports the provision of VDSL, sub-loop unbundling and bitstream access should be mandated.
- If the State aid measure supports the provision of broadband provision over a cable network duct and bitstream access should be mandated.

215 See also para. 71 and para. 27.

- If the State aid measure supports the deployment of passive network infrastructure of an integrated operator, the access obligations may be imposed on all relevant levels of the operation and not only on those which are directly subsidised.
- If the State aid measure supports the provision of broadband services via satellite, mobile or fixed wireless networks, mandatory sharing of certain network elements should be considered as an access opportunity if there is a respective demand from other operators.
- For wholesale open access products on NGA networks we refer to Section 4.3.2.

(23) The Guidelines should encourage public authorities to impose further wholesale open access products which are mandated by NRAs under the SMP regulation.

(24) There might be cases in which access obligations formally enter into force only after network deployment has been finalized and/or the provision of network services has been launched. Such an approach may lead to disadvantages for access seekers inasmuch as they do not have sufficient time to market their own services and, thus, they cannot compete with the beneficiary on a level playing field. The Guidelines should therefore specify that access obligations imposed under the State aid rules take effect as early as possible so that access seekers are not disadvantaged compared to the beneficiaries.

4.2.7 Benchmarking pricing exercise (para. 51 g)

(25) Benchmarking wholesale prices is a complex regulatory task even for experienced NRAs. Public authorities in particular at a local level are often missing a comparable expertise as well as specific know-how and therefore are unable to assess wholesale price proposals of awarded operators effectively. This holds true even when relevant benchmarks are potentially available. The Guidelines should foresee a stronger role of NRAs to assess wholesale pricing issues of State aid projects and the corresponding obligations. Some MS have assigned such tasks directly to their NRAs. In other MS NRAs don't have the possibility to act in areas and topics which are not directly allotted to them by the relevant telecommunications legislation. They may also face a lack of resources for an involvement in a potentially high number of local or regional State aid cases. The Guidelines should first consider a stronger mandate for the NRAs to engage in wholesale access pricing issues of open tender processes, the assessment of wholesale price proposals and corresponding obligations to awarded operators. Second, the Guidelines should encourage MS to provide the proper legal framework for such a mandate of the NRA within the respective national legislation. This includes the proper staffing for this additional mandate.

(26) The Guidelines should foresee that wholesale prices are properly calculated. In case subsidies are provided for certain network elements used to provide wholesale services, the calculation of the corresponding wholesale price should take such subsidies into proper consideration. Access seekers should face the same opportunity costs of the wholesale services as the beneficiary access provider. As a result of such calculations wholesale prices may differ within a country. This is not a distortion of competition, it just reflects the tendency that NGA deployment may lead to subnational markets.

4.2.8 Claw-back mechanism to avoid over-compensation (para. 51 h)

(27) Public authorities seem to have problems to define effective claw-back mechanisms at low cost of administration. In some cases these difficulties have even led to limit State aid virtually below a (national) threshold for introducing a claw-back mechanism. The European Commission should consider the following options to amend the Guidelines:

- Encourage public authorities to use independent auditors to testify the existence or non-existence of over-compensation at the expense of the awarded operator.
- Specify important elements of an effective claw-back mechanism, e.g.
  - Time for the first over-compensation test;
  - Duration of the period to be monitored for avoiding over-compensation;
  - Threshold values for over-compensation;
  - Criteria for the calculation methodology.
- Giving up the claw-back mechanism totally as under the assumption that the competitive tender processes work effectively and efficiently there should (at least theoretically) occur no excessive profits.

(28) The Guidelines should provide MS with the option to abstain from a reverse payment mechanism regarding excessive profits and instead to require a re-investment by the beneficiary in order to extend the coverage area and to include additional unprofitable areas.

4.2.9 Amendments with regard to broadband networks in general

(29) Some terms used in the Guidelines are not sufficiently transparent and precise to market participants, public authorities and NRAs. This applies e.g. to:

- Active infrastructure;
- Passive infrastructure;
- Wholesale open access;
- Market failure.

The Guidelines should provide appropriate demarcations of the respective terms.

(30) Some market participants and/or public authorities request a more detailed specification of e.g.

- Relevant criteria for the market investor test;
- Relevant criteria for the selection of the most advantageous offer.

The Guidelines should provide more details on specifications of the respective criteria.

(31) In particular local and regional authorities express concerns over the proper understanding of relevance and meaning of the State aid approach. The Guidelines should encourage MS to set up framework programmes at a more central level which give clear guidance for implementation details for rather decentralised State aid measures in particular with regard to the State aid provisions. Furthermore, the Guidelines should encourage MS to provide advice at a central level on the details and provisions of State aid to the benefit of local or regional public authorities.

(32) If State aid is provided under framework programmes the Guidelines should request a proper implementation and monitoring approach for individual projects supported within a framework programme.

4.3 State aid and NGA projects

4.3.1 Distinction of NGA areas (para. 68 ff.)

(33) The distinction of white, grey and black NGA areas is focusing on the availability of one or more NGA networks while other characteristics of the NGA networks (e.g. implications for competition) are not considered at this stage. This seems to be a problem from the viewpoint of some market participants particularly in the case of grey NGA areas. But the aspect of competition is part of the more detailed analysis of a broadband measure by the European Commission according to para. 75. Thus, the criticism does not require or even justify an amendment of the Guidelines.

(34) In order to justify their activities in white or grey NGA areas public authorities have to substantiate a demand of residential and business users in the respective area which cannot be satisfied without intervention. The proof of the needs tends to be time and resource consuming for the public authorities. Moreover there is a chicken-and-egg problem with regard to supply and demand of NGA based Internet access and it is widely accepted that over time basic broadband infrastructures will be replaced by NGA networks. Against this background the European Commission could give up the requirement to demonstrate that there is an end-user demand which will not be satisfied without intervention. Such an approach would also be more in line with the Digital Agenda.

4.3.2 Additional conditions for NGA networks (para. 79)

(35) There is sufficient evidence from market experience and analytical studies that the access concept of full unbundling provides the best opportunities for effective competition (besides full replication of network infrastructure if economically feasible) also in an NGA environment. Therefore, the Guidelines should keep the requirement that any NGA network infrastructure that will benefit from State aid should support effective and full unbundling which is unbundling at the ODF. The P2P architecture which supports ODF unbundling gives most flexibility to all market participants with regard to their choice of the active electronics and technology of their NGA networks. Access provider and access seeker can make their technological decision independent of each other and the access provider does not determine the technological choice of the access seeker as its decision in favour of a P2MP architecture does. There are only low additional investment cost to deploy a P2P compared to a P2MP passive fibre infrastructure if at all. If there are somewhat higher investment costs they are more than overcompensated by the competitive advantages in terms of welfare which is generated by the greater potential of competition.

(36) If, for whatever reason, a P2MP architecture has been deployed supported by State aid, effective unbundling via WDM-PON should be mandated as early as that technology becomes commercially viable.

(37) Besides full unbundling the Guidelines should request for NGA networks the mandatory provision of bitstream and duct access as wholesale access products. Other access products like sub-loop or concentration point unbundling should only be requested if there is actual demand from access seekers and/or the same or similar wholesale access products are requested from the NRA in the context of SMP regulation.

(38) It is not yet demonstrated that the additional investment cost of a multi-fibre deployment can be outweighed by welfare gains through more effective competition as compared to unbundling (which does not require additional investment cost). Therefore, the Guidelines should not make multi-fibre deployment a mandatory requirement of State aid for NGA.

(39) The Guidelines should continue to follow the concept to involve relevant NRAs in the formulation and control of access conditions imposed under State aid measures. MS may even strengthen the role of NRAs such that they should either set themselves or at least approve the access conditions. Only such a formal involvement guarantees that access conditions are imposed which are identical or at least in line with remedies imposed under the SMP regulation in the broadband markets. In some MS NRAs don't have the legal mandate (and the resources) to be actively involved in the access condition part of State aid measures. The Guidelines should encourage MS to provide the proper legal framework for such activities of the NRAs.

4.3.3 Amendments with regard to NGA networks

(40) The Guidelines should clarify that State aid should in principle not be used to subsidise an infrastructure which substitutes any already existing NGA infrastructure in grey NGA areas. Rather, competition should be strengthened in the case of grey NGA areas by application of regulatory instruments. Only in case there are (for whatever reasons) no access obligations to the existing NGA infrastructure State aid may be justified.

(41) NGA investments or investments to support the deployment of NGA (e.g. ducts) are more and more conducted by public utilities. Thus, NRAs responsible for electricity (or water and gas) regulation increasingly face the situation that they have to make decisions how to deal with the cost allocation of such investments between the regulated electricity business and the telecommunications or other businesses. The Guidelines should make clear whether or not there is a concern to such cost allocations from a State aid perspective. In case there is a concern the Guidelines should set principles which should be followed by the NRAs.

(42) Some market participants express concerns over the potential crowding out effects of business activities of state owned local utilities in the field of NGA. The opinions and suggestions range from forbidding such public local business activities to limiting them to investments into passive NGA network elements. The Guidelines should make clear whether or not there is a concern related to such business activities of state owned local utilities from a State aid perspective. In case there is a concern the Guidelines should formulate principles which should guarantee that investments of local public utilities do not distort competition to private sector initiatives.

(43) The Guidelines should make clear that State aid in the field of NGA should be limited to the passive network infrastructure (and should not be awarded to investments in CPE or other electronic components of the network) to avoid distortions of the service competition between the integrated subsidised NGA network operator and a competing service provider.

(44) The Guidelines don't yet address the provision of guarantees and capital cost subsidies granted by public authorities to broadband investors (in particular for NGA networks). The Guidelines should address this issue and make clear under what conditions public guarantees and capital cost subsidies are acceptable from a State aid perspective to support broadband investments. In particular the Guidelines should clarify their relationship to the Commission Notice on guarantees.

(45) The Guidelines don't yet address PPP to deploy broadband networks (in particular NGA networks). The Guidelines should address whether there are State aid concerns regarding PPP. Potential areas of clarification may be:

- Risk sharing;
- Selection of partners;
- Ownership and rights of use of assets generated under the PPP;
- Valuation of infrastructure provided to the PPP;
- Valuation of equity shares;
- Third party access.

4.4 Separation

(46) The Guidelines should abstain from formulating specific conditions for imposing an obligation for structural separation. The European Framework provides the respective conditions specifying the feasibility and appropriateness of this instrument.

(47) The Guidelines should, however, consider a mandatory accounting separation obligation in case of State aid. This shall make it easier for NRAs or public authorities to control that subsidized network operators take subsidies into consideration when calculating wholesale prices.

(48) In case a MS aims at setting up a broadband deployment program on a national (or supra-regional) scale it might nonetheless be efficient to implement a regionalized tender process. Indeed, it is a priori unclear which of the options "single national operator" vs. "several regional operators" provide a better outcome regarding efficiency and competition. In order to enable a pertinent and appropriate decision regarding the (dis)advantages of both options the Guidelines should encourage the MS to regionalize the tender process considering the following requirements: (1) Regional lots have to be demarcated whereby cost and profitability conditions should be taken into account regarding the size of the lots. (2) The tender terms should allow both bids for a single or only some of the regional lots and bids for all lots. (3) Despite the regionalized tender process a single operator should be awarded in case the advantages of this approach outweigh its disadvantages.

Annex

Annex A.1 Abbreviations

Annex A.2 Glossary

Annex A.3 References

Annex A.4 Organisations interviewed in the analysis

A.1 Abbreviations

ADSL	Asymmetrical Digital Subscriber Line
ALA	Active Line Access
APOP	Aggregated Point of Presence
ARPU	Average Revenue Per User
ATM	Asynchronous Transfer Mode
AWM	Advantage West Midlands
BEREC	Body of European Regulators for Electronic Communications
BNetzA	Bundesnetzagentur (German NRA)
BT	British Telecom
CA-TV	Cable Television
CFH	Crown Fibre Holdings
CMTS	Cable Modem Termination System
CPE	Customer Premises Equipment
CS	Consumer Surplus
DE	Germany
DOCSIS	Data-Over-Cable System Interface Specification
DP	Distribution Point
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
DWDM	Dense Wavelength Division Multiplexing
EAFRD	European Agricultural Fund for Rural Development
EC	European Commission
EDTE	Economic Development, Transport and the Environment
ERG	European Regulators Group
EU	European Union
FDM	Frequency Division Multiplex
FICORA	Finnish Communications Regulatory Authority
FTTB	Fibre to the Building
FTTC	Fibre to the Curb
FTTH	Fibre to the Home
FTTN	Fibre to the Node
FTTP	Fiber to the Premise
FWA	Fixed Wireless Access
Gbps	Gigabits per Second
GNA	Glasvezelnet Amsterdam CV
GPON	Gigabit Passive Optical Network
GRW	Gemeinschaftsaufgabe Verbesserung der regionalen Wirtschaftsstruktur (Joint Federal Scheme for the Improvement of Regional Economic Structures)
HFC	Hybrid Fibre Coax
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access

ICT	Information and Communications Technology
IP	Internet Protocol
IPTV	Internet Protocol Television
IRU	Indefeasible Rights of Use
ISP	Internet Service Provider
ITP	Invitation to Participate
kbps	Kilobits per Second
KPN	Koninklijke PTT Nederland
LAN	Local Area Network
LFC	Local Fibre Companies
LLU	Local Loop Unbundling
LRIC	Long Run Incremental Cost
LTE	Long Term Evolution
Mbps	Megabits per Second
MC	Marginal Costs
MDF	Main Distribution Frame
MDU	Multi-Dwelling Units
MEIP	Market Economy Investor Principle
MPoP	Metropolitan Point of Presence
MS	Member State
MSAN	Multi-Service Access Node
MVNO	Mobile Virtual Network Operator
NBN	National Broadband Network
NGA	Next Generation Access
NGN	Next Generation Network
NGOA	Next Generation Optical Access
NRA	National Regulatory Authority
NZ	New Zealand
ODF	Optical Distribution Frame
OJEU	Official Journal of the European Union
OLT	Optical Line Termination
OMDF	Optical Main Distribution Frame
ONT	Optical Network Termination
ONU	Optical Network Unit
OSDF	Optical Street Distribution Frames
P2MP	Point-to-Multipoint
P2P	Point-to-Point
PON	Passive Optical Network
POP	Point of Presence
PPP	Public Private Partnership
QoS	Quality of Service
RABBIT	Remote Area Broadband Inclusion Trial
RBAG	Rural Broadband Access Grants
RBAP	Rural Broadband Access Project
RF	Radio Frequency

SDH	Synchronous Digital Hierarchy
SDSL	Symmetrical Digital Subscriber Line
SDU	Single-Dwelling Unit
SGEI	Services of General Economic Interest
SHDSL	Symmetrical High-bit-rate Digital Subscriber Line
SMEs	Small and Medium Enterprises
SMP	Significant Market Power
SPV	Special Purpose Vehicle
TDM	Time Division Multiplexing
TNZ	Telecom New Zealand
TV	Television
UFB	Ultra-Fast Broadband Initiative
UK	United Kingdom
UMTS	Universal Mobile Telecommunications System
UPS	Uninterruptable Power Supply
USO	Universal Service Obligation
VDSL	Very High Speed Digital Subscriber Line
VoD	Video on Demand
VPN	Virtual Private Network
VSAT	Very Small Aperture Antenna
VULA	Virtual Unbundled Local Access
vULL	Virtual Unbundled Local Loop
W	Welfare
WDM	Wavelength Division Multiplexing
WDM PON	Wavelength Division Multiplexing Passive Optical Network
WIK	Wissenschaftliches Institut für Infrastruktur und Kommunikationsdienste (Scientific Institute for Infrastructure and Communication Services)
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WMNC	West Midlands Networking Company Ltd.
WMRBN	West Midlands Regional Broadband Network
WtP	Willingness to Pay
xDSL	Generic term for different types of DSL

A.2 Glossary

Access Access enables an operator to utilize the facilities of another operator in the furtherance of its own business and in serving its own customers.

Access network The network comprised of the subscriber access lines (the local loop or the last mile of the telecommunication network).

ADSL Asymmetric Digital Subscriber Line: The most common technology for providing (asymmetric) consumer broadband services over copper telephone lines.

ATM Asynchronous Transfer Mode: 48-byte cell oriented transmission technology which allows the cells to be used in a TDM or statistical TDM manner with five different classes of service. Outdated technology considering its cost.

Backhaul Realisation of the network link from a given node to the core network.

Bitstream access The access provider installs a high-speed access link to the customer premises and makes this access link available to third parties over a shared access facility to enable them to provide high-speed services to customers.

Concentration network Network segment between the MPoP and the core network.

Core network The high speed backbone of the network where typically servers and interconnection facilities are located.

Dark fibre Unlit fibre without transmission systems connected.

DOCSIS Data Over Cable Service Interface Specification: An industry standard for broadband data communication over HFC networks.

Drop cable segment The part of the network between the street cabinet and the end-user.

DSLAM Digital Subscriber Line Access Multiplexer: The active equipment that manages the transmission of data signals (in parallel to existing traditional voice signals) with end-users in a copper network and which aggregates the traffic to a single upstream link.

Ethernet A data link access protocol originally designed for Local Area Networks enabling to connect many computers with one single cable. It is now also used as standard transmission protocol in switch-based local and wide area networks.

Hybrid fibre coax The original network architecture of cable TV operators: Fibre runs to a node between the central site (head-end) and the end-user in the field. From there on coax cabling connects the end-users.

IP Internet Protocol: A data communications standard that allows computers to communicate with one another over digital networks. Together with the TCP protocol, IP forms the basis of the Internet.

IPTV Television over IP: Distribution of video programming (one way) by means of the Internet Protocol.

IRU	Indefeasible rights of use: A long-term (typically greater than 15 years) usage agreement for sharing infrastructure and transmission systems.
Jitter	Variability of delay (expressed in ms).
Label Edge Router	Router at the edge of a network which eases routing through the network by attaching a label to each data packet and using pre-defined paths.
Latency	Transmission time it takes a packet to be routed through a network (expressed in ms).
Layer	0 - Physical Infrastructure: The ducts and cables of a network. 1 - Transmission: The technologies that control the transmission between two nodes. 2 - Transport: In charge of media access (access to links) and Data Link Control (end-to-end control) of connections. 3 - Switching: Packet and circuit switching in the network.
LTE	Long Term Evolution: An industry standard for a new generation of mobile networks completely based on packet communication.
MPoP	Metropolitan Point of Presence: In a Next Generation Access network the MPoP is the location of the first Ethernet switch that aggregates user traffic.
MSAN	Multi Service Access Node: A generic term for active equipment that concentrates subscriber access lines and manages the communication with the end-user. MSANs typically deal with voice and data traffic.
Multiplexing	Parallel transmission of information over one communication link.
NGN	Next Generation Network: The ITU defines a Next Generation Network as "… a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users."
ODF	Optical Distribution Frame: a passive distribution frame that enables cross-connecting incoming and outgoing fibres with patch cables.
OLT	Optical Line Terminator: The active equipment that lights the fibre in a Passive Optical Network (PON) and manages the communication of multiple end-users (including transmission right assignment) and aggregates their traffic.
ONU	Optical Network Unit: The customer premises equipment that communicates with the OLT in a PON. Typically, the term ONU is used in reference to equipment that manages multiple end-users, such as in a Fibre to the Building architecture.
ONT	Optical Network Terminator: The customer terminal that communicates with the OLT in a PON.
OSDF	Optical Street Distribution Frame: A (small) optical distribution frame in a street cabinet.

OSI Reference Model	Open Systems Interconnection Reference Model: A layered data communications protocol model.
Packet loss	The probability that a packet never reaches its destination. This could be due to transmission errors, but errors are quite rare in modern fibre-based fixed networks. More often, packets are lost because the number of packets waiting for transmission is greater than the available storage capacity (buffers).
Passive Optical Network	Generally, any Passive Optical Network only has active equipment at the end of the links. More specifically, the phrase typically refers to a Point-to-Multipoint network topology with splitters (see Point-to-Multipoint) where the shared bandwidth of the access network is managed by an OLT at the central site.
Point-to-Multipoint	A network topology that has dedicated individual customer lines to an intermediate passive node (e.g. street cabinet) where these lines are aggregated onto a shared line. Aggregation could be either passive (with splitters such as in a PON architecture) or active (such as FTTC).
Point-to-Point	A network topology where customer lines remain dedicated all the way from the customer to the MPoP.
QoS	Quality of Service: In an IP-based environment, QoS often denotes measures of latency, jitter, and the probability of packet loss.
Real time application	An application which requires communication in real time without major delays such as voice and video conferencing, some forms of gaming.
RF-TV	Radio Frequency Television: Distribution of TV signals over radio frequency.
SHDSL	Symmetric High Speed Digital Subscriber Line: A symmetric variant of DSL.
(Optical) Splitter	A passive device that splits the light of one fibre into many fibres.
Street cabinet	A cabinet between the Main Distribution Frame and the end-user location. It hosts a (street) distribution frame that connects the cables coming from the end-users with the cables running to the Main Distribution Frame.
Sub-loop	The part of the local loop from the street cabinet to the end-user.
TCP/IP Reference Model	The layered data communications protocol model used by the Internet.
TDM	Time Division Multiplexing: Divides a shared connection into several parallel channels of fixed bandwidth.
VDSL	Very high speed digital subscriber line: An asymmetric DSL variant that increases the bandwidth over shorter loop lengths compared to ADSL.
WDM	Wavelength Division Multiplexing: Allows the use of multiple wavelengths (frequencies) on the same fibre each providing additional capacity.
WiMAX	Worldwide Interoperability for Microwave Access: An industry standard for a wireless broadband communication technology.

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A.4 Organisations interviewed in the analysis

Administrative District Rotenburg (Germany)

Advantage West Midlands (UK)

British Foreign & Commonwealth Office (UK)

Brussel's office of Lombardy Region, Presidenza Regione Lombardia/Delegazione presso la UE (Italy)

Bundesnetzagentur (Germany)

Chambers Heuking, Kühn, Lüer, Wojtek (Germany)

City of Amsterdam (Netherlands)

Cluster Management Information- and Communications Technologies North Rhine-Westphalia/University of Wuppertal (Germany)

Conseil Général des Hauts-de-Seine (France)

Department for Communities and Local Government (UK)

Department of Communications, Energy and Natural Resources (Ireland)

Deutsche Telekom AG (Germany)

Dirigenza U.O. Energia e Reti Tecnologiche D.G. Ambiente Energia e Reti/ Regione Lombardia (Italy)

European Competitive Telecommunication Association

Federal Ministry of Economics and Technology (Germany)

Finnish Communications Regulatory Authority (Finland)

Glasvezelnet Amsterdam bv (Netherlands)

Kabel Deutschland Holding AG (Germany)

KPN nv (Netherlands)

Management Consultancy ITCcon GmbH (Germany)

Micus Management Consulting GmbH (Germany)

Ministère des affaires étrangères et européennes (France)

Ministry for Rural Areas and Consumer Protection of the Federal State Baden-Wuerttemberg (Germany)

Ministry of Employment and Economy (Finland)

Ministry of Foreign Affairs (Netherlands)

Ministry of Internal Affairs and Kingdom Relations (UK)

Ministry of the Interior and Kingdom Relations (Netherlands)

Ministry of Transport and Communications (Finland)

NYnet Ltd (UK)

Reggefiber ttH bv (Netherlands)

Secrétariat général des affaires européennes (SGAE) (France)

Société Sequalum (France)

University of Muenster (Germany)