Consultation – cover note / questions

This **ERG Consultation Document on Regulatory Principles of NGA** (ERG (07) 16 describes the ERG's current thinking on Next Generation Access roll-out and the regulatory implications stemming from it. It focuses explicitly on wireline NGA implementation and analyses two scenarios: FTTCab and FTTB/H. Some *general* proposals have been developed as to how the Recommendation on relevant markets susceptible to ex-ante regulation and the ECNS Regulatory Framework may be adjusted to cope with the regulatory challenges growing out of the different fibre deployment scenarios. It is envisaged to develop this document further to an "ERG Common Position on Regulatory Principles of NGA".

- Do you agree/disagree with the general approach?
- Do the scenarios describe the relevant roll-out alternatives for NGA?
- Do you agree/disagree with regard to the conclusions on economics and business case studies?
- What is your opinion on the regulatory implications and on the evolution of the ladder of investment? Additionally please provide more specific comments regarding the issue of multicast capabilities and their regulatory treatment.
- Do you agree/disagree with the conclusions?

The consultation period ends on **11 June 2007.**

Please e-mail your comments to the following address: erg-secretariat@ec.europa.eu.

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ERG Consultation Document on Regulatory Principles of NGA

Executive Summary

This paper has explicitly focused on wireline NGA implementation issues and related regulatory implications, as current upgrades of copper and fibre access networks being carried out in a number of Member States[1] have become a key challenge for regulatory authorities recently.

In general knowledge of plans for NGA roll-out is limited. In several countries incumbents plan to roll out fibre to the cabinet with copper being used for the last mile. Also FTTB/H roll-out is considered. Country case studies show a large variety of network rollout strategies across Europe. Information on rollout strategies of incumbents is crucial for managing the transition process.

Network upgrades in the context of NGA comprise some deployment of optical fibre. The broad options available may be generically distinguished as to how far fibre is rolled out towards the end-user, enabling increasing reach and bandwidth to the end-user. For the purpose of this paper, two broad scenarios, one being called FTTCab and the other one FTTH/FTTB, have been defined (and described in Chapter 2):

- **Fibre to the cabinet**, which consists of a hybrid solution with DSL technology and fibre going to the street cabinet and copper between the street cabinet and the end-user.
- **Fibre to the home** which is a fully optical solution going to the end-user premises. Fibre to the building is included in the Fibre to the home scenario even though, technically, it has to be considered a hybrid solution.

Their regulatory implications have been analysed in the following chapters.

Chapter 3 deals with economic implications of the access (and backhaul) upgrades for the electronic communications sector, such as the replicability of wireline NGA networks or the balance between infrastructure and service competition. In analysing the economics of NGA networks, the results of a number of business case studies are evaluated.

With the deployment of NGA networks, regulators need to consider whether the roll-out of these new networks result in a fundamental change in the underlying economics of wireline local access networks, having impact on the competitive dynamics of the relevant market(s) and possibly requiring adjustments of regulation.

As operators move to NGA networks, different technologies may be deployed in different geographic areas in order to deliver end-services to customers. It is likely that the most effective strategy for NGA deployment will utilise a mixture of technologies to deliver these services depending on specific local characteristics, including

- copper local loop and sub-loop lengths;
- customer density and dispersion;
- presence of multi-dwelling units, and

1 E.g., with the deployment of IP DSLAM, utilizing the copper line with xDSL technologies in combination with PONs to directly reach the street cabinet or the building via passive fibre architectures. More aggressive strategies opt for the deployment of fibre connections directly to the end customer's homes or offices, already happening in some Member States as well.

- the quality and topology of existing network architecture, in particular the number of street cabinets per MDF.

As a result, the economics of NGA networks are likely to vary across different technologies and different geographies. Conditions are likely to differ largely among Member States and within different regions of Member States. It may be the case that, to some degree and in certain locations, these scale economics mean that there is a natural monopoly in certain areas of the electronic communications value chain.

Several factors/parameters constitute cost drivers influencing the overall infrastructure costs and the following broad cost categories can be distinguished, namely:

- (horizontal) trenching/ducting cost (civil engineering), constituting the most significant cost factor;
- (horizontal) fibre cabling deployments;
- (vertical) costs of in-house wiring; and
- equipment cost per node.

An increase in costs per line/user can be seen – as operators deploy fibre closer to the customer's premises, with higher costs associated with fibre deployment (including civil engineering) – due to a lower number of end customers per node. Therefore, the average costs of provision are likely to increase compared to the "classical" roll-out of a (fibre) network to the MDF.

As a number of business case studies show, apart from structural parameters, the profitability of VDSL roll-out also critically depends on the ability of operators to generate higher ARPU for the services offered on these lines.

NGA investments are likely to reinforce the importance of scale and scope economies, thereby reducing the degree of replicability, potentially leading to an enduring economic bottleneck. The degree to which this is the case will vary depending on the specific technology deployed, but may mean that effective competition will increasingly require significant scale in order to compete with incumbents' deployments of NGA, even though for the time being it is uncertain what the minimum scale exactly is.

Given that next generation access networks may be more likely to reinforce rather than fundamentally change the economics of local access networks, NGA may be likely to, at least, provide the same competition challenges to regulators as current generation wireline access networks.

Chapter 4 targets the regulatory challenges of NGA deployment. Implications for existing regulation and challenges to the Regulatory Framework have been analysed, particularly with regard to Markets 11 and 12 of the Recommendation. The scenarios previously described were taken as a reference to describe possible barriers to NGA deployment. The issue of occurrence of old and potential new bottlenecks has been raised, together with considerations on appropriate wholesale products applicable to mitigate envisaged competition problems for each scenario. Some additions, with regard to changes of the Recommendation and the Review of the Framework,[2] are suggested as a result of the analysis. Although the aforementioned developments might not lead to a fundamental change in the regulatory approach, it is necessary to analyse adjustments needed in order to preserve a level playing field for competition and to provide the right incentives for efficient investment.

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2 See also IRG/ERG response to the Review of the EU Regulatory Framework for Electronic Networks and Services of 27th October 2006. I/ERG thinks that the Framework is fundamentally sound, but adjustments need to be made where necessary.

Some *gener*al proposals are made as to how the Recommendation and the ECNS Regulatory Framework may be adjusted to cope with the regulatory challenges growing out of the different fibre deployment scenarios. According to the ECNS Regulatory Framework, the regulator has to follow a process consisting of 3 steps: market definition, market analysis and in case of SMP finding the imposition of specific regulatory obligations ("remedies") to overcome the competitive problems identified, bearing in mind the objectives laid down in Art. 8 FD, namely to promote competition and efficient investment for the benefit of the users. Also, in case of imposing obligations on a SMP operator rolling-out NGA, the overall "package" of existing and additional (or amended) remedies must be proportional in order to avoid overregulation.

It goes without saying that as usual any *specific* market definition, market analysis or "remedies decision" based on such an adjusted Framework would have to be carefully carried out by the NRAs using the prescribed methodology[3] that may lead to different result in different Member States reflecting national circumstances and different fibre deployment strategies. Thus there is no one-size-fits-all solution and NRAs in undertaking market reviews are going to have to exercise their judgement based on the specific situation in their countries. Furthermore in order to ensure predictability it is important that NRAs signal in time to all market players in which way existing obligations are carried forward and whether or how wholesale access products might need to be adapted.

Implications for Markets 11 and 12

The network developments might have implications for the analysis of Markets 11 and 12 of the Recommendation, but NGA roll-out could affect other markets as well, e.g. Market 13 (leased lines terminating segments). The FTTCab and the FTTH/FTTB scenarios imply different regulatory challenges. Unbundling may not solve the access problem in the same manner as it did in traditional copper networks. However, to foster effective competition, additional or other remedies may have to be identified and applied in order to adapt regulation to further challenges.

Market 11

In the Recommendation, Market 11 is defined as wholesale unbundled access (including shared access) to metallic loops and sub-loops. Looking to the definition of the AD, where the "local loop" is defined as the physical circuit connecting the network termination point at the subscriber's premises to the main distribution frame or equivalent facility in the fixed public telephone network (Art. 1 e AD), in the NGA context, a local loop can be described more precisely as a dedicated line between the network termination point at the subscriber's premises and the (copper/optical) distribution frame at the first aggregation point. Thus it can be said that the AD would allow a broader definition of Market 11. Therefore, while the current Recommendation defines Market 11 with explicit reference to metallic loops, the AD refers to the physical circuit – which could include both a metallic and a fibre local loop, satisfying the requirement of technology neutrality.

With the introduction of NGA, the former definition of local loop could be adapted to include both Scenarios, i.e. FTTCab as well as FTTB/FTTH (in a point-to-point or point-to-multipoint configuration):

- FTTCab - the local loop consists of the copper line from the cabinet to the home;

3 NRAs will continue to conduct their specific market analysis using the competition law criteria (e.g. hypotetical monopolist's test, substitutability, pricing constraints).

- FTTB - the local loop consists of the copper line from the building entrance (where fibre ends) to the end-user premises;
- FTTH - the local loop would be constituted by optical fibre from the ODF to the end-user (home), whatever the architecture chosen (point-to-point or point-to-multipoint). Feasibility of local loop unbundling might however be challenged depending on the type of architecture chosen by the SMP operator:
  - in point-to-point solutions, it may be possible to unbundle the local loop in a manner very similar to that used today for copper – full LLU of the loop is applied from the ODF;
  - in a point-to-multipoint solution (shared infrastructure topology, such as PON), it is no longer easily possible to associate a single physical element of connectivity with a particular end-user. In this situation, options for unbundling become more challenging – unbundling of the subscriber fibre loop could be done at the passive optical splitter level, where the dedicated end-user fibre is connected to the shared fibre (connecting the splitter and the ODF).

In all these unbundling scenarios, the alternative operator gets access at the physical level of the transmission medium: a (copper, fibre) loop or a frequency band/wavelength within the loop. So it can be concluded that, independently on the technology adopted and according to the above reported AD definition, physical access (layer 1) to the copper or to the fibre or a portion of the bandwidth (wavelength), from a connection point/distribution frame, would be considered unbundling.

The inclusion of the fibre loop into market 11 is compatible with the definition of the AD, but would require a change of the Recommendation to include fibre into the relevant market.

Market 12

According to the Recommendation, Market 12 includes all broadband access services such as (what is traditionally referred to as) bitstream services based on the access infrastructures and on a packet-based transport network. Currently, Market 12 products are mainly based on ATM/Ethernet over xDSL copper access from the CPE to the DSLAM. Similarly, bitstream offers on FTTx architecture can provide the same type of services using Ethernet at the access plus backhauling to Ethernet switches at different levels or the IP level. Ethernet services allow more features such native multicast (e.g. of TV channels).

As has been the case for the bitstream markets currently notified, after the substitutability test have been carried out for the individual markets, a characteristic of Market 12 products is likely to remain: the competitor accesses the wholesale service at layer 2 or layer 3 of the communication protocol stack, which consists of a well defined stream allocated by the incumbent (a VP/VC in an ATM scenario or a VLAN in an Ethernet scenario). When carrying out a substitutability test between Markets 11 and 12, a relevant factor is that bitstream access by the competitor at layers 2/3 reduces the freedom of the competitor to control quality parameters, compared to the LLU case, where the authorized operator gets access to the physical line (layer 1 access).

Market 12 does not require a change of the Recommendation as, by definition, it already comprises all kind of wholesale broadband access products that can be delivered higher in the network. NRAs will assess in their respective market analysis whether these different wholesale products can indeed be considered substitutes also taking into account the corresponding end user service (e.g. IPTV features) that will be provided on the basis of wholesale broadband access. Bitstream products might need to be enhanced to allow the provision of high quality services. Besides that, changes in the SMP-party’s network also imply changes of the WBA product that have to be adapted accordingly.

Analysis of the two Scenarios

FTTCab

With regard to the FTTCab scenario, the following possible barriers must be considered:

- Colocation at the street cabinet, including equipment which might have to be installed and operated by the alternative operator inside or next to the SMP party's street cabinet, similarly to (current) distant colocation. Furthermore, individual or combined roll-out procedures must be considered and allocation principles of colocation cost are looked at;
- Backhaul between the Street Cabinet and the operators' networks.

Possible consequences for wholesale products:

- With regard to LLU - in view of changing infrastructure which may include reconfiguration or phasing out of MDFs - a balance has to be found between the commercial freedom of the SMP-party to develop its networks and services and the objectives of the NRAs to promote competition, which – depending on national circumstances – may also require a continuation of LLU at the MDF. A way to find this balance is to define a proper migration path and set conditions under which the SMP-party is allowed to phase out its MDFs. These conditions could e.g. comply the period between the announcement and the actual phasing out.
- Sub-loop Unbundling being part of Market 11 implies an access obligation to provide it in all Member States.
- Hence, unbundling the shortened local loop ending at the street cabinet implies the need for colocation at the street cabinet and backhaul service from the cabinet to the operator's node:
    - Colocation could be imposed as an ancillary service obligation to SLU, provided it is technically feasible taking into account the relevant constraints;
    - Backhaul may be difficult for alternative operators to provide for themselves unless duct-sharing is available. Backhaul could be considered: as an ancillary service to market 11 to the shortened local loop or SLU; as a wholesale terminating segment of leased lines (market 13); or a separate backhaul market could be defined.
- Duct sharing could be imposed as an ancillary service to Market 11.
- Wholesale bitstream offers (Market 12) may have to be enhanced to allow for the provision of high quality services and adapted to changes in the SMP party's network.

FTTH/FTTB Scenario

The two main barriers identified in the case of FTTH/FTTB deployment are:

- Civil engineering cost (horizontal barrier), which can represent up to 80% of the total cost per subscriber and;
- In-house wiring (vertical barrier), where property rights arrangements vary across Member States, having implications for regulation.

Possible consequences for wholesale markets are:

- Fibre has to be included in Market 11. If SMP is assessed on such a widened market 11 (including the fibre loop, as described above), unbundling of the optical local loop could be imposed as an obligation;
- No changes are required with regard to the definition of Market 12 of the Recommendation; but bitstream offers may have to be adjusted to FTTH/FTTB architecture.

To deal with FTTH/FTTB deployment, NRAs may also look into other possible wholesale products or ancillary services such as duct sharing, particularly taking into account that effective roll-out of FTTH/FTTB networks has already begun in some of the Member States.

Two approaches to SMP-regulation can be distinguished: Duct sharing could be imposed as an ancillary service on a widened Market 11 encompassing both copper and fibre loops or alternatively as a direct remedy to an SMP position on a separate relevant market of ducts used for electronic communications services, if such a market fulfils the 3-criteria test.

In the long run symmetric regulation based on Article 12 FD could be strengthened in the Review process to ease facility sharing, e.g. for ducts and/or in-house wiring. A modification of Art 12 FD could further strengthen the powers of national regulators allowing them to impose the following measures on all operators symmetrically:

  - Obligation to negotiate sharing of facilities under reasonable requests
  - Settlement procedures before NRA in case of refusal;
  - Intervention by Member State in particular for promoting fair competition, particularly imposition by NRA to set up extra facilities.

Ladder of investment

In the final section of Chapter 4 it is analysed how the ladder of investment looks like under NGA deployment. Given the increasing importance of scale in the deployment of NGA networks and the new technologies that can be used to deliver these innovative services, we may witness a shift of the enduring economic bottlenecks, possibly resulting in a change of the most suitable access point(s) for the promotion of competition. These effects of NGA deployment on the current regulatory environment will need to be assessed by NRAs taking account of national circumstances. The level in the network where regulatory remedies could be applied to NGA networks may differ substantially from the current copper-based generation broadband access network, as the economics of NGA networks are likely to vary across different technologies and different geographies and Member States. This requires a number of different wholesale products on different rungs of the ladder to complement each other.

However, the principle of promoting competition at the deepest level in the network where it is likely to be effective and sustainable is still appropriate for the regulation of enduring economic bottlenecks in NGA networks. Where it is practically and economically feasible to promote infrastructure based competition, this should be the aim of NRAs. In those instances where replication of access is not considered feasible, promoting service competition is an important goal for the NRA.

Unbundling of the local loop is assumed to take place at the MDF. In case of sub-loop unbundling, it takes place at the street cabinet. Being confronted with reconfiguring or phasing out of the SMP operators' MDFs in the FTTCab Scenario, the alternative operator can either climb up on the ladder by further investing to roll out fibre to the street cabinet (Scenario 1) or to the Home/Building (Scenario 2), or remain at the MDF or the closest aggregation node and use Wholesale Broadband Access. WBA is generally seen as a lower step of the ladder of investment than LLU. However, in the case of phasing out MDF access, the importance of LLU as a means to derive competition may decrease compared to WBA, especially if alternative operators are not able to roll-out their networks towards the street cabinets. Therefore, WBA at the core-node, DSLAM, or even at lower levels, may gain importance. In order to maintain the benefits of infrastructure competition based on LLU, the design of the WBA product might need to be enhanced to allow alternative operators maximum control of quality parameters possible.

It is important that infrastructure and service competition are not seen as opposed to each other, but are linked through the ladder of investment allowing competitors, through a sequence of regulated access products that are consistently priced to invest in a step-by-step manner in own infrastructure. Service competition based on regulated access at cost-oriented prices can be (and in general is) a vehicle for long term infrastructure competition. Therefore, regulators should impose remedies that enable the new entrants to reach a point of the investment ladder which makes economic sense and which tends to maximize the extent of economically efficient competing infrastructure.

ERG Project Team NGN

ERG Draft Consultation Document on Regulatory Principles of NGA

1 Introduction

The introduction of Next Generation Networks (NGN[4]) sets the communications sector on the verge of a new era. Furthermore, as new plans and investments in next generation access (NGA) networks are gaining momentum in several Member States, ERG considers that this is the correct moment to prospectively analyse the developments in this area, which will have an impact in the way access is and will be regulated in the near future. Also, given the pace of recent developments, regulators need rapidly to set clear and detailed guidance in order to positively affect the competitive nature of the (access) markets and efficient investment in general.

The gradual migration from traditional TDM-based networks to IP-based NGNs, already taking place in several Member States[5], has the potential to influence the communications industry on all levels of the value chain, from access to core and to services alike. The NGN architecture is structured according to a service layer and an IP-based transport layer[6], which provides IP-connectivity to end-user equipment. Investments and developments on a single all-IP network to substitute multiple traditional core networks may be distinguished from developments in NGA.

In about half of the countries that contributed to the "Fact Finding Questionnaire of the Project Team on IP-Interconnection and NGN" (See **Annex 1**), NRAs stated that implementation of NGNs is, normally, beginning at the core (transport) level followed by changes in access networks.[7] Differences between Member States exist in particular with regard to the pace of migration to NGN and NGA, depending on the actual strategy chosen by the operator, according to the Fact Finding. The aim is the same, the possibility to provide a wide array of services including those requiring high bandwidth (voice, hi-speed data, TV and video) over one or very few platforms.

In previous work, IRG/ERG already identified major issues to be taken into account when implications and regulatory treatment of IP interconnection in a NGN environment are discussed[8]. Further work on these and other issues will be taken up in the second half of 2007 and dealt with in separate document. In the Draft Interim Report on NGN, great importance was attached to provide an insight on the overall picture of NGN implementations and related consequences on all layers involved. With NGN standardisation being an ongoing process and practical experiences regarding NGN implementations scarce, conclusions on regulatory principles were initially drawn applying a top-down approach, i.e.

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4 A list of definitions and acronyms is presented in Annex 4.

5 In the last year, the migration towards NGNs has gathered pace mainly amongst incumbent network operators.

6 This potentially allows for the provision of service-related functions and applications independently from the underlying transport technology, similar to services on the Internet. But unlike Internet services, ITU/ETSI-based NGNs aim to ensure a high degree of security and quality of service by means of a strong control layer. IP-connectivity is provided to NGN user equipment by the transport layer, under the control of the network attachment subsystem (NASS) and the resource and admission control subsystem (RACS). These subsystems hide the transport technology used in access and core networks below the IP layer.

7 Several NRAs stated that the relevant information was not available to answer whether implementation begins first in the core or the access networks. In one country the modernisation of access network is deemed to be more urgent than the core network and one country refers to a simultaneous implementation. See Annex 1.

8 ERG (2007).

concluding from generic principles of future NGN architectures. With more information from the market becoming available gradually, the results are increasingly complemented with a bottom-up approach, i.e. concluding from practical implementations in various Member States.

Next Generation Access (NGA)

Although NGN standards refer to the overall concept of core NGNs, the term often is used as a catch-all phrase also with regard to access networks.[9] For the purpose of this paper, however, a NGA concept implies current and future developments in the local loop implying significant investment in infrastructure, covering the segment between multi-functional access/aggregation nodes[10] and the end-users. Such a NGA network can be made of fibre, copper utilizing xDSL technologies, coaxial cable, powerline communications, wireless technologies, or hybrid deployments of these technologies, e.g. combining fibre and copper. However, the ERG will mainly focus on wireline access networks[11], given the current and planned extent of the rollout of technologies like wireless and cable in most Member States. Country case studies, summarizing the current and future plans of NGA roll out in a number of Member States, can be found in **Annex 2**.

Hence – and as wireline access networks have historically been an enduring economic bottleneck – this paper explicitly focuses on wireline NGA implementation issues and related regulatory implications, as current upgrades of copper and fibre access networks being carried out in a number of Member States[12] have become a key challenge for regulatory authorities recently. This might have implications for the analysis of Markets 11 and 12 of the Recommendation on Relevant Markets susceptible to ex-ante regulation[13].

These developments imply that the part of the network dedicated to a single user (from the customer to the first network aggregation point) is potentially changing with possible implications for the feasibility of unbundling of the local loop and that today's borderlines between access, backhaul, and core network are beginning to blur or change. With the introduction of fibre in the access, the relevance of backhaul connections potentially increases with regard to competition issues.

Also, the timing and specific technology adoption may vary between Member States, from area to area, and from operator to operator as these depend on a number of complex factors including level of (intermodal) competition in the market, state and age of existing network infrastructure, length of local loop, distribution of number of users and number of street cabinets per MDF, population density, and structure of the housing market. Hence, different access network migration strategies may be used by operators in the Member States and have to be taken into account by regulatory authorities evaluating appropriate measures.

9 According to the ITU-T Y101 NGN access network is defined as an implementation comprising those entities (such as cable plant, transmission facilities, etc.) which provide the required transport capabilities for the provision of telecommunications services between a Service Node Interface (SNI) and each of the associated User Network Interfaces (UNIs).

10 In some Member States so-called Multi Service Access Nodes (MSAN) will be used as a platform capable of supporting various access technologies and services, and of providing a gateway to the IP backhaul and core transport network. IP is the unifying protocol on which the various access technologies concentrate.

11 Thus, for the purpose of this document wireline NGA does not include cable (or powerline).

12 E.g. with the deployment of IP DSLAM, utilizing the copper line with xDSL technologies, in combination with Passive Optical Networks (PON) to directly reach the street cabinet or the building via passive fibre architectures. More aggressive strategies opt for the deployment of fibre connections directly to the end customer's homes or offices, already happening in some MS as well.

13 Commission Recommendation 2003/311/EC of 11 February 2003, hereafter Recommendation.

As a consequence of these differences there will be changes governing the economics of the electronic communications sector, probably affecting the business models for operators, and several questions arise (e.g.):

- Replicability of wireline NGA networks - What will happen to the market structure due to technological changes leading to economies of scale and scope in core and access? Are new bottlenecks arising, and do old ones become obsolete? Is there a danger of leveraging market power from access networks to other markets?
- Will there be stranded investment of alternative operators as a result of changes in network structure of the incumbents? What are the consequences for regulation?
- Balance between infrastructure and service competition - What are the benefits of infrastructure competition today? How will this affect the balance between infrastructure and service competition? How does the concept of efficient investment relate to investments in NGA at either the infrastructure or service level?

These developments might not lead to a fundamental change in regulation, but the necessity of adjustment needs to be analyzed with regard to preserving a level playing field for competition and promote efficient investment. In order to develop a set of common regulatory principles, there is the need to more specifically address questions like: is the existing legal/regulatory framework still appropriate in an NGA environment? I.e., are immediate changes required to the framework? Do existing SMP products that are based on traditional architecture and cost have to be modified and, if yes, how? What is the future of unbundling at the MDF? Or how will the ladder of investment look like in an NGA environment?

When considering an appropriate regulatory approach to NGA all these issues and questions must be addressed and the main purpose of this consultation document is to discuss possible options and solutions to those and, as a result, provide a set of common guidelines to operators and NRAs on how to address the developments in this area.

Structure of Document

Chapter 2 is providing a technical overview regarding NGA (and backhaul) basic scenarios. Starting with an introduction to technologies available for upgrading the access network, this section mainly focuses on the most widely adopted implementation strategies and related deployment scenarios: first, “Fibre to the Cabinet” and second, “Fibre to the Home”.

Chapter 3 deals with economic implications of the access (and backhaul) upgrades for the electronic communications sector as such. As already mentioned, several projects are underway in a number of Member States, migrating to NGA (and core) networks in different ways, bringing up, therefore, a number of regulatory challenges. This section will deal with fundamental questions regarding, for example, the replicability of wireline NGA networks or the balance between infrastructure and service competition. In analysing the economics of NGA networks the results of a number of business case studies are evaluated (the business case studies are summarized in **Annex 3**). Regulatory implications of NGA economics will then be outlined and, finally, attention is drawn to a number of other factors impacting on the feasibility of NGA roll-out.

Chapter 4 explicitly targets the regulatory challenges of NGA deployment in detail. Implications for existing regulation and challenges to the regulatory framework are analysed, particularly with regard to Markets 11 and 12 of the Recommendation. The scenarios previously described are taken as a reference to describe possible barriers to NGA deployment. The issue of occurrence of old and potential new bottlenecks is thus raised together with considerations on appropriate wholesale products applicable to mitigate envisaged competition problems for each scenario. Some additions, with regard to changes of the Recommendation and the Review of the Framework,[14] are suggested as a result of the analysis. Further sections of this chapter will be dedicated to highlighting possible changes in the ladder of investment in an NGA environment. Although the aforementioned developments might not lead to a fundamental change in the regulatory approach, it is necessary to analyse adjustments needed in order to preserve a level playing field for competition and to provide the right incentives for efficient investment.

Finally, **Chapter 5** draws conclusions on the main objects of the consultation document, that is focussing on the regulatory effects of NGA network introduction and, specifically, on how the current wholesale products have to be adapted in order to be able to provide a proper level of competition.

The Common Position of ERG on Regulatory Principles on NGA is here envisaged.

14 See also IRG/ERG response to the Review of the EU Regulatory Framework for Electronic Networks and Services of 27th October 2006. I/ERG thinks that the Framework is fundamentally sound, but adjustments need to be made where necessary.

2 Overview over Access / Backhaul Scenarios

2.1 Technologies available

Currently, almost all wireline access lines between the central office (CO[15]) and the end-user are based on (twisted pair) copper loops, mostly through the incumbent's ducts or (in older neighbourhoods) buried in the ground or via poles (aerial drops). Although the CO is already connected to the core network through optical fibre, without capacity constraints, the bandwidth[16] available to the end-user over copper lines is limited by the length and the quality of the copper loop.

The roll-out of enhanced access networks is then considered fundamental to a number of electronic communications providers as they intend to deliver very high bandwidth services to their subscribers. Today's copper loop extends from the end-user premises to the MDF. The sub-loop, usually connecting the end-user premises to the street cabinet, is part of the local loop that ends at the MDF. Increasing the bandwidth to the end-user can be achieved, in a wireline fixed network, by:

- shortening the copper loop, by using the DSL equipment (e.g. DSLAM) closer to the customer (e.g. at the cabinet or at any building premises); this approach is generally combined with backhauling, based on the use of fibre from the DSLAM to the switch node/CO;
- by using more advanced DSL technologies from the MDF or from the cabinet;
- installing a fibre loop with an optical network termination very close or at the end-user premises.

All of the suitable technologies available, and foreseen for the short-medium term, comprise some deployment of optical fibre. Options available (see the figures below) may be distinguished as to how far fibre is rolled out towards the end-user, enabling increasing bandwidth available to the end-user: The "copper loop" (ADSL/ADSL2+); fibre to the (street) cabinet[17] (using ADSL2+ and/or VDSL/VDSL2), fibre to the building[18] or fibre to the home[19] (fibre only).[20]

15 CO – dedicated building with a MDF and, normally, access/switching (PSTN) equipment.
16 Typical maximum values are shown in Figure 3.
17 Fibre to the Cabinet: FTTCab.
18 Fibre to the Building: FTTB.
19 Fibre to the Home: FTTH.
20 Some more varieties of FTTX are conceivable where the fibre ends between FTTCab and FTTB, sometimes called FTTCurb or Fibre to the Node (FTTN) or Fibre to the Premises (FTTP).

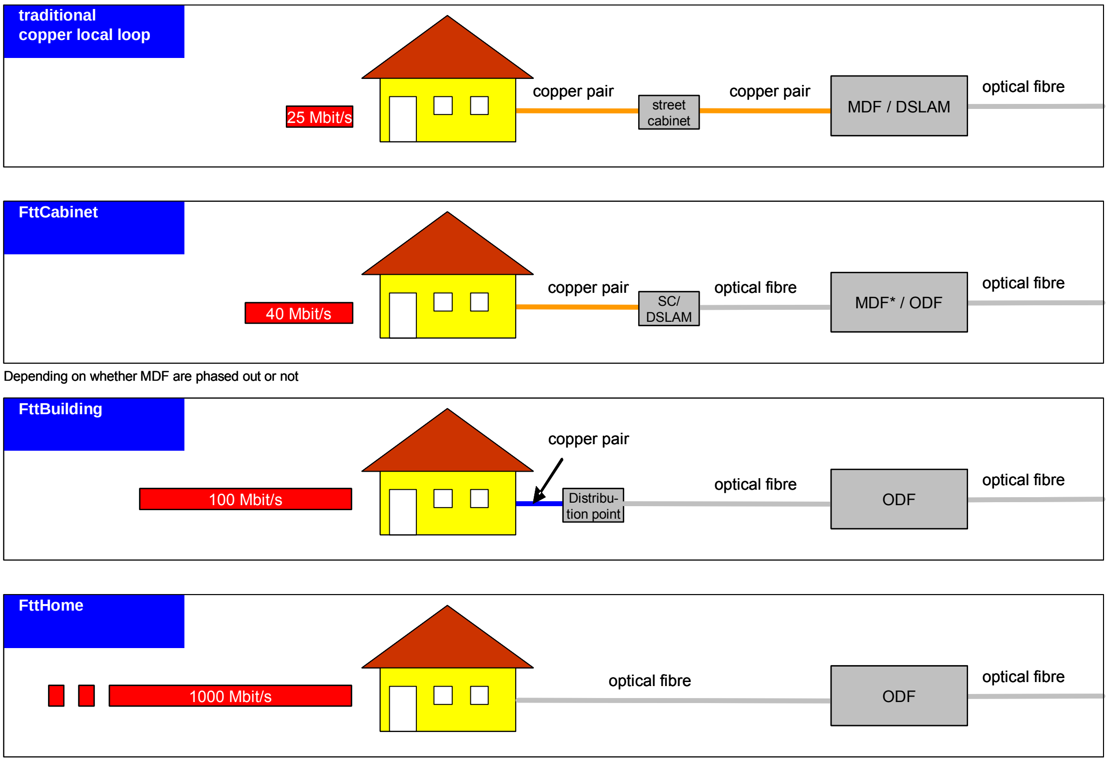


Figure 1: Access architectures using fibre (source Arcep).

There is not a single (FTTx) architecture that may fit in all circumstances and/or for all operators alike. The operators have to make technology decisions based on their service goals and business plans (return on investment), taking into account several factors including the existing infra-structure (e.g. fibre, ducts), network location, cost of deploying the network, subscriber density or administrative restrictions (e.g. municipal permits). The investment in NGA also has to be seen in the context of the overall migration to All-IP networks, possibly implying a rearrangement of network nodes at the lower level (currently, at the CO level).

For the purposes of this paper, two scenarios will be discussed more extensively since they appear to be the most relevant cases in several Member States:

- **Fibre to the cabinet**, which consists of a hybrid solution with fibre going to the street cabinet[21] and copper between the street cabinet and the end-user. It implies the use of DSL technology;
- **Fibre to the home** which is a fully optical solution going to the end-user premises. Fibre to the building will be included in this scenario even though, technically, has to be considered a hybrid solution – active electronic equipment and (vertical) in-house copper wiring and DSL technology will still be used. For the present discussion, it is relevant that both solutions involve the same amount of horizontal fibre extension to the building. Also, the two terms are often used interchangeably.

Hence, this document will focus on those two broad architectural scenarios, where the expected demand, actual network development and specificities, current or new access bottlenecks, market's competitive environment and regulatory intervention, will determine the choice of the operators.

The following picture shows, under different technology scenarios, the local loop extension and the possible handover points for the operators' access: to unbundling services or bitstream services that will be discussed in more detail in Chapter 4.

21 Replacing the current copper feeder network.

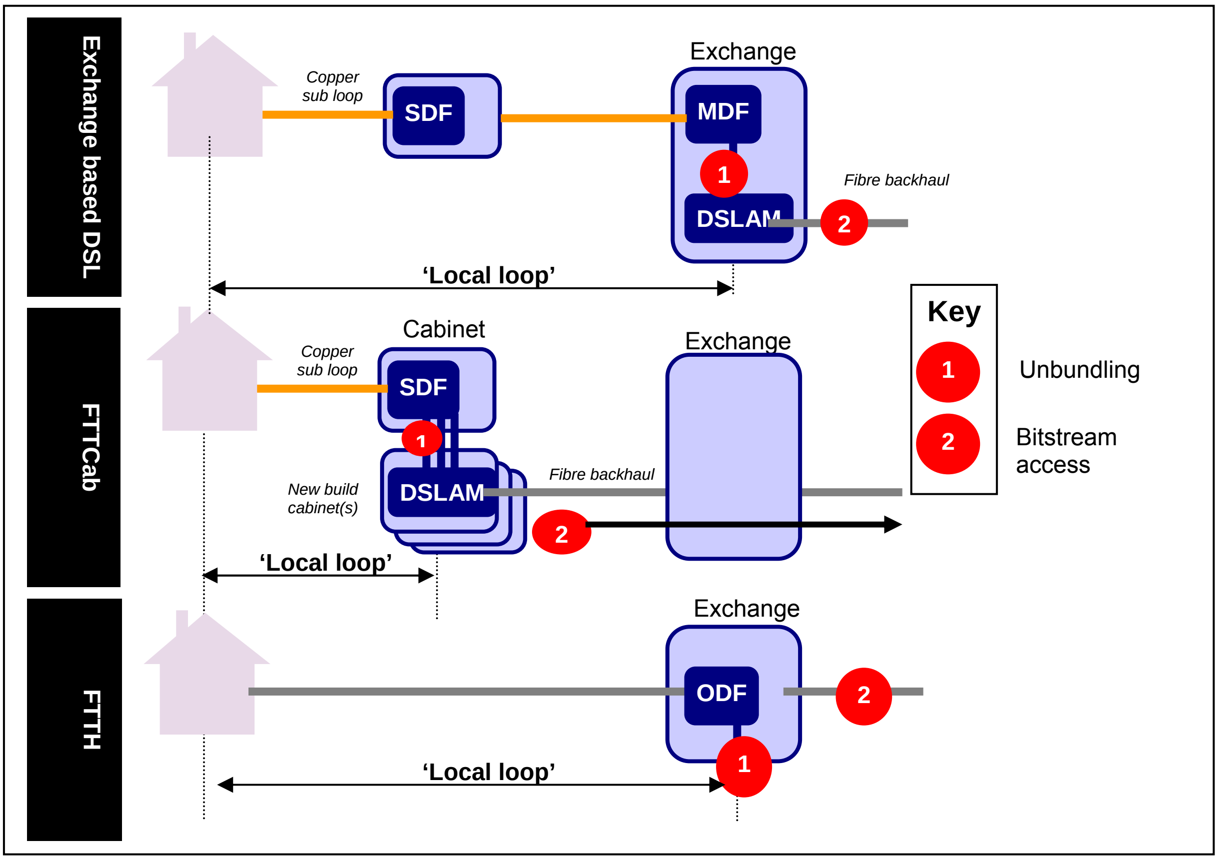


Figure 2: Examples of the 'local loop' under different technology deployments

The two Scenarios will be used predominantly in chapter 4 to analyse the regulatory challenges resulting from changes in the access infrastructure, particularly with regard to market definition, market analysis and, in case of SMP finding, the imposition of specific regulatory obligations ("remedies") to overcome the competitive problems identified. Among other effects, the architecture of the local loop may impact on Markets 11 and 12 of the Recommendation including access to the local loop and/or the shortened local loop), sub-loop unbundling and bitstream access (see Figure 2 above).

2.2 Scenario I: Fibre to the Cabinet (FTTCab)

The FTTCab scenario implies an extension of optic fibre to the street cabinet, which serves as a flexibility point in today's copper networks. The street cabinet contains a cable distributor, also known as a Sub-loop Distribution Frame (SDF).[22] As opposed to the other Scenario considered in this paper, copper remains on the last "mile" between cabinet and end-user.

Advanced (V)DSL technology[23] is/will be used on the shortened copper-line between cabinet and end-user, i.e. active equipment has to be installed in the cabinet. The benefits of VDSL when deployed at the street cabinet lie in greater speed and reach of customers that can get higher bandwidth. By bringing fibre to the street cabinet level, operators would be able to

22 In a Cable distributor (SDF) incoming cables are connected with outgoing cables. In this way, for example, copper wire local loops of the individual connections (secondary distribution copper network) are connected with the cables from the primary distribution copper network the street cabinet. The length may vary from a few hundreds of meters to around 800 meters..

23 E.g. VDSL (ITU-T G.993.1) and VDSL2 (ITU-T G.993.2). The VDSL2 technology is downward compatible with ADSL 2+.

boost the reach of their high speed DSL networks to a significantly higher percentage of the population.[24]

VDSL-technology on the basis of a shorter local loop is being rolled out by incumbents in the Netherlands and Germany, VDSL-equipment being installed in the street cabinets. In Germany, according to Deutsche Telekom's press releases, the parallel copper infrastructure between cabinet and MDF is kept. In the Netherlands, KPN plans to move towards the new infrastructure, implying giving up the MDF locations.

Such an access infrastructure in combination with VDSL-technique allows bandwidth of up to 100 Mbit/s symmetric and, like ADSL2+, allows the use of broadband services with higher needs for bandwidth like High Definition TV (HDTV). Compared to ADSL 2+, under favourable conditions (shorter loops – see Figure 3), VDSL-access lines between end-user location and DSLAM allow a higher download up to the factor 2.5 and a much higher upload (factor 5 to 10)[25] (see Figure 3). Offers on the market already provide bandwidths up to 50 Mbit/s (downstream) on the basis of VDSL2.

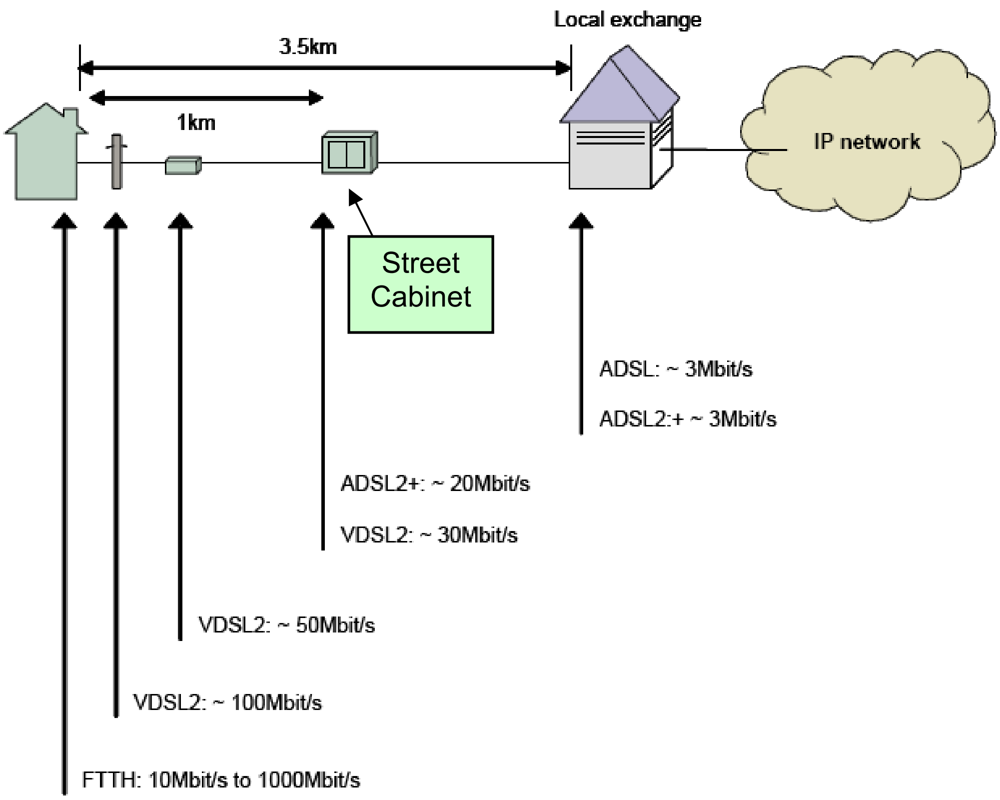


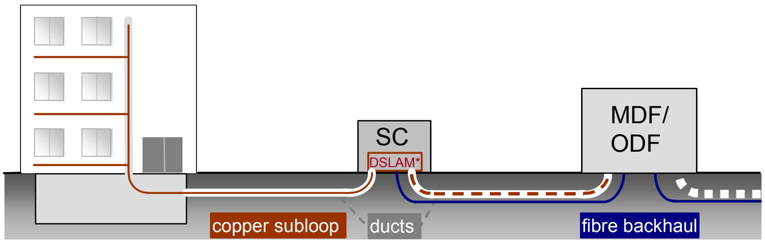
Figure 3: Decreasing loop length, increasing bandwidth (source OVUM).

Due to the technical characteristics (e.g. attenuation) of the copper based line, these high transmission rates can only be offered to end-users over a distance of a few hundred meters.

24 These statements have to be qualified by the fact that apart from the length of the line, the diameter and the isolation of the copper cable are limiting factors as well. It can be read that only 40-60% of the access lines of a cabinet can be operated with VDSL. However, since VDSL2 is not a mature technology yet, more certainty about this can be achieved after substantial testing. Also the in-house cabling can be a limiting factor. See e.g. http://www.heise.de/newsticker/result.xhtml?url=/newsticker/meldung/82647&words=VDSL.

25 This is possible thanks to the use of frequencies up to 30 MHz, whereas ADSL only uses frequencies up to 2,2 MHz. With both options, ADSL2+ and VDSL, customers can receive high definition TV (HDTV needs a download speed of 8-12 Mbit/s), but only VDSL allows to watch more channels simultaneously in HDTV technology.

Therefore, the DSLAM[26] is shifted from the MDF to the street cabinet (SC) as an Outdoor-DSLAM and the local loop dedicated to the end-user ends at the cabinet (see figure 4). Aggregated traffic from all the end-users connected to the DSLAM is transported via the new optic fibre link between the cabinet and the ODF thus shifting the fibre based backhaul network to the cabinet closer to the customer.



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

Figure 4: FTTCab generic design

Consequently, the incumbent may no longer see the need for parallel copper lines, from the cabinet to the MDF.

At the upper network level, an Ethernet switch[27] (at the CO and/or other metro core node) has to be installed to handle multiple DSLAMs located at the cabinets (around 30 per switch). The MDF may or may not be preserved as a network node. An important question is whether existing MDFs in local COs will remain active and how the migration from the MDF to the SDF of operators is managed by the NRA. It is also conceivable that some MDFs become a node of a higher hierarchy level, where also traffic from other MDF areas is concentrated (Metro/core node).

Fibre deployed between the street cabinets and the CO in the FTTCab Scenario can be considered future proof in the sense that it might be used in a PON-architecture FTTH network (see scenario II below).[28]

2.3 Scenario II: Fibre to the Home / Fibre to the Building

Fibre to the home (FTTH[29]) is a fully optical solution going to the end-user premises, i.e. a broadband access system fully based on fibre-optic cables and associated optical electronics for delivery of multiple advanced services such as VoIP, broadband Internet and television (triple play) across one link all the way to the home or business and for speeds ranging from 100 Mbps to nGbps per customer.

In this scenario, the entire (old) copper loop[30] is replaced by optical fibre, along with the MDF and street cabinets, although some of these may be of use for the optical distribution frames

26 Or MSAN – Multi-service Subscriber Access Node. The DSLAMs of the new generation are called IP-DSLAMs or NG-DSLAMs. Sometimes they will be MSAN, allowing for the provision of other access lines e.g. PSTN/ISDN-access lines through functionalities (gateway to PSTN). In the context of FTTx, this node is also known as the ONU – Optical Network Unit.

27 The introduction of ADSL and VDSL is normally accompanied by the replacement of ATM by Ethernet/IP technology in the concentration/backhaul/core network.

28 See JP Morgan (2006), p. 22

29 Fibre to the Home (FTTH) – Single and dedicated fibre deployed until single homes or apartments and business or (apartment) buildings.

30 In a FTTB solution, the in-house copper wiring is kept.

(ODF) and optical splitters. Depending on the type of solution, some electronic equipment might also be needed.

No "one-size-solves-all" architecture exists today, even in this scenario, so operators must make a technology decision based on their service goals and one primary consideration for FTTH providers is whether to deploy point-to-point[31] or point-to-multipoint – "Passive Optical Network" (PON) – networks.

- Point-to-point architecture:

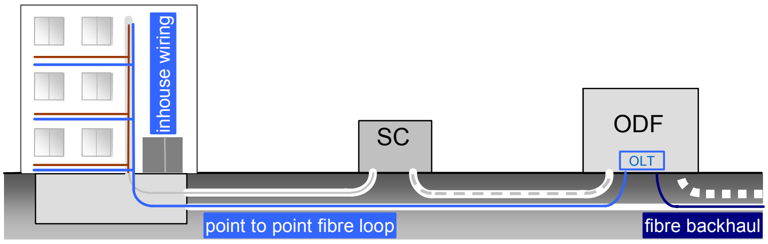


Figure 5: Point-to-point FTTH design

Each subscriber is provided with a dedicated "pipe" – no capacity or traffic sharing – accessing the full bidirectional bandwidth available from the OLT[32]/switch (and it can be as far as 80 km). On the long term, this might be considered the most flexible architecture.

In this solution, the access to the subscriber fibre loop is technically viable at an ODF (e.g. at the CO and/or the first ODF), where the dedicated fibre is connected.

- Point-to-multipoint architecture: PON networks, on the other hand, use passive splitters[33] to distribute fibre to individual homes:

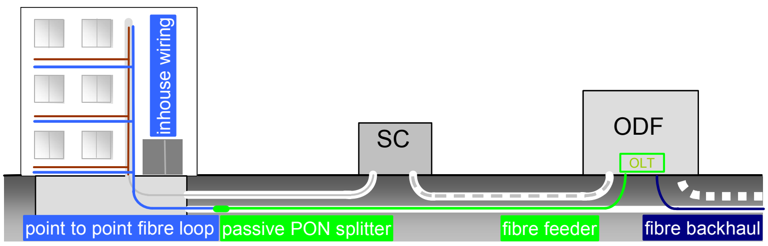


Figure 6: Generic PON design

31 Active FTTH networks utilize powered (i.e. "active") electronic equipment (Ethernet) in a specific area, usually one equipment cabinet/CO for every 4 to 1000 subscribers (average 400-500 subscribers). This neighbourhood equipment performs layer 2/layer 3 switching and routing, offloading full layer 3 routing to the carrier's central office. The IEEE 802.3ah standard enables service providers to deliver up to 100 Mbit/s full-duplex over one single-mode optical fibre to the premises depending on the provider.

32 Optical Line Terminal (OLT) unit. Normally, located in the CO.

33 The splitter is a simple passive device (with no electronics or energy and maintenance requirements), allowing the traffic to be distributed from and onto the shared portion of the fibre.

The basic architecture for communications in the PON is a point-to-multipoint network[34], where the OLT (e.g. at the CO) serves as the control point for the entire PON[35]. A *single* fibre – the OF feeder – runs from the OLT towards the optical splitters, which may be located in very small street cabinets (or underground), and drop off short runs of dedicated (point-to-point) fibre towards each customer. These passive optical splitters are used to pass from a single fibre (single OLT) to currently 64 fibres (each dedicated to single user) over a maximum distance of 10-20 km.

Compared to the point to point solution the passive optical network provides:

- Reduced wiring and space requirements;
- Potentially reduced operational expenditures;
- Potentially lower capital costs for fibre deployment.

But there are also several different PON architectures to consider, like APON[36], BPON[37], EPON[38] and GPON[39].

In this solution, the access to the subscriber fibre loop is technically viable at the optical splitter level, where the dedicated fibre is connected.

As previously mentioned, in a FTTB solution – see a basic design in Figure 7 –, fibre is extended to the building (usually the basement), very close to the customer's premises, and both point-to-point and point-to-multipoint architectures may be considered, but the existing in-house cabling continues to be used. Hence, it is technically a hybrid solution – fibre + DSL –, but in this solution the fundamental technical and economical bottlenecks arising from the need to horizontally deploy optical fibre cables through extended distances to all the buildings are much more similar those found in a (full) FTTH scenario.

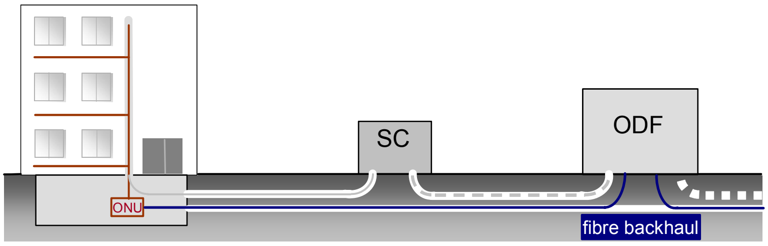


Figure 7: Generic FTTB design

In this solution, the access to the subscriber loop at the ONU[40] requires optical connections

34 Protocols are now defined to provide bandwidth management, QOS, and other capabilities. The result is that the basic point-to-multipoint architecture of a PON can support point-to-point communications in the normal way.
35 The switching and routing is done at the operator's central office.
36 APON (ATM PON) was the first PON standard.
37 BPON (Broadband PON) appeared in a later phase, largely replacing APON in PON deployments because of its superior characteristics: resilience, WDM support for video overlay, higher bandwidths, dynamic bandwidth allocation and can be run at 622 Mbps or 1.2 Gbps.
38 EPON (Ethernet PON), a 2004 standard by IEEE (Institute of Electrical and Electronics Engineers Inc.), running at 1.25 Gbps symmetric and using Ethernet instead of ATM data encapsulation. Ethernet and PON technologies can a most cost-effective and high-performance access technology, combining the point-to-multipoint technology inherent in the original Ethernet technology.
39 GPON is IP-based and appears to be a standard choice for high-volume FTTP networks, combining attributes of BPON and EPON. It recognizes gigabit Ethernet interfaces to enable pure IP transport and does not require active powering points in the access network. GPON is the platform for all FTTP deployments.
40 DSLAM/MSAN/Ethernet switch, etc.

(generically, a OF backhaul[41]) to each and every building, where the optic-electronic equipment is installed.

FTTH/FTTB deployment has so far been announced or begun by operators for example in Paris, other major cities of France, Sweden (Bredbandsbolaget) and in Germany (Netcologne). Furthermore, several municipalities are engaging in fibre deployment, some of which are conceived as open access networks, e.g. in France, in the Netherlands (Amsterdam, Nuenen, Hillegom) or in Finland.[42]

2.4 Shared fibre access technologies – Wave Division Multiplexing

There is a further technology that is of particular importance when considering the capability of fibre to support shared access, for example by competitive providers (see Section 4.2.1). Optical light can be divided into wavelengths through either coarse wave division multiplexing (CWDM) or dense wave division multiplexing (DWDM), coarse or dense refers to the granularity of division, DWDM transmission supporting up to 160 wavelengths at the current time.[43] Each wavelength can act as an entirely separate 'carrier' for the purposes of communications conveyance. Without WDM technology it is not currently possible to have shared access to an optical signal fibre.

DWDM technology is currently extensively used in the core/transmission in order to increase the bandwidth of fibre in the ground. Both are used to a certain extent in the metro areas, particularly for provision of services in business areas. However, DWDM is rarely if at all used in the access due to the expense of the equipment involved and its sensitivity to factors in its environment - temperature and humidity for example. In Korea, DWDM is being trialled in the access and it is possible that in the longer term it will be seen more often closer to the end user.

41 Although in the case of a “PON solution” (for the fibre going towards the building), the principles identified for FTTH/PON are also applicable.

42 See JP Morgan (2006), p. 63 cf. for an overview, see also Annex 2.3, 2.4.

43 CWDM uses passive add-drop filters and DWDM uses active ones.

3 Implications of Access/Backhaul Upgrades for the Economics of the Electronic Communications Sector

3.1 General principles

According to Art. 8 of the Framework Directive (FD), regulators have the objective of promoting effective competition as well as efficient investment.[44] This includes ensuring that users derive the maximum benefit in terms of choice, price and quality and that there is no restriction or distortion of competition. Competition can deliver both static and dynamic efficiency gains. In general, where entry barriers are structural and competition is (at least in the short run) unlikely to emerge, regulation needs to ensure that the resulting market power is not exploited, focusing in particular on behaviour that distorts or prevents competition in the SMP market or related markets and behaviour that is otherwise to the detriment of end users.

With the deployment of NGA networks, regulators need to consider whether these new networks result in a fundamental change in the underlying economics of wireline local access networks as a result of the roll-out of new infrastructure that may impact on the competitive dynamics of the relevant market(s). Traditionally, current fixed local access networks have constituted a non-replicable asset. This may be because of a number of reasons, above all the fundamental economics of building competing infrastructure.

Changing economies of scale and scope will lead to changes in the structural barriers to market entry affecting the 3-criteria-test and the degree to which assets are replicable. In particular the presence of assets that are not replicable in the foreseeable future may result in the emergence of an enduring economic bottleneck.

In markets with high structural barriers to entry the owner of a bottleneck resource is likely to have SMP in the relevant market. In determining if any operator has SMP, a forward looking definition and analysis of the relevant product and service market need to be carried out applying the substitutability criteria of standard competition law analysis. In case SMP is found on a market susceptible to ex-ante regulation, at least one specific obligation needs to be imposed. In order to ensure a level playing field for competition, regulators should give careful consideration to maintain appropriate access regulation and adjust existing SMP products (namely LLU[45] and BSA[46]) where necessary to allow competitors to gain scale.

Following the launch of NGA networks, a number of issues may arise with respect to these general principles:

- The effect of NGA networks on the fundamental economics of electronic communications networks needs to be considered;
- The implications of the economics of NGA on existing regulatory principles; and
- Other factors that may affect the commercial case for investment in NGA networks.

44 Furthermore NRAs shall contribute to the development of the internal market and the welfare of the European citizen.

45 Local Loop Unbundling.

46 Bit-Stream Access (wholesale broadband access).

3.2 Implications of NGA on the economics of electronic communications networks

3.2.1 Economics of NGA

With the exception of cable infrastructure alternative technologies (e.g. wireless) may not provide an adequate competitive alternative to wireline deployments of NGA networks yet. If this is the case, the question for regulators is therefore “will there be effective competition emerging in the provision of end to end wireline infrastructure?”. In some member states this maybe the case, mainly through the availability of cable networks capable of offering TV, telephony and Internet services.

Especially in the situation where there are no alternative infrastructures, NRAs need to consider if the NGA network of an incumbent may be replicable in the foreseeable future. This requires an assessment of the economics of NGA network deployments.

Non-replicable assets relate to those assets in a communications network that either:

- cannot be commercially replicated by competitors in similar circumstances; or
- cannot be substituted by deployments of alternative technologies.

In terms of replicability, it is important to note that the replicability of a particular asset type may vary in different circumstances: for example, local access networks may be more “easily” replicable in geographic areas with a greater population density or in different Member States where there are differing prevailing competitive situations.

Thus it should be noted that, as operators move to NGA networks, different technologies may be deployed in different geographic areas in order to deliver end-services to customers. It is likely that the most effective strategy for NGA deployment will utilise a mixture of technologies to deliver these services depending on specific local characteristics, including copper local loop and sub-loop lengths (see Fig. 8 below), customer density and dispersion, presence of multi-dwelling units, and the quality and topology of existing network architecture, in particular the number of street cabinets per MDF. The number of street cabinets per MDF range from 10 in France to about 40 in Germany.[47] As a result, the economics of NGA networks are likely to vary across different technologies and different geographies.

47 France 10, Italy around 14, UK 16, Netherlands 21, Germany 40.

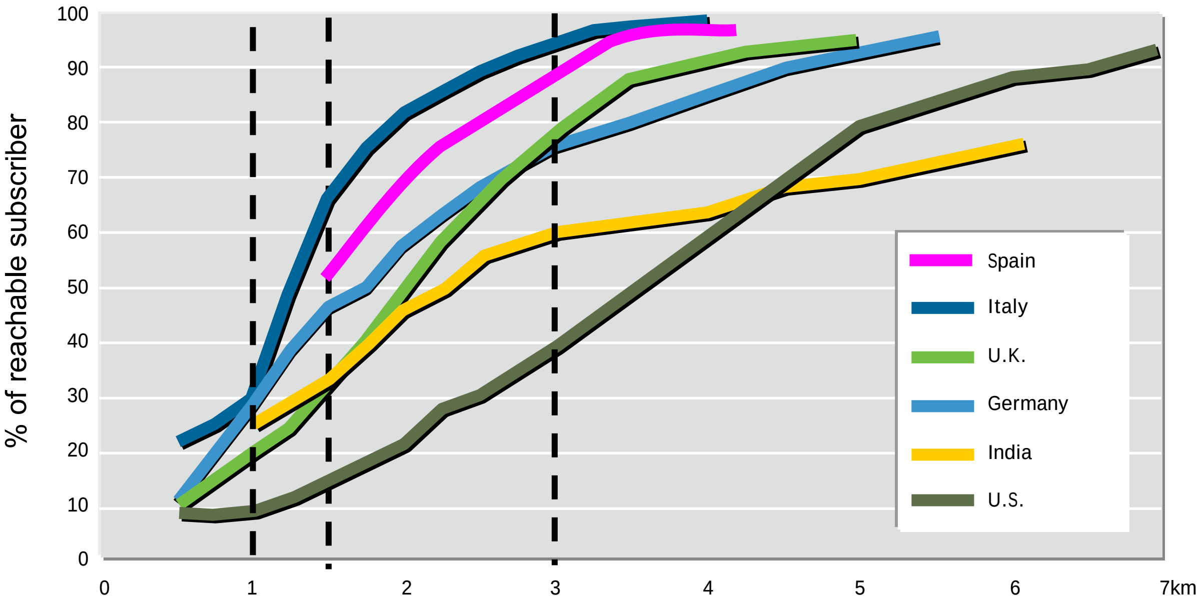


Figure 8: Distribution of Subscriber Loop Length.
Source: Alcatel

Some of these differences are explored in several business case studies, which are summarized in the next section.

3.2.2 Business case studies

Results of a number of business case studies (Analysys, Arcep, JP Morgan, Ovum and WIK) are used here to give a quantitative flavour to the fundamental economics of NGA fibre deployment. The studies are summarized in **Annex 2** with regard to their focus/perspective, their assumptions/scenarios and their results. They have been conducted for a number of NGA scenarios differing mainly with regard to:

- Technology (FTTCab vs. FTTH);
- Incumbent perspective vs. competitors perspective;
- Assumptions with regard to country specific parameters determining deployment cost;
- Assumptions with regard to demand (penetration rate, market share, ARPU).

The approach of most of the studies is to estimate cost factors for fibre roll-out projects and to evaluate the profitability of projects under different scenarios governing demand (penetration rate, market share, ARPU).

3.2.2.1 Cost factors

Several factors/parameters constitute cost drivers influencing the overall infrastructure costs and the following broad cost categories can be distinguished:

- (horizontal) trenching/ducting cost (civil engineering);
- (horizontal) fibre cabling deployments;
- (vertical) costs of in-house wiring, and
- equipment cost per node.

The horizontal trenching and ducting cost have to generally be considered a crucial cost factor for fibre roll-out. For the FTTCab scenario they are a relevant factor for connecting the street cabinet to the MDF or next network node, besides costs for active equipment (like DSLAMs) and colocation cost.

They are even more relevant for the FTTH scenario, as fibre is rolled out all the way to the building. Thus, costs increase exponentially. It can be shown that the cost of civil engineering per subscriber is inversely proportionate to urban density (See Figure 9 below) and significantly impacts on the CAPEX per subscriber for FTTH roll-out.

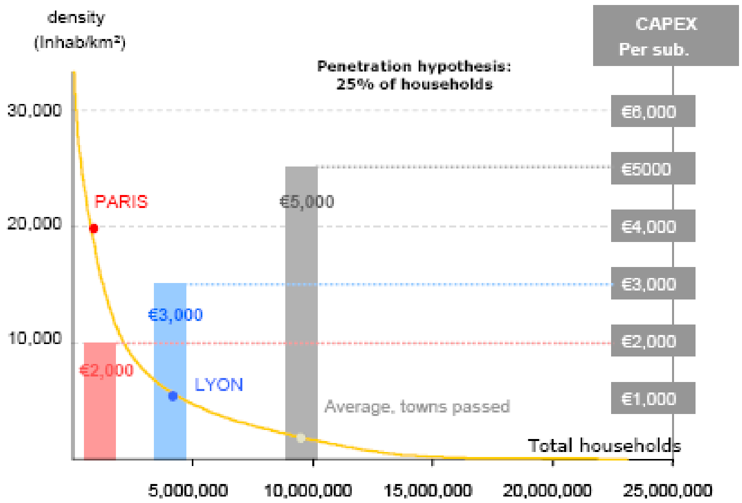


Figure 9: CAPEX (per subscriber) vs. total households/density (Source: Arcep).

Different studies assume these costs to constitute between 50% (in Paris) and 80% of the total cost per customer depending on the population.[48] On the other hand, it has to be taken into account that civil engineering is more expensive in urban than in rural areas: the cost of civil works per meter lie between €55/meter in rural areas to around €120/meter in urban areas.[49]

The level of the – horizontal – roll-out cost depends to a large extent on the usage of existing infrastructure such as trenches or ducts, as this reduces the civil engineering costs. For example, in situations where the existing narrowband infrastructure can be used, the cost of network deployment may be substantially reduced as no new digging costs are incurred. WIK, in its study on the incumbent's VDSL deployment cost in Germany, assumes three cost scenarios ranging from €3/meter if fibre deployment is calculated at marginal cost, to around €64/meter in case of a Total Service LRIC approach, where approximately one third of the costs for ducting and trenching are allocated to VDSL, up to around €130/meter if calculated on a stand alone basis (see also Annex 3.5).

Other cost components to be considered for the FTTCab scenario are the costs of the DSLAM and other electronic equipment (modem etc.), colocation cost as "fixed" cost and OPEX cost. Colocation might also be complicated by factors relating to property rights of municipalities and space availability (see Section 3.4).

Certainly, for the replicability and viability of the business case (in particular for an alternative operator), the most important part is (absent civil engineering costs) equipment cost, as these "fixed" costs per node (e.g. street cabinet) have to be recouped per line. With the

48 See Arcep (2006), IDATE (2006), JP Morgan (2006).
49 See Ibid.

number of lines/customers reachable per node being considerably smaller than per MDF (even in densely populated areas, the critical factor being the number of street cabinets per MDF), it will become much more difficult to make a viable business case as the case studies show. When calculating this category in the JP Morgan study the incremental investment only is considered when moving from the MDF (LLU) to street cabinets, whereas Analysys and Ovum also require revenues to be earned for the LLU investment, thereby implying stricter conditions for a viable FTTCab business case.

According to the JP Morgan study, for a market such as the Netherlands with 21 street cabinets per CO – the additional monthly costs per subscriber of VDSL compared to ADSL deployment, account for €10/month/customer (€2), assuming an unbundled operator with a 5% market share (30%).[50]

The results differ significantly depending on the relation SC/CO, which varies between approximately 10 in France and 40 in Germany. Therefore, the number of lines that are connected to a street cabinet are significantly lower in Germany than in France. With a 10% market share, the additional costs in France (10 SC per CO) amount to €2.6 compared to €12 in Germany (40 SC per CO). A German operator would have to have a market share of +40 % to achieve a similarly low additional cost as in France. Other relevant parameters are the length of the backhaul segment between CO and cabinet and the length of the loop between cabinet and end-user.

Whereas the exact result depend on geographic parameters and assumptions on fibre deployment, the average cost of provision are likely to increase as costs per line/user increase due to higher cost associated with fibre deployment and due to a lower number of end customers per node.

Looking at overall cost for the FTTCab Scenario, the following Figure 10[51] illustrates well how the monthly cost per customer depend on the customers served within a typical urban exchange area.[52] Whereas for LLU the economies of scale are typically exhausted once a competitor has succeeded to win 500 customers per exchange, the economies of scale are much more significant for sub-loop unbundling and they continue to be significant even as the number of customers rise well above 1000 per exchange. This suggests that even given tight regulation of essential facilities at cost-based rates, the competitor is always likely to be at a relative disadvantage to a larger incumbent.

50 Assumptions: Average costs of street cabinet including installation: €10,000. Energy costs per month and subscriber at SC 100% higher compared to CO, due to outdoor location and more challenging air conditioning requirements. Costs of maintenance/customer provision at SC: +100%. Cost uplift due to higher unbundling/backhaul charges are not considered. No access to incumbent’s street cabinets.

51 See Analysys (2007b).

52 Costs are annualized over 5 years and are based on vendor prices and typical EU rates for copper loops colocation and backhaul to the core network – al assumed to be regulated at cost.

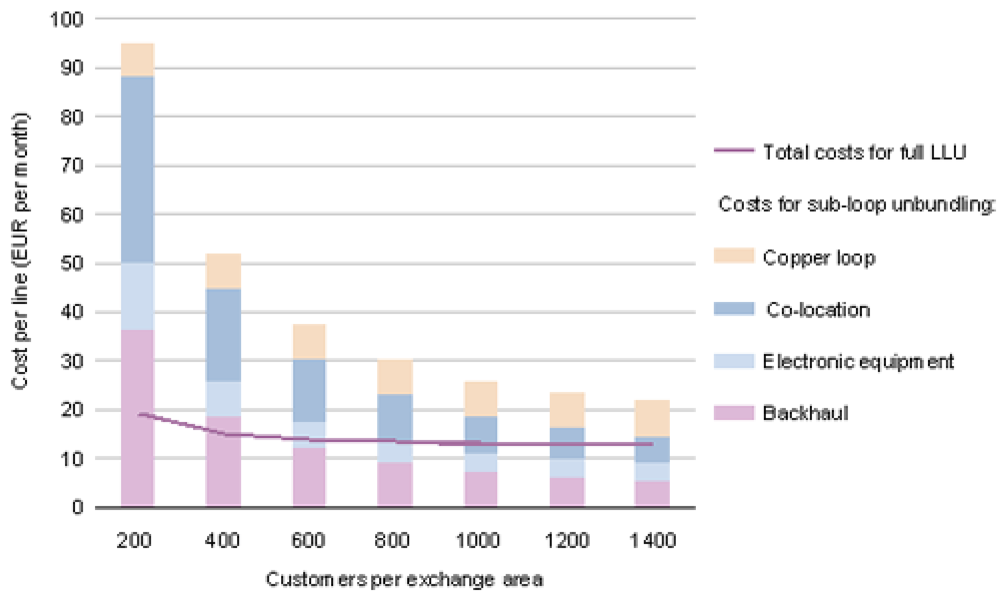


Figure 10: Cost per line vs. customers per exchange area (Source Analysys).

The diagram shows that, depending on the reachable customers per exchange area (i.e. per MDF or SDF), the costs are much higher in areas where the number of reachable customers is only 200. The relevant part of the cost curve depends on the country, but is likely to lie more on the left hand side then on the right end.

For the FTTH scenario, the horizontal costs - due to more civil engineering works - are by far the most significant cost component. But another significant cost component in this case is the cost associated with the vertical roll-out (for in-house wiring). They are of a different nature, because they (often) result from difficulties with the physical conditions of buildings (e.g. availability of internal trays) or with the house owners. These difficulties (as well as others not directly related to the costs that can be controlled by network operators) are dealt with in chapter 3.4. They are mainly relevant for the FTTH scenario and, according to Arcep, the indoor wiring constitutes the second largest cost item next to civil engineering ranging from €300 to €500 per customer.

Included in the CAPEX per subscriber, are the costs for active electronic equipment in the network and active subscriber components.

3.2.2.2 Results, taking account of demand factors

Besides the cost factors, the profitability of any such deployment critically depend on penetration rate, market share and the possibility of realizing a higher ARPU per customer.

In the WIK study, it is assumed that the VDSL retail price that can be recouped amounts to €34.99 per customer and month. The profitability of the incumbent’s VDSL roll-out to approximately 5.5 million households crucially depends on the demand for VDSL access. The critical penetration rate (relationship of VDSL lines/total lines) required for a break even of the incumbent’s VDSL roll-out ranges from 14% of all households passed (760.000 households) in the case where the ducts can be used at marginal cost up to 31% (1.7 million households) under stand-alone conditions.[53]

With regard to the viability of alternative providers’ business cases, the following results were found:

53 When calculating this break even penetration rate upfront costs or revenues from flat rates are not considered.

Analysys case study for the Netherlands identified a number of conclusions[54]:

- Based on the current wholesale offers of KPN, the use of SLU[55] by an alternative provider is not economically viable as an alternative to continuing use of LLU, except under certain conditions. Analysys estimates that a business case for SLU with similar economic viability to that of continuing use of LLU for 60% of the population would require both:
  - a market share greater than 55% of all broadband lines (including cable) in areas served;
  - Analysys' highest estimate for incremental revenue (an increase in ARPU across all broadband users of €10 per month by 2016).
- For an alternative provider with a 10% market share of all broadband lines in areas served, Analysys estimates that it may be economically viable to deploy SLU to around 1.000 of the largest street cabinets in the dense urban areas, provided that:
  - the tariffs for SLU line rental, co-location and links to the street cabinets are reduced significantly (Analysys tested 50%);
  - an increase in ARPU of around €9 per user per month can be achieved for the entire period, which is considered reasonable if business customers are targeted.
- The strong local economies of scale effects, that are evident in deployment at the street cabinet level, mean that even if such significant cuts of 50% in KPN's wholesale tariffs were to be realised, the use of SLU would still not be economically viable as an alternative to LLU to reach the mass market, unless is assumed, for example:
  - a market share of 25%, together with an increase of ARPU of €5 per month;
  - a market share of 16%, together with an increase of ARPU of €10 per month.
- The prices which affect the viability of an alternative operator's business plan the most are those for the line rental, SDF co-location and SDF-MDF link. Furthermore, Analysys' assessment of the cost of building a competitive network to provide backhaul to street cabinets indicates that unless very substantial revenue streams can be generated from services other than SLU backhaul, then it will not be possible for a third party to provide such backhaul at prices at the same level as, or below, the current offer of KPN.

The JP Morgan study concludes that, in a typical market, at least double-digit market shares and a large premium market would be required to justify a new entrant VDSL deployment, whereas low market share operators would have no VDSL business case. For an average new entrant operator in a country with average network topology, VDSL would most likely be a loss maker. Even a market share of 40 % would not justify VDSL investment, unless there is an increase of ARPU.

54 The main assumptions, on which the Analysys study is based, are 1) Providers have already deployed LLU and borne the associated start-up costs; and 2) KPN plans to sell off its existing exchanges, meaning that LLU at the MDF is no longer available

55 Sub Loop Unbundling.

3.2.2.3 Conclusion of business case studies

An increase in costs per line/user can be seen as operators deploy fibre closer to the customer premises, with higher costs associated with fibre deployment (including civil engineering) and due to a lower number of end customers per node, so the average cost of provision is likely to increase compared to the "classical" roll-out of a network to the MDF.

Conditions are likely to differ largely among Member States and within different regions of Member States. It may be the case that, to some degree and in certain locations, these scale economics mean that there is a natural monopoly in certain areas of the electronic communications value chain.

The profitability of VDSL roll-out depends on structural parameters such as population density, penetration rate and the ability of operators to generate higher ARPU for the services offered on these lines.

"Horizontal" engineering costs constitute an important cost driver. Access to existing ducts thus allows to significantly lower roll-out costs. Therefore, existing ducts owned by the incumbent are likely to constitute an enduring economic bottleneck. Hence, capacity sharing and wholesale access are regulatory options that need to be analyzed in Chapter 4.

As shown, NGA investments are likely to reinforce the importance of scale and scope economies, thereby reducing the degree of replicability, potentially leading to an enduring economic bottleneck. The degree to which this is the case will vary depending on the specific technology deployed, but may mean that effective competition will increasingly require significant scale in order to compete with incumbents' deployments of NGA, even though for the time being it is uncertain what the minimum scale exactly is. The viability of the business case also depends on the demand side and the additional ARPU that can be realized by offering customers innovative services.

As JP Morgan states: "*unless regulation forces the incumbent to provide access to its street cabinets, the option of deploying a VDSL network of their own may not be available to all or most of the LLU operators active today, implying a serious 'replicability' issue*".

Given that next generation access networks may be more likely to reinforce rather than fundamentally change the economics of local access networks, NGA may be likely to, at least, provide the same competition challenges to regulators as current generation wireline access networks.

3.3 Other factors impacting on the feasibility of NGA roll-out

There are a number of factors beyond the economics of NGA networks that also need to be taken into consideration when calculating the business case for NGA deployment. These additional factors may affect the investment decision as well, but are generally (or at least in most cases) not under the control of electronic communications regulation:

- Physical limitation of space in the street cabinets[56].
- Availability of alternative way leaves or duct infrastructure, including:
  - a) Utility infrastructure, inclosing sewers, water and gas and electricity distribution networks;
  - b) Ducts and infrastructures, owned by municipalities/(public) utilities;
  - c) In-house (building) infrastructure.
- Property rights of:

56 Although space in street cabinets is more limited than in COs, this does not release operators from finding creative solutions to use the available space as efficient as possible, see also paragraph 4.3.1.

a) Municipalities (installation of additional street cabinets);

b) House owners (in-house wiring).

- Publicly funded infrastructure (possibly crowding out commercial NGA roll-out).

The physical feasibility (some times also dealt with as “practicalities”) relates to those barriers to new network deployment that are not directly related to the scale economics. For example, FTTCab and VDSL in the sub-loop may require larger street cabinets. However, it may be the case that local planning policies or space limitations means it is not possible to build these new cabinets in the required location. Another example relates to the upgrade of existing cabinets for NGA networks. It may be the case that the space in the street cabinet (or the box) is too small to colocate multiple operators’ electronic equipment, although this problem may be alleviated over time with technological progress further “miniaturising” the equipment. Another case of physical feasibility is where limited space for in-house wiring aggravates fibre roll-out to the building.

Some of these practical issues can be addressed by specific approaches that may be considered outside the current regulatory approaches. For example, as mentioned above, the usage of existing ducts (and sewers) can reduce horizontal roll-out costs, e.g. when shared by different operators. However, the owner of a duct or sewer is not necessarily a telecommunications operator, but may be a public utility or a municipality (e.g. sewers in Paris are owned by the city of Paris), thus falls outside the scope of the regulatory framework.[57]

Municipalities also play an important role as they, in general, decide on rights of way, and thus may bloc the deployment of a bigger or numerous street cabinets. Other players whose property rights might pose difficulties are house owners, e.g. for in-house wiring.

As possibilities to overcome these “barriers” one can think of arrangements with municipalities and/or commercial solutions between operators.

As mentioned in Chapter 2, in some countries municipalities are engaging in fibre deployment. Such an engagement of municipalities and/or public utilities has to be carefully evaluated in a differentiated manner. Relevant criteria may be:

- how the fibre deployment is financed and whether public funding is involved;
- whether the fibre network is constructed as a neutral network offering access to all operators on a non-discriminatory basis or whether the municipality intends to offer services itself;
- whether the municipal investment possibly crowds out a viable private sector investment.

3.4 Regulatory implications of NGA economics

Regulation seeks to ensure consumer welfare is increased through both the promotion of competition and the presence of investment and innovation in new technologies and services. Welfare gains can result from two main sources:

- *Static efficiency gains* – these are derived from the most efficient use of existing technologies. Static efficiency is maximised through intense competition and subsequent lower prices;

57 For possibilities of duct sharing between telco operators e.g. as an ancillary service to the local loop – cf. also ERG (06) 40rev1 on the practicality of duct sharing and ch. 4 below.

- *Dynamic efficiency gains* – these are gains related to the additional value generated by innovative new technologies and services that may be produced at lower cost and customers may attach a higher value to.

Following the principles for the choice of the appropriate remedies set out in the ERG Remedies CP (ERG (06) 33), the NRA will form a view on the mode of competition to be promoted that will depend on the individual circumstances for each deployment and location (see below). However, in general, infrastructure competition is associated with greater dynamic efficiency given the prospects for innovation. Competition over competing infrastructure has many advantages. The pressure to minimise costs is exerted over the whole value chain, inducing greater scope for innovation in products and processes which creates a downward dynamic for costs. Consumers also benefit from more diversified offerings, which correspond more closely to their individual needs.[58]

Given the increasing importance of scale in the deployment of NGA networks and the new technologies that can be used to deliver these innovative services, we may witness a shift of the enduring economic bottleneck. This may result in a change of the most suitable access point(s) for the promotion of competition. These effects of NGA deployment on the current regulatory environment will need to be reassessed by NRAs taking account of national circumstances (See section 3.2).

The level in the network where regulatory remedies could be applied to NGA networks may differ substantially from the current copper-based generation broadband access network. The options available for the promotion of competition are also likely to be dependent on technology choices made by industry, and may vary for different customers, or in different geographies or countries. However, the principle of promoting competition at the deepest level in the network where it is likely to be effective and sustainable is still appropriate for the regulation of enduring economic bottlenecks in NGA networks.

There are a number of practical or economic factors relevant to determining the points in the network at which access regulation might apply. Each of these factors will need to be assessed by NRAs in determining the most appropriate regulatory approach for NGA.

The challenge for regulators is to identify the point in the network where effective and sustainable competition can be promoted. As outlined by the ERG in its Common Position on Remedies (ERG (06) 33):

> *"where as part of the market definition and analysis process, replication of the incumbent's infrastructure is viewed as feasible, the available remedies should assist in the transition process to a sustainable competitive market".*

The ERG has identified two main principles when deciding on the appropriate remedies[59]:

- Protecting consumers where replication is not considered feasible;
- Promoting feasible infrastructure investment.

The first principle is described as follows:

> *"where infrastructure competition is not likely to be feasible, due to the persistent presence of bottlenecks associated with significant economies of scale or scope or other entry restrictions, NRAs will need to ensure that there is sufficient access to wholesale inputs. Thus, consumers may enjoy the maximum benefits possible. In this instance, NRAs should also protect against the potential behavioural abuses that might occur".*

58 Cf. ERG (2006), p. 60.
59 In fact the ERG identified 4 main principles, 2 of which are particularly relevant here. Cf. ERG (2006), pp. 11 and chapters 4 .2.2 and 4.2.3, pp. 57.

For the second principle the ERG Remedies CP states that:

> *"where as part of the market definition and analysis process, replication of the incumbent's infrastructure is viewed as feasible, the available remedies should assist in the transition process to a sustainable competitive market.*[60] *Where there is sufficient certainty that replication is feasible these markets should be treated in an analogous manner to those markets where replication is known to be feasible. In other cases with more marked uncertainty the NRA should keep an open mind and engage in on-going monitoring and discussion with the industry to continually re-assess their views".*[61]

Where it is practically and economically feasible to promote infrastructure based competition, this should be the aim of NRAs. The practical issues related to NGA competition are discussed below. Effective and sustainable infrastructure competition will result in the greatest benefits to consumers and, therefore, NRAs should seek to ensure that competitors invest in infrastructure at the deepest level of non-replicable assets that is both economic and practical, i.e. the point where efficient competing infrastructure is sustainable. For example, this could include – if practicable - access to ducts if this is the bottleneck, or in the case of the current generation copper access networks, access to the copper (sub-)loop. Remedies under this approach will enable competitors to develop competing infrastructure at the point in the network determined to be the deepest available for effective and sustainable competition.

In those instances where replication of access is not considered feasible, promoting service competition is an important goal for the NRA as it is only through vigorous competition in services that consumers can enjoy the maximum benefits possible. Service competition increases consumer choice, which is an important end in itself. NRAs will also have to be mindful that they encourage efficient investment in infrastructure and that they promote innovation.

For service based competition, NRAs should:

- ensure as much services competition is encouraged as is feasible; and
- ensure that there is a sufficient return on the existing infrastructure to encourage further investment and to maintain and upgrade existing facilities for which the setting of access prices is critical.

In either case, regulators should strive to ensure that competitors can gain access to upstream inputs that are equivalent to those used by bottleneck asset owners own downstream division.

However, it is important that infrastructure and service competition are not seen as opposed to each other, but are linked through the ladder of investment allowing competitors, through a sequence of regulated access products[62] to invest in a step-by-step manner in own infrastructure. Service competition based on regulated access at cost-oriented prices can be (and in general is) a vehicle for long term infrastructure competition. Therefore, regulators should impose remedies that enable the new entrants to reach a point of the investment ladder which makes economic sense and which tends to maximize the extent of economically efficient competing infrastructure.[63]

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60 When referring to replication in this document, what is really being referred to is other infrastructure that is capable of delivering the same services. Thus, the replication needs not be on the basis of the same technology and, even if it is, there is no assumption that it will be configured in the same manner.

61 ERG (2006), p. 12.

62 Consistently priced.

63 Cf. ERG (2006), p. 61. The impact of NGA investment on the ladder of infrastructure will be analyzed further in ch. 4 below.

Incentives for efficient investment

One of the main challenges for regulation is how to ensure that potential investors in assets that may constitute enduring economic bottlenecks can be confident that they will be allowed to earn an appropriate level of return. In an environment where access to non-replicable assets is regulated, it is important that the regulated price that the owner of a non-replicable asset can charge its own and third party downstream divisions will allow an appropriate rate of return on its investments. This return should adequately reflect the degree of risk faced at the time the investment is made.

Given that, absent competition, the incentives for investment to realise dynamic benefits from innovation, for example new technologies, are modest, it is important to note that regulators should be concerned with incentives for efficient investment. Otherwise, this may result in reduced benefits to end consumers. Whilst this is true for lower levels of competition, it is worth noting that at some point the incentives to innovate may diminish as competition intensifies and the benefits from innovation are competed away more quickly.

However, it is not the role of regulators to provide operators with incentives to make particular investments at a particular point in time. Rather, they should endeavour to ensure that the incentives for efficient investment are not distorted, and that regulation prevents the exploitation of market power.

Where regulation prevents a bottleneck asset owner from leveraging market power into higher returns downstream, resulting in the bottleneck asset owner deciding not to deploy NGA, efficient investment incentives have not been distorted. In this case, the incentive to invest is based on the ability to leverage market power in the bottleneck asset into a downstream market. If the business case for this investment relied upon such leveraging of market power into downstream markets by the bottleneck asset owner, it would not be an efficient investment.

However, efficient investment incentives could be distorted by regulation if, in the face of demand uncertainty, regulation does not take into account the level of risk incurred at the point of investment, for example in the rate of return or more generally the terms of regulated access products.

4 Implications for Regulation

NRAs are faced with a situation in which developments are rapidly taking place – to the point that someone refers to NGN as "now" generation networks. In the short term – next few years –, NRAs will have to continue to use the existing legal instruments[64], with the notable exception of an amended Recommendation on relevant markets, which could see the light in the near future. In the longer term, possible changes to the existing framework will likely further address market definition/market analysis remedies (e.g. access obligations, price controls) and, to some extent, the way to deal with the classification of some services as non-telecommunication services (e.g. ducts or colocation at the cabinet). This section explores the implications of technological change for market definition and analysis, which will continue to be the prerequisite for the adoption or amendment of regulatory remedies.

According to the ECNS[65] Regulatory Framework, the regulator has to follow a process consisting of 3 steps: market definition, market analysis and, in case of SMP finding, the imposition of specific regulatory obligations ("remedies") to overcome the competitive problems identified, bearing in mind the objectives laid down in Art. 8 FD, namely to promote competition and efficient investment for the benefit of the users.

In this section, some *general* proposals are made as to how the Recommendation and the ECNS Regulatory Framework may be adjusted to cope with the regulatory challenges growing out of the different fibre deployment scenarios described in Chapter 2. It goes without saying that any *specific* market definition, market analysis or "remedies decision", based on such an adjusted Framework, would have to be carefully carried out by the NRAs using the prescribed methodology, which may lead to different results in different Member States reflecting national circumstances and different fibre deployment strategies.

a) Market definition/ analysis

For the market definition and analysis, the legislation foresees a competition law analysis based on economic criteria including the hypothetical monopolist's test. Therefore, the inclusion/exclusion of products/services in the broadband access markets, by evaluating their substitutability and price constraints, will continue to be the key factors of market definition with regard to NGA.

Most importantly, a basic principle of today's market regulation – the fundamental principle of technological neutrality according to Art. 8 FD – will hold true even in the new environment: Access obligations in markets for which the 3 criteria test – i.e. markets susceptible to ex-ante regulation – is fulfilled and where SMP has been found must be independent of the technology used.

b) Remedies

Where remedies are to be imposed to overcome the lack of competition, NRAs will want to consider generic obligations, such as non discrimination in relation to the provision, upon reasonable requests, of access and associated facilities in general terms (self supply), <u>not</u> restricting competitors to offering identical products to those of the dominant player, but allowing innovation.

Also, specific measures will need to be considered, such as a detailed description of the key products (and associated facilities) to be provided, with specific pricing conditions, terms and conditions.

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64 Cf. also I/ERG (2006), Response to the Review of the EU Regulatory Framework for Electronic Networks and Services, 27th October 2006.

65 ECNS – Electronic Communication Networks and Services.

When imposing specific obligations, NRAs must assess their proportionality. Also, remedies must be appropriate and must relate to the nature of the problem.[66] Thus in case of imposing obligations on a SMP operator rolling-out NGA, the overall "package" of existing and additional (or amended) remedies must be born in mind in order to avoid overregulation.

4.1 Implications of NGA deployments on existing regulation

The deployment of NGA infrastructure may have a number of implications for existing regulation, including remedies put in place for a number of different relevant economic markets. Also, and as already mentioned, it is not clear that the same economics or network deployments will apply to all areas, even within a single national market. Therefore, regulators may need to consider the application of variable remedies on the basis of the prevailing competitive conditions and degree of NGA deployments.

NRAs will need to consider the appropriate level of support for current wholesale products as operators move to NGAs. For example, these may include physical access products, including LLU and SLU or various forms of bitstream access products.

Some of the access network upgrade technologies, that a local access network owner might choose to deploy, would make it difficult or expensive to offer some physical access products. For example, it may be much more expensive for the operators to roll out FTTCab and provide DSL from the cabinet compared to LLU from the MDF.

The decisions that NRAs take on requirements to support today's wholesale access products could therefore affect both the bottleneck asset owners' incentives to make an investment in NGA, as well as the incentives of competitive operators to invest in current and NGA infrastructure.

The NRAs' role is not to protect commercial investments against market risks that may arise, for example from the emergence of new technology developments that supersede some operators' current market propositions. However, it may be appropriate for NRAs to consider operators' interests in terms of the availability of wholesale inputs, throughout the life of their investments. On the other hand, at some point in the lifecycle of any wholesale access product, it may no longer be sensible to continue to support this product (at least, under the same conditions). The specific timing of such decisions would need to be made on a case-by-case basis, taking into account the prevailing market environment and the impact on consumers and industry from the removal or amendment of regulatory obligations to provide certain wholesale products.

Transparency in any decision to remove or modify regulated wholesale products, including suitable signalling of intent and a well defined migration path for operators and consumers using these products would be fundamental as predictability of regulatory intervention is key factor for operators when taking investment decision. Depending on national circumstances and more specifically on actual roll-out of NGA a continuation of LLU in its existing form – i.e. at the MDF – may be required.

4.2 Regulatory challenges in the existing Framework

Wireline access networks have historically been an enduring economic bottleneck. This paper is explicitly focused on wireline NGA implementation issues and related regulatory

66 Cf. for a more extensive description ERG Revised CP on Remedies, ERG (06) 33.

implications, as current upgrades of copper and fibre access networks being carried out in a number of Member States[67] have recently become a key challenge for regulatory authorities.

The developments might have implications for the analysis of Markets 11 and 12 of the Recommendation. On these markets, SMP has been determined in almost all Member States (exception: Market 12 in the Netherlands[68]) and respective access obligations imposed. The strongest impact will be seen on Markets 11 and 12, but NGA roll-out could affect other markets as well, e.g. Market 13 (leased lines terminating segments).

As has been described in Chapter 2, the network upgrades in the context of NGA comprise some deployment of optical fibre. The broad options available (see figures in Chapter 2) may be generically distinguished as to how far fibre is rolled out towards the end-user, enabling increasing reach and bandwidth to the end-user. For the purpose of this paper, two broad scenarios, one being called FTTCab and the other one FTTH/FTTB, have been defined and their regulatory implications will be analysed and discussed in more detail below.

These two scenarios imply different regulatory challenges, and unbundling may not solve the access problem in the same manner as it did in traditional copper networks. However, to foster effective competition, additional or other remedies may have to be identified and applied in order to adapt regulation to further challenges. NRAs will continue to conduct their specific market analysis using the competition law criteria (e.g. HM test, substitutability, pricing constraints).

4.2.1 NGA and Market 11

In the Recommendation, Market 11 is defined as wholesale unbundled access (including shared access) to metallic loops and sub-loops.

Looking to the definition of the Access Directive (AD)[69] where the "local loop" is defined as the physical circuit connecting the network termination point at the subscriber's premises to the main distribution frame or equivalent facility in the fixed public telephone network (Art 1 e), a local loop can be described more precisely as a dedicated line between the network termination point at the subscriber's premises and the distribution frame at the first aggregation point. Thus it can be said that the AD would allow a broader definition of Market 11. Therefore, while the current Recommendation defines Market 11 with explicit reference to metallic loops the AD refers to the physical circuit – which could include both metallic and fibre local loops, satisfying the requirement of technology neutrality.

Hence, with the introduction of NGA, as described in Chapter 2, the former definition of local loop could be adapted to include both Scenarios, i.e. FTTCab as well as FTTB/FTTH (in a point-to-point or point-to-multipoint configuration):

- FTTCab - the local loop consists of the copper line from the cabinet to the home;
- FTTB - the local loop consists of the copper line from the building entrance (where fibre ends) to the end-user premises;
- FTTH - the local loop would simply be constituted by optical fibre from the ODF to the end-user (home), whatever the architecture chosen (point-to-point or point-to-

67 E.g. with the deployment of IP DSLAM, utilizing the copper line with xDSL technologies, in combination with PONs to directly reach the street cabinet or the building via passive fibre architectures. More aggressive strategies opt for the deployment of fibre connections directly to the end customer's homes or offices, already happening in some MS as well.

68 In the Netherlands there was no SMP found on the market for low quality wholesale broadband access in the Market Analysis Decision of December 2005. However, mainly due to the plans of the incumbent to exploit a NGA, OPTA has started a new analysis of market 12.

69 Directive 2002/19/EC of 7 March 2002.

multipoint). Feasibility of local loop unbundling might however be challenged depending on the type of architecture chosen by the SMP operator:

- o where point-to-point fibre technology is chosen, it may be possible to unbundle the local loop in a manner very similar to that used today for copper; full LLU of the loop is applied from the ODF. Each operator would be authorized to use the full frequency spectrum of the dedicated fibre loop.

  The shared access approach can be applied if the physical line (optical fibre) could be shared, using one or more wavelengths for each competitor. In this case, the operator could use part of the frequency spectrum, dedicating each wavelength to a single user. However, shared access to the optical spectrum is only possible through the application of WDM technology (see Section 2.4). This technology is expensive. Therefore, it is unlikely that this would be an economic option in access networks for some time.

- o if a shared infrastructure topology, such as Passive Optical Networks, is chosen, it is no longer easily possible to associate (end-to-end) a single physical element of connectivity with a particular end-user. In this situation, the options for unbundling become more challenging. For example,
  - ▪ Unbundling of the subscriber fibre loop could be applied at the passive optical splitter level, where the dedicated end-user fibre is connected to the fibre shared by the end-users (connecting the splitter and the ODF);
  - ▪ In addition it may be possible to associate wavelengths with end users to achieve a form of unbundling (at the ODF level). However, and as mentioned above, WDM technology required to support this form of unbundling is relatively untested for use in the access network and may be both complex and expensive to implement.

In all these unbundling scenarios, the alternative operator gets access at the physical level of the transmission medium: a (copper, fibre) loop or a frequency band/wavelength within the loop. So it can be concluded that, independently on the technology adopted and according to the above reported AD definition, physical access (layer 1 of the OSI model) to the copper or to the fibre or a portion of the bandwidth (wavelength) from a connection point (MDF or ODF), would be considered unbundling.

The inclusion of the fibre loop into Market 11 is compatible with the definition of the AD but would require a change of the Recommendation to include fibre into the relevant market.

4.2.2 NGA and Market 12

According to the Recommendation, Market 12 includes all broadband access services such as (what is traditionally referred to as) bitstream services based on the access infrastructures and on a packet-based transport network. Currently, Market 12 products are mainly based on ATM over xDSL copper access from the CPE to the DSLAM, plus ATM/SDH or Ethernet/WDM fibre transport from the DSLAM to the switch (ATM or Ethernet feeder node) or on ATM/SDH fully fibre streams from the CPE to the switch.

In accordance with the bitstream interconnection options described in its Common Position on Bitstream Access[70], present bitstream (DSL access link plus a backhaul service) offers include several options according with the operators' access and traffic handover point:

- Access at the DSLAM (Option 1);

70 ERG (03) 33rev2, ERG Common Position - Adopted on 2nd April 2004 and amended on 25th May 2005, p. 5.

- Access at the ATM level (ATM or Ethernet backhauling capacity to parent or distant switch) (Option 2);
- Access at the IP level (Option 3);
- Access at the IP level (Option 4).

The above reported options are based on the use of copper from the CPE to the DSLAM and, generally, fibre up to the node.

Similarly, bitstream offers on FTTCab or FTTB architecture can provide the same type of access services, with the difference that the aggregation node (DSLAM/MSAN) is closer to the user, but still using copper from the CPE to the Cabinet (or in the building, for FTTB).

In the case of FTTH, bitstream services would be only based on fibre (Ethernet over fibre), but the access/handover can be at IP or Ethernet level (Ethernet services allow more features such native multicast):

- Ethernet over fibre (connection at OLT) plus Ethernet partial backhauling capacity (connection to an intermediate backhaul equipment if that exists);
- Access at the Ethernet parent switch over fibre plus full backhauling capacity (connection to Ethernet parent switch);
- Access at the Ethernet distant switch plus backhauling capacity;
- Access at the IP level.

As has been the case for the bitstream markets, currently notified after a substitutability test have been carried out for the individual markets, a characteristic of Market 12 products is that the competitor accesses the wholesale service at layer 2 or layer 3 of the communication protocol stack, which consists of a well defined stream allocated by the incumbent (a VP/VC in ATM scenario, or a VLAN in a Ethernet scenario). When comparing Markets 11 and 12 in terms of substitutability, a relevant factor for the competitor is that bitstream access at layers 2/3 reduces his freedom to control the quality parameters compared to the LLU case, where the authorized operator gets access to the physical line (layer 1 access).

If we apply this concept to NGA, we can say that whenever the competitor accesses the incumbent network at layers 2/3 of the communication stack – behind an active access equipment like a DSLAM mostly in combination with a backhaul service to any concentration node (or behind any system placed at the MDF site, or in the SC or in the Building) –, the corresponding wholesale service can be considered bitstream access and, consequently, included in Market 12.

Market 12 does not require a change of the Recommendation as, by definition, it already comprises all kind of wholesale broadband access products[71] irrespective of the technology and speed. NRAs will assess in their respective market analysis whether these different wholesale products can indeed be considered substitutes also taking into account the corresponding retail services (e.g. IPTV) that will be provided on the basis of wholesale broadband access.

71 See Recommendation. Market 12: “This market covers ‘bit-stream’ access that permit the transmission of broadband data in both directions and other wholesale access provided over other infrastructures, if and when they offer facilities equivalent to bit-stream access .”

4.3 Regulatory challenges in scenario I: Fibre to the Cabinet

In all Member States there is SMP found on Market 11, which includes wholesale unbundled access to metallic sub-loops, but in most countries SLU is not yet implemented. However, in some Member States the SMP-party has announced the roll-out of FTTCab solutions, requiring NRAs to look more deeply into SLU as a possible form of access for alternative operators.

4.3.1 Possible barriers

In the implementation process of LLU, NRAs have experienced that SMP-parties established several barriers to delay its roll-out. Based on these experiences, it is reasonable to assume that similar (or new) barriers may be created to try to delay the roll-out of alternative operators' networks based on SLU. This section gives an overview of the possible barriers to the development of SLU. It should be noted that this overview is not exhaustive, since experiences with SLU as an access form are relatively new.

4.3.1.1 Colocation at the street cabinet

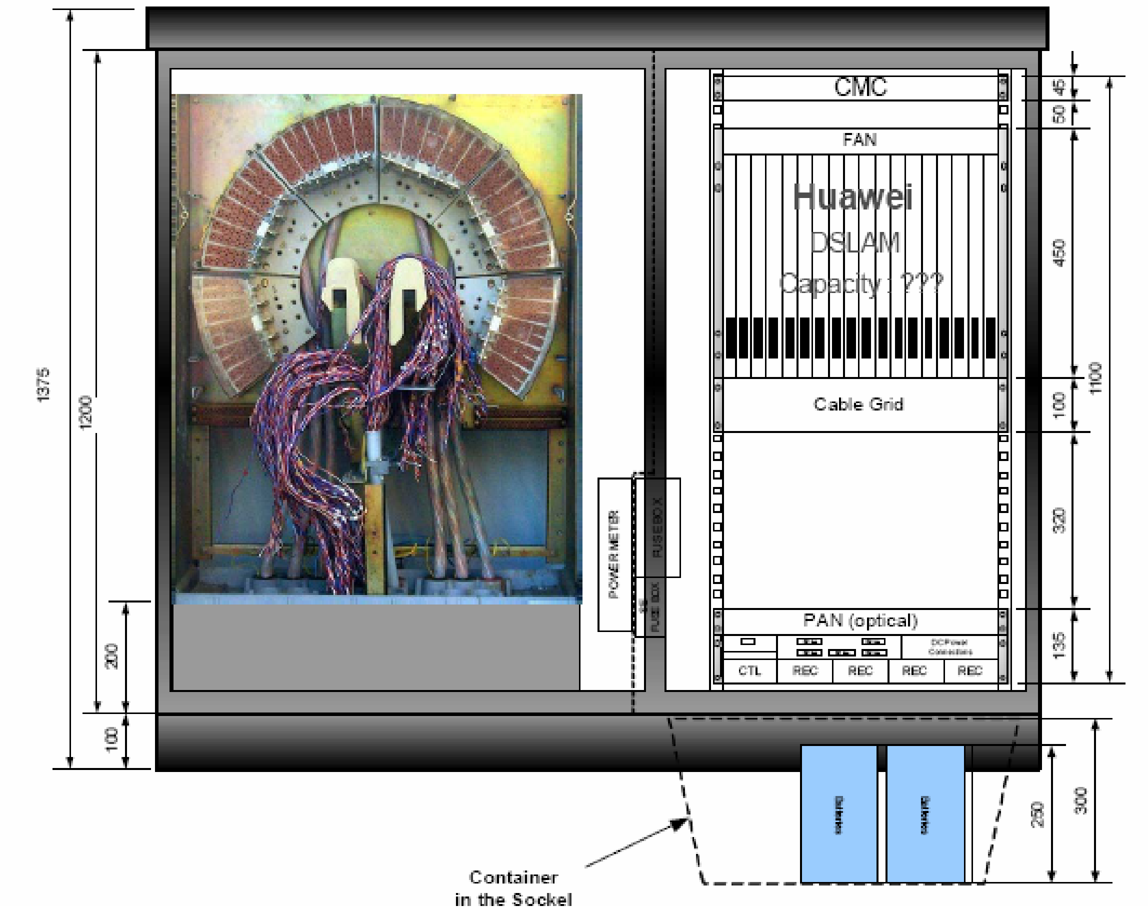
Alternative operators who wish to roll-out to the street cabinets and install their own equipment in the street cabinet will be, normally, faced with scarcity of space for colocation, even more than in the COs. New equipment for larger outdoor facilities is normally available in a standard 19" rack, although smaller racks are also commercially available.

Some examples of equipment which might be installed (and if possible shared by operators) at the street cabinet include:

- DSLAM (e.g.VDSL2) or MSAN;
- splitter-devices to provide shared-line service (this facility can be integrated in the DSLAM/MSAN);
- ODF (optionally to be shared with the incumbent or other alternative operators) to connect the fibre backhaul with the DSLAM equipment;
- tie cabling inside cabinets and between cabinets;
- power supply unit. If the delivered services require the use of an UPS[72], a separate space may be required (within the cabinet, or in the foundation of the cabinet) for the location of one or more batteries;
- a monitoring facility for the detection of power fluctuations, malfunction of equipment or a violation to the integrity of the physical shelter of the street cabinet facility;
- space for a cable grid and fan/airflow.

The following Figure 11 gives an example of a street cabinet which is designed for offering VDSL2 from the street cabinet.

72 Uninterruptible Power Supply.



Source: www.kpn-wholesale.com

Figure 11: Example of a street cabinet designed for delivering VDSL2 services

There may also be barriers for colocation within or next to the street cabinet, which are not related to the SMP parties. There may be, for example, the need for a permission from the local authority for the enlargement or duplication of street cabinets.

Equipment operated by the alternative operator next to the street cabinet of any SMP-party (similar to distant colocation)

Since space in street cabinets is scarce, it may well be that alternative operators cannot install their equipment in the same street cabinet as the SMP-party, but only in his own street cabinet within close by. However, this may be insurmountable when there is simply not enough space within the vicinity of the street cabinet of the SMP-party. Furthermore, for the surrounding inhabitants and municipalities, several street cabinets next to each other are not attractive or acceptable (according to municipal policies) and therefore this may lead to the denial of the requests to install other street cabinet(s).

Equipment operated by the alternative operators inside the street cabinet of any SMP-party

Another solution might be the alternative operators and the SMP-party sharing a new (or upgraded) street cabinet. This requires explicit transparency of both the SMP-party and the alternative operators about what space and facilities they actually need in the street cabinet to deliver xDSL services. In that case, the SMP-party can take all the needs of the interested parties (including itself) into account and make an efficient design (or upgrade) of the street cabinet and some efficiency can also be reached by sharing some facilities, including the splitter. In some Member States it is common practice that the alternative operator has its own splitter in the (LLU) colocation room. In case of colocation at the street cabinet, a shared splitter facility is more obvious.

NRAs should facilitate the discussions between market players to seek sensible solutions satisfying the requirements of all operators who want to be present at the street cabinet rather than allowing the SMP-party to unilaterally create facts that cannot be undone easily afterwards. In case that no commercial agreement is found, NRAs will have to intervene with formal regulation.

Roll-out procedure (individual or combined)

Another potential barrier to the deployment of competing infrastructures at the cabinet will be the issue of timing. It will be easier for any SMP-party to design its network architecture to account for the requirements of third party providers (including co-location space etc) at the time of initial deployment. The dilemma is whether it is reasonable to oblige the SMP-party to reserve some (scarce) space and facilities in its own street cabinets, which might not even be used in the future, a rather inefficient investment in that case. However, the SMP-party should have a procedure for providers who wish to roll-out at a later or earlier moment in time. This means that probably the delivery times of co-location at a later stage will be longer than when co-location is ordered at approximately the same time as the SMP-party installs their equipment.

The alternatives would be to oblige an SMP-party to provide additional space after the deployment, or for competitors to locate equipment in new cabinets near to any SMP-party's cabinets. However, these alternatives may incur additional costs, either for the SMP-party or the competitors.

An additional challenge for regulators and SMP-parties is to manage potentially diverse geographic requests for access to existing infrastructure. Attempting to meet all demand for access to infrastructure by several competitors may place significant resource constraints on SMP-parties. This situation is analogous to that of some Member States where initial requests for LLU outstripped the SMP-parties ability to unbundle exchanges in the short term. Whilst regulators should be aware of this potential barrier to early unbundling, they should also take into account potential strategic deployment plans of SMP-parties that may seek to either prioritise their own deployments above competitors, or else allow competitors access in the short term to infrastructure locations that are less commercially attractive.

Colocation costs and allocation principles

As Analysys pointed out in its study for the Netherlands, the costs for colocation and SLU influences the question whether there is a business case for SLU. The cost allocation principles are a key element in the evaluation of (regulated) SLU tariffs. For example, it makes a huge difference whether the alternative operator has to pay for all the new street cabinet or just for the space and facilities that it actually uses (lease/share). Another example is the difference between dividing the costs between the operators present at a certain location or between the lines that the different operators have connected. Another difficulty might be that there are no realistic forecasts yet as the service did not exist before.

Considering the limited space available for colocation inside the street cabinet of an SMP-party, the need to develop allocation principles is obvious. The following situations need to be distinguished: Colocation inside the street cabinet of an SMP party; if colocation cannot take place inside the street cabinet, each competitor can either install its *own* street cabinet (next to the street cabinet of an incumbent) or competitors *share* a street cabinet (next to an incumbent's street cabinet). It needs to be carefully analysed which equipment (see paragraph on "colocation at the street cabinet" above) is actually shared. Moreover, the question of cost allocation is closely related to the roll-out procedure (see above) and the question how scarce space is allocated.

4.3.1.2 Backhaul

Alternative operators need a backhaul link to connect their equipment in the street cabinets to their own transport networks. There are several ways to realise this backhaul. Though it may not be economically viable to roll-out an entire backhaul network, an alternative operator could opt for installing its own backhaul connection to certain street cabinets. In that case (and for a new street cabinet) it might be desirable that the alternative operator and the SMP-party build their backhaul connection at the same time, for the obvious reason to avoid inconvenience by opening up the ground twice or more (also, this might not be acceptable by the municipalities).

Based on the conclusions of current studies study it can be said that it may be very difficult for an alternative operator to provide backhaul to (all) street cabinets by himself unless duct-sharing is available.

4.3.2 Wholesale products in the access/backhaul infrastructure: possible modifications with regard to Market 11 and Market 12

The plans of SMP-parties in some Member States do have consequences for the wholesale products LLU and Wholesale Broadband Access (WBA). Furthermore, it requires the NRAs to look more into other possible wholesale products such as SLU and Backhaul (e.g. wholesale leased lines). In this section the consequences for the different wholesale products will be described.

4.3.2.1 Unbundling of the Local Loop (Market 11)

LLU (Market 11)

Currently, a few SMP parties have plans to roll-out fibre to the street cabinet nationwide and, with one exception, have not explicitly announced that they will phase out the MDFs. However, in those areas where SMP-parties will roll-out fibre to the street cabinet, ERG believes that the coexistence of different network infrastructures will not last indefinitely. Hence, there will be consequences for LLU providers who are colocated at MDFs that will be reconfigured or phased out. It could also be the case that the copper infrastructure remains where it is, but that the customer configuration is changed, as the SMP-party's DSLAMs are moved to the street cabinets.

In the first case (reconfiguration) there is the question whether the DSL product which is provided from the street cabinet will disturb the DSL product which is provided from the CO (spectral management issues).[73]

In the case of a SMP-party who plans to phase out MDFs where alternative operators are colocated, the question is whether the SMP-party is allowed to do it, given the current obligation to provide LLU. A balance has to be found between the commercial freedom of the SMP-party to develop its networks and the objectives of the NRA to promote competition, which – depending on national circumstances – may also require a continuation of LLU at the MDF. A way to find this balance is to define a proper migration path and to set conditions under which the SMP-party is allowed to phase out its MDFs. These conditions could e.g. comply with the period between the announcement and the actual phasing out.

73 For a possible coexistence of ADSL from MDF and VDSL from street cabinet, a VDSL2 solution with (spectrum) mask shaping might address the problem (e.g. recently, Belgacom have taken the engagement to deploy VDSL2 only with mask shaping and the alternative operators have agreed to this solution).

Sub-loop unbundling

In all Member States, Sub-loop unbundling is part of Market 11 as defined in the Recommendation, which implies that there is an access obligation to provide sub loop unbundling. However, in the past years NRAs have experienced a lack of interest for alternative providers to invest in these solutions. With the roll-out of fibre to the street cabinet SLU may become more important in the future.

"Shortened" LLU

There is a need to also unbundle the shortened local loop which ends at the cabinet (See Figure 2 in Chapter2). This requires colocation at the street cabinet for those competitors intending to further roll out their infrastructure closer to the end-customer. In that case, backhaul services stretch from the cabinet to the next node.

Colocation

Being SLU part of Market 11 as defined in the Recommendation, there should be an obligation to provide colocation as an ancillary service to the unbundling of the sub-loop to allow the alternative operator to make (full) use of the sub-loop. However, there are several constraints to be taken into account when defining this "service", e.g., do the current SMP-party's street cabinets have (space and technical) conditions to hold the alternative operators' equipments? Will it be possible to use external colocation (e.g. and get municipal permissions for installing multiple equipments)?

If colocation is possible and mandated inside the street cabinet, the facility sharing conditions must be defined, at least for the (space for) DSLAM, splitters and power supply (remote feeding and batteries), cable grid and tie cabling.

4.3.2.2 Backhaul / Duct sharing

Based on the conclusions of current studies it can be said that it may be very difficult for an alternative operator to provide backhaul to (all) street cabinets by himself. Therefore, it may be necessary to oblige the SMP-party in the relevant market to provide SDF-backhaul and/or duct sharing.

When assessing the need to impose an obligation to provide backhaul services, proportionality requires looking also at commercial backhaul offers. SDF-backhaul can be provided in different manners: at physical level (e.g. dark fibre, wavelength (WDM)) at layer 2/3 level (e.g.Ethernet-based, Leased Lines).

The advantages and disadvantages of the possible options should be weighed by the NRA. The question is whether there is a market which covers SDF-backhaul and what solution or solutions to use. Here are some possibilities:

- Backhaul at physical level could be considered as ancillary Service to Market 11;
- SDF-backhaul at layer 2/3 level could be considered as a wholesale service belonging to Market 12 (as is today in some Member States) or as terminating segment of leased lines (Market 13 of the Recommendation), including possibly Ethernet solutions;
- Finally, one could define a separate market for SDF-backhaul.

Duct sharing could be imposed as an ancillary service to Market 11 (Art. 12 Access Directive).[74]

4.3.2.3 Wholesale Broadband Access (Market 12)

Market 12 does not require a change of the Recommendation as it already comprises, by definition, all kinds of wholesale broadband access products that can be delivered at layer 2 or 3 of the protocol stack.

WBA has so far been seen as a lower step of the ladder of investment than LLU. However, in the case of phasing out MDFs, the importance of LLU as a means to derive competition may decrease compared to WBA, especially if alternative operators are not able to roll-out their networks towards the street cabinets. Therefore, WBA at the core-node, MDF, or even at lower levels, may gain importance. In order to maintain the benefits of infrastructure competition based on LLU, the design of the WBA product might need to be enhanced to allow alternative operators maximum control of quality parameters possible.

Besides that, changes in the SMP-party's network also imply changes of the WBA product. When carrying out the market analysis and the substitutability test, NRA's should consider whether the WBA product in its current design is still appropriate and feasible when the SMP-party implements the changes in its network, considering the corresponding end-user services that alternative operators may want to offer using WBA (e.g. IP TV capabilities).

4.4 Regulatory Challenges in Scenario II: Fibre to the Home / Fibre to the Building

As with FTTCab roll-out, in Member States where one operator, or more, has announced its decision to roll-out FTTH/B, the deployment of a optical local loop may have a significant impact to the existing broadband situation, and thus to the existing broadband regulation.

At first, possible barriers are identified which can be dealt with either by asymmetric regulation on Markets 11 (if appropriately extended to include optical fibre to the ODF of the first aggregation point)[75] and 12 or by symmetric regulation (see below).

4.4.1 Possible barriers

In case the incumbent decides to roll-out FTTH/FTTB, it is most likely structurally advantaged compared to alternative DSL-operators who would also decide to roll-out FTTH/FTTB. Taking into account the deployment of optical fibre to the building or to the end-user's premises (within the building), two main barriers may be identified, one related to the horizontal roll out of optical fibre from the CO to the building, the other one related to the vertical roll out of in-house wiring within the building in order to reach the end-user's premises.

4.4.1.1 "Horizontal" barrier: civil engineering costs

Civil engineering works necessary to the deployment of optical fibre in a FTTH/FTTB scenario, i.e. the digging of trenches so as to roll-out ducts, are estimated to represent the most significant part of the total cost per subscriber (between 50% and 80%, according to the

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74 BNetzA is consulting on a remedies decision with regard to market 11, where duct sharing between the cabinet an MDF is imposed as an ancillary service, published on 4th April, 2007 available under www.bundesnetzagentur.de.

75 See Recommendation. Market 12: "This market covers 'bit-stream' access that permit the transmission of broadband data in both directions and other wholesale access provided over other infrastructures, if and when they offer facilities equivalent to bit-stream access."

density of the area[76]). Hence, outside the most densely populated cities, civil engineering costs could jeopardize the deployment of FTTH/FTTB.

Compared to its competitors, the incumbent is likely to be in a more advantageous position insofar as it owns ducts[77], which can be considered as a crucial asset for fibre deployment. Thus, the civil works' "horizontal" barrier is an even more substantial barrier in the FTTH/FTTB scenario compared to the FTTCab scenario, as the number of buildings to connect is normally much higher than the number of cabinets.

The possibility to have access to existing ducts suitable for fibre deployment could significantly reduce the corresponding costs for new entrants, and thus lower the "horizontal" economic barrier resulting from civil engineering works. Existing ducts could be for example those owned by the incumbent, by other telecommunications-operator, or by public utilities or municipalities (e.g. sewers).

Duct sharing (could) be very significant in lowering entry barriers for operators to deploy new fibre access infrastructure. However sharing existing ducts might rise "difficulties of practical implementation, above all (the evaluation of) available spare capacity (and the) network integrity."

4.4.1.2 "Vertical" barrier: in-house wiring

Property rights arrangements with regard to in-house wiring vary across Member States: In a number of Member States in-house wiring is included in Market 11 and accordingly the obligation to unbundle applies. In other Member States it is unclear whether it is owned by the incumbent or house owners.[78] There are also Member States where in-house wiring is owned by house owners and therefore not included in Market 11.[79]

Within a building, in-house wiring is deployed, between the basement of the building and each flat, normally inside dedicated cable trays. In a FTTH scenario, when an operator reaches a building, it rolls-out point-to-point fibre in the cable trays so as to connect each of the flats with an individual optical loop.

In case several FTTH/FTTB/xDSL operators reach the same building, some problems may arise with parallel in-house wirings, not only because of lack of space (or even lack of dedicated cable trays), but especially because co-ownership property representatives could refuse the roll-out of more than one in-house optical wiring. Moreover, end users could find it not appropriate to have more than one optical socket in their flat.

In case of FTTH, on the basis that only one optical in-house wiring could be rolled out within a building (or considering the cable trays could be already occupied or non-existing, e.g. in old buildings), the in-house wiring represents a structural barrier for all competitors, incumbent included, insofar as there would be a risk that the first operator who reaches a building pre-empts this facility thus preventing its competitors from having access to the end users living in the building. The incumbent might however be in a more advantageous position than its competitors insofar as it can have privileged relationships with co-ownership property representatives due to its former copper local loop monopoly status.

Each competitor which connects to this node – where an ODF or splitter is located – will thus have to rent the point-to-point dedicated fibre linking the end user it wants to reach. This node could be located either at the base of the building (in case of big buildings), or in the

76 Civil engineering (digging trenches and installing subsoil ducts up to buildings if necessary) is the single largest cost item in an FTTH/FTTB network deployment. Source Arcep.

77 Information must be available where the ducts are.

78 E.g. Spain, Austria

79 In Finland all in-house wiring belongs to the house owners and was therefore not included in the definition of market 11 by FICORA. Therefore this section (and all of the following dealing with in-house wiring) does not apply to Finland.

street, higher in its optical loop network so as to mutualise several buildings or houses. The relevant localisation of this point of mutualisation depends essentially on one hand on the architecture chosen by the first operator reaching the area, on the other hand on economic facts (see Chapter 3), considering the density of the area.

In case of FTTB (where in-house wiring consists of copper), the SMP-party could grant access to the copper in-house wiring at the basement of the building. However, in case of coexistence with xDSL, possible perturbations on the existing services provided at the central exchange or at the cabinet would have to be taken into account.[80]

4.4.2 Possible modifications with regard to Market 11 and Market 12

The roll-out of FTTH/B networks may influence existing wholesale products, such as LLU and WBA.

4.4.2.1 Market 11

The definition of Market 11 in the Recommendation may have to be adapted to include fibre loops. Then after carrying out a market analysis according to competition law principles, in case SMP was found in such an "extended" Market 11, NRAs would be able to deal with optical fibre loops and may impose access obligations at different levels, similar as was done with the copper loop.

Regarding Market 11, which in the current draft version of the Recommendation refers to "metallic loop and sub-loop and equivalent", the explicit inclusion of the optical loop in the definition should be considered to accommodate the FFTH/B scenario, so that Market 11 would not in principle be limited to "metallic" loops anymore. In particular, it would still match up with the definition of local loop specified in the Access Directive (see 4.2).

Where market analysis, applying the substitutability test, justifies the inclusion of fibre loops in Market 11 and SMP has been established, offering unbundled access to the optical local loop at a reasonable number of access points, like ODFs, could be mandated. Specific remedies, responding to issues relevant in each national relevant markets, would have however to be applied in order to assure effective unbundling of fibre architectures where possible.

- in case of point-to-point FTTH

  A point-to-point FTTH could be unbundled considering there is one single optical fibre dedicated per end-user between the ODF (where the active equipments are located) and the end-user premises. It would result in that case in the same kind of system which is in place today on the copper local loop.

- in case of point-to-multipoint FTTH (like PON)

  A point-to-multipoint FTTH solution, like PON (which implies passive traffic sharing between several end users), could not be easily unbundled as such between the ODF and the end-user premises.[81] Only the last segment of a PON solution, consisting of point-to-point optical fibre between the last passive optical splitter and the premises of the end user, could be unbundled. There is effectively no technical possibility to retrieve the traffic of one single end user at the level of the feeder without active equipment: in the case of PON, the traffic sharing on the feeder segment implies that

80 Other options for vertical cabling are possible (e.g. Ethernet cabling).

81 But there may be more than one pair of fibre as operators deploy several fibres to allow for an increase in demand.

there is, per passive optical splitter, a bundle – consisting of the splitter, the feeder optical fibre and the active element –, which can not technically be unbundled.

So that new entrants might have access not at the level of the last splitter but at the level of the ODF (e.g. at the CO), considering they don't roll out their own fibres to the last passive optical splitters, it would be necessary to evaluate solutions enabling them to bring their traffic from the splitters to the ODF.

This could, among other remedies, be granted by imposing the SMP operator to provide, as ancillary services, both splitters and dark fibres on the feeder segment. If such remedies are mandated, the SMP operator would have to deploy extra dark fibres on the feeder segment and extra splitters. However, this solution implies that all new entrants asking for access at the level of the ODF need to use the same PON technology as the SMP parties and commit to roll-out their own networks.

To achieve this, the NRA may need to intervene in the SMP-parties' network design of a PON (e.g. number of splitters). This requires a careful assessment of the proportionality of such an intervention, balancing on the one side the commercial freedom of the SMP party and on the other hand the objectives of regulation, mainly to promote and maintain competition. It may be justified on the grounds that otherwise the SMP party would foreclose the market and there is a danger of re-monopolization. However, due to a number of practical difficulties, this scenario – though technically feasible – is not very likely achievable.

- in case of FTTB

  Considering FTTB, imposing unbundling would imply for the SMP operator to grant access to competitors at the "basement" of each building. Actually, only the last segment, consisting of a point-to-point metallic loop between the base of the building and the end-user's premises (in-house vertical wiring) can effectively be unbundled. Availability of ancillary services such as dark fibres would thus have to be mandated also. Colocation at the basement would also need to be available.

4.4.2.2 Market 12

Market 12 does not require a change of the Recommendation as by definition it comprises already now all kinds of wholesale broadband access products. NRAs will assess in their respective market analysis whether these different wholesale products can indeed be considered substitutes also taking into account the corresponding end user service (e.g. IPTV features) that will be provided on the basis of wholesale broadband access. As has been the case for the bitstream markets currently notified after substitutability test have been carried out for the individual markets a characteristic of Market 12 products is likely to remain that the competitor accesses the wholesale service at layer 2 or layer 3 of the protocol stack, in particular:

- DSL-based access, thus including DSL access activated at the CO and possibly at the street cabinet (FTTCab) or even at the building (FTTB)
- FTTH access (whatever the architecture, point-to-point or point-to-multipoint).

Once SMP is found on the wholesale broadband access market, an obligation to provide a wholesale offer for bitstream access delivered at specific multiplexer/switch nodes could be imposed, whatever the technology is. In particular, the SMP operator could be mandated to provide a wholesale bitstream offer for access based on FTTH/FTTB.

4.4.3 Remedies to deal with FTTH/FTTB deployments

Actually, the fundamental nature of Market 11 and Market 12, as defined in the Recommendation, permits the NRA to mandate respectively LLU and bitstream, as remedies to SMP positions. By mandating LLU and bitstream offers, NRAs can grant access to competitors at different levels of the playing field, so as to allow them to climb the ladder of investments.

When applied to FTTH, as described previously, a modification of Market 11 to include optical loops could result in known remedies like unbundling of the optical local loop, once SMP is assessed on this market.

Furthermore, it requires the NRAs to look more into other possible wholesale products or ancillary services such as duct sharing, which may be relevant for the point-to-multipoint PON scenario and shared use of in-house-wiring.

Considering the main horizontal barrier previously identified, which corresponds to the costs of civil works, the sharing of existing ducts, particularly those of the incumbent, could be mandated. National regulators have to be clearly empowered to ensure sharing of ducts. This is the case already under the current framework as the Commission has confirmed in its impact assessment published in June 2006, that NRAs are already entitled to impose access and sharing of facilities like ducts, under article 12 of the Access Directive. This approach (SMP regulation) is described in the section 4.4.3.1.

An additional approach of symmetrical regulation under Art 12 FD may also be considered (See Section 4.4.3.2).

With regard to lowering the “vertical” structural barrier for all competitors, sharing of in-house wiring might be put in place. In case of FTTH, this sharing principle would suppose that any first operator reaching a building grants access for all its competitors at a node consisting of a kind of optical distribution frame, at which level every end user connected is linked in point-to-point optical fibre.

The following reasoning might also apply to the sharing of in-house wiring.

4.4.3.1 Duct sharing as SMP regulation

Under the current framework, two options within SMP regulation could be distinguished:

- Duct sharing could among other remedies be imposed on a widened Market 11, encompassing both the copper and the optical local loop as an ancillary service.
- Definition of a separate relevant market for ducts used for electronic communications could be considered by an NRA, if such a market fulfils the 3-criteria test and as a direct remedy to a SMP position on this market, sharing of ducts could be mandated.

4.4.3.2 Duct sharing as symmetrical regulation (Art. 12 FD)

A few Member States have specific national laws, allowing NRAs to impose duct sharing under this legal basis. However, the vast majority has to rely on the regulatory framework.

Under Art. 12 FD, NRAs must “encourage” the sharing of facilities or property. It also states that when undertakings are deprived of access to viable alternatives, Member States “may” impose the sharing of facilities or property on an operator. NRAs have to individually assess the most viable alternative

It would be beneficial to clarify and strengthen the legal powers of the NRAs stemming from Art.12 AD and Art.12 FD of the existing framework to facilitate duct sharing, where this is practical and justified.

It could thus be considered to improve the framework, by explicitly setting up symmetrical rules for facilities sharing for any operators that require it, as it is already the case for interconnection. Therefore, Art 12 FD could be modified in order to:

- impose a symmetrical obligation to any electronic communications operator to negotiate sharing of facilities under reasonable requests from another operator, and allow operators to bring any refusal for sharing of facilities before the relevant NRA for settlement of disputes;
- allow Member States to intervene in particular for promoting fair competition, and in this context to impose the setting up of extra facilities.

NRAs may also look into other possible wholesale products or ancillary services such as duct sharing, which may be particularly relevant for the point-to-multipoint PON scenario. Taking into account that effective roll-out of FTTH/FTTB networks has already begun in some of the Member States a two-step approach seems adequate:

1. As a first step under the SMP framework duct sharing could be imposed as an ancillary service on a widened market 11 (including the fibre and copper loop) or alternatively as a direct remedy to an SMP position on a separate relevant market of ducts used for electronic communications services, if such a market fulfils the 3-criteria test.
2. As a second step, modifying Art 12 FD could further strengthen the powers of national regulators with regard to the sharing of ducts. Furthermore, a strengthened Art 12 might also be applicable to impose the sharing of in-house wiring.

4.5 How will the ladder of investment look like in an NGA environment?

The ladder of infrastructure investment is a regulatory model[82,83] which was developed among others by Prof. Martin Cave.[84] It assumes that investments are made in a step by step way by new entrants. In order to allow new entrants to gradually (incrementally) invest in own infrastructure they need a chain of (complementary) access products to acquire a customer base by offering their own services to end users based on (mandated) wholesale access. Once they have gained a critical mass generating revenues to finance the investment, they will deploy their own infrastructure[85] taking them "progressively closer to the customer and increasingly able to differentiate their service from that of the incumbent"[86], also making them less dependent of the incumbent's infrastructure. This involves migration from one access product (or access point) to another (moving to the next rung). Thus "the entrant passes progressively through several stages of infrastructure competition, as it ascends a "ladder of infrastructure"[87], the initial phase being service competition, which can therefore be seen as a *vehicle* to infrastructure competition[88,89], which is the ultimate aim as

82 For a more extensive description of the ladder concept cf. to the ERG Remedies CP (ERG (06) 33), in particular section 4.2.3 and the ERG Updated Broadband market competition Report (ERG (05) 23rev2), Ch. 3, all available at www.erg.eu.int.

83 Cf. ERG Updated Broadband market competition Report (ERG (05) 23rev2), p. 31.

84 E.g. Cave, The Economics of Wholesale Broadband Access, Proceedings of the RegTP Workshop on Bitstream Access – Bonn – 30 June 2003, MMR-Beilage 10/2003. Recently Cave expressed himself more critically in 2 papers prepared for KPN and DT.

85 Cf. ERG Common Position on Remedies, p. 68.

86 Cave, Remedies for Broadband Services, Study for the Commission, Sept. 2003, available at http://europa.eu.int/information_society/topics/ecomm/useful_information/library/studies_ext_consult/index_en.htm#2003, p. 20.

87 Ibid. p.10.

88 Cf. ERG Common Position on Remedies (ERG(06)33), p. 68.

it ensures sustainable competition in the long run. Once the process gets started and provided the right regulatory measures are taken (see next paragraph), the process will get its own dynamic and with the different elements reinforcing each other will become self-propelling[90].

Given the increasing importance of scale in the deployment of NGA networks and the new technologies that can be used to deliver innovative services, we may witness a shift of the enduring economic bottlenecks. This may result in a change of the most suitable access point(s) for the promotion of competition. These effects of NGA deployment on the current regulatory environment will need to be assessed by NRAs taking account of national circumstances. The level in the network where regulatory remedies could be applied to NGA networks may differ substantially from the current copper-based generation broadband access network.

As operators move to NGA networks, it is likely that the most effective strategy for NGA deployment will utilise a mixture of technologies to deliver these services depending on specific local characteristics (e.g. including copper local loop and sub-loop lengths, customer density and dispersion, presence of multi-dwelling units, the quality and topology of existing network architecture, in particular the number of street cabinets per MDF). As a result, the economics of NGA networks are likely to vary across different technologies and different geographies. Therefore we may expect the deepest level of efficient infrastructure investment to vary across Member States and within regions of Member States.

This requires a number of different wholesale products on different rungs of the ladder to complement each other.

However, the principle of promoting competition at the deepest level in the network where it is likely to be effective and sustainable is still appropriate for the regulation of enduring economic bottlenecks in NGA networks. Where it is practically and economically feasible to promote infrastructure based competition, this should be the aim of NRAs.

Unbundling of the local loop is assumed to take place at the MDF. In case of sub-loop unbundling, it takes place at the street cabinet. Currently this form is not used extensively. This further step could be inserted in the ladder in the following way (Figure 12).[91]

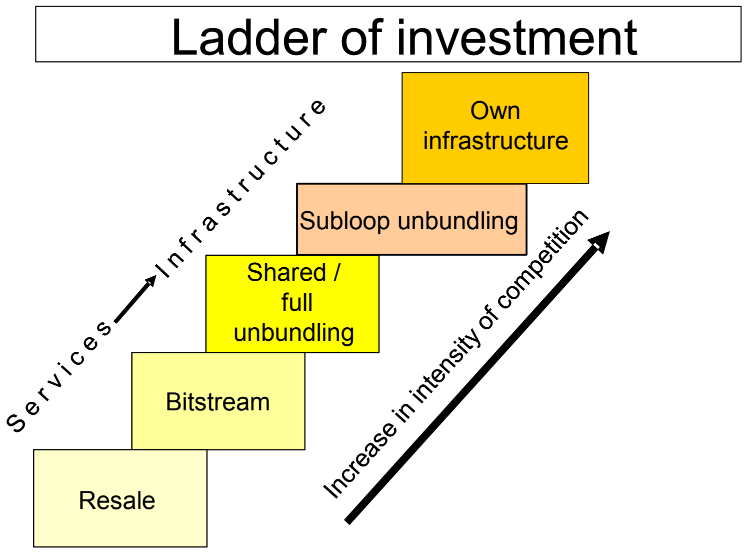

Figure 12: Ladder of investment

89 This does not imply a complete duplication of the access network, thus only *efficient* investment shall be encouraged to promote infrastructure competition.

90 Allowing ultimately to remove regulation.

91 Cf. ERG Updated Broadband market competition Report, p. 37 (Diagram 5.a).

The inclusion of the two scenarios of fibre roll-out analysed in this paper – FTTCab and FTTB/H – in the ladder of investment, would lead to the following result (Figure 13). In the FTTCab scenario, the alternative operator would unbundle at the street cabinet and a complementary backhaul service is needed. In the FTTH/B scenario, the operators would roll-out fibre up to the building or house (own infrastructure level). This move could also be made in the FTTCab scenario in a second step (dotted arrow).

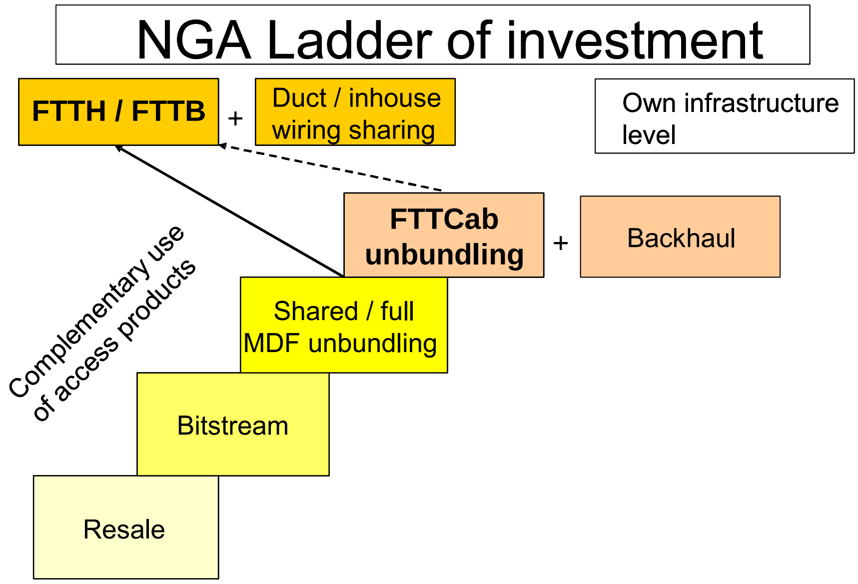

Figure 13: Ladder of investment in the context of NGA

Being confronted with at reconfiguring or phasing out of the SMP operators MDFs in the FTTCab Scenario, the alternative operator can either climb up on the ladder, by further investing to access the street cabinet, or remain at the MDF or the closest aggregation node and use Wholesale Broadband access.

WBA has so far been seen as a lower step of the ladder of investment than LLU. However, in the case of phasing out MDFs, the importance of LLU as a means to derive competition may decrease compared to WBA, especially if alternative operators are not able to roll-out their networks towards the street cabinets. Therefore, WBA at the core-node, MDF, or even at lower levels, may gain importance. In order to maintain the benefits of infrastructure competition based on LLU, the design of the WBA product might need to be enhanced to allow alternative operators maximum control of quality parameters possible.

5 Conclusions

This paper has focused on wireline NGA implementation issues and related regulatory implications, as current upgrades of copper and fibre access networks being carried out in a number of Member States[92] have become a key challenge for regulatory authorities recently.

In general knowledge of plans for NGA roll-out is limited. In several countries incumbents plan to roll out fibre to the cabinet with copper being used for the last mile. Also FTTB/H roll out is considered. Country case studies show a large variety of network rollout strategies across Europe. To date, limited knowledge of NGA rollout plans. Information on rollout strategies of incumbents is crucial for managing transition process

For the purpose of this paper, two broad scenarios, one being called FTTCab and the other one FTTH/FTTB, have been defined (and described in Chapter 2):

- **Fibre to the cabinet**, which consists of a hybrid solution with DSL technology and fibre going to the street cabinet and copper between the street cabinet and the end-user.
- **Fibre to the home** which is a fully optical solution going to the end-user premises. Fibre to the building is included in this scenario even though, technically, has to be considered a hybrid solution.

Economics of NGA

As operators move to NGA networks, it is likely that the most effective strategy for NGA deployment will utilise a mixture of technologies to deliver these services depending on a number of parameters and specific local characteristics, including

- copper local loop and sub-loop lengths;
- customer density and dispersion;
- presence of multi-dwelling units, and
- the quality and topology of existing network architecture, in particular the number of street cabinets per MDF.

As a result, the economics of NGA networks are likely to vary across different technologies and different geographies, i.e. between Member States and even within Member States.

An increase in costs per line/user can be seen – as operators deploy fibre closer to the customer's premises, with higher costs associated with fibre deployment (including civil engineering) – due to a lower number of end customers per node. Therefore, the average costs of provision are likely to increase compared to the "classical" roll-out of a (fibre) network to the MDF. The viability of the business case also depends on the demand side and the additional ARPU that can be attained by offering customers innovative services.

NGA investments are likely to reinforce the importance of scale and scope economies, thereby reducing the degree of replicability, potentially leading to an enduring economic bottleneck. Given that next generation access networks may be more likely to reinforce rather than fundamentally change the economics of local access networks, NGA may be likely to, at least, provide the same competition challenges to regulators as current generation wireline access networks.

92 E.g., with the deployment of IP DSLAM, utilizing the copper line with xDSL technologies in combination with PONs to directly reach the street cabinet or the building via passive fibre architectures. More aggressive strategies opt for the deployment of fibre connections directly to the end customer's homes or offices, already happening in some MS as well.

Implications for regulation

Some *general* proposals have been developed as to how the Recommendation and the ECNS Regulatory Framework may be adjusted to cope with the regulatory challenges growing out of the different fibre deployment scenarios. For the market definition and analysis, the legislation foresees a competition law analysis based on economic criteria. Also, in case of imposing obligations on a SMP operator rolling-out NGA, the overall "package" of existing and additional (or amended) remedies must be proportional in order to avoid overregulation.

Implications for Markets 11

- Stranding problems with regard to traditional LLU at the MDF may occur in view of changing infrastructure which may include reconfiguration or phasing out of MDFs: a balance has to be found between the commercial freedom of the SMP-party to develop its networks and services and the objectives of the NRAs to promote competition, e.g. by setting conditions under which the SMP-party is allowed to phase out its MDFs.
- With the introduction of NGA, the former definition of local loop could be adapted to include both Scenarios, i.e. FTTCab as well as FTTB/FTTH :
  - FTTCab - the local loop consists of the copper line from the cabinet to the home;
  - FTTB - the local loop consists of the copper line from the building entrance (where fibre ends) to the end-user premises;
  - FTTH - the local loop would simply be constituted by optical fibre from the ODF to the end-user (home).
    - in point-to-point solutions, it may be possible to unbundle the local loop in a manner very similar to that used today for copper – full LLU of the loop is applied from the ODF;
    - in a point-to-multipoint solution (shared infrastructure topology, such as PON), it is no longer easily possible to associate a single physical element of connectivity with a particular end-user. In this situation, options for unbundling become more challenging – unbundling of the subscriber fibre loop could be done at the passive optical splitter level, where the dedicated end-user fibre is connected to the shared fibre (connecting the splitter and the ODF).
- In all these unbundling scenarios, independent of the technology adopted and according to the definition of the AD definition the alternative operator gets access at the physical level of the transmission medium (layer 1), be it a copper or fibre loop or a frequency band/wavelength within the loop.
- A local loop can thus be defined as a dedicated line between the NTP at the end-user's premises and the distribution frame at the first aggregation point. This is in line with Art 1 lit. e AD, where the "local loop" is defined as the physical circuit connecting the network termination point at the subscriber's premises to the main distribution frame or equivalent facility in the fixed public telephone network.
- The FTTCab and the FTTH/FTTB scenarios imply different regulatory challenges. Unbundling may not solve the access problem in the same manner as it did in traditional copper networks. However, to foster effective competition, additional or other remedies may have to be identified and applied in order to adapt regulation to further challenges.

Implications for Market 12

- Market 12, as defined in the Recommendation already comprises all kinds of wholesale broadband access products. Therefore no change is required.
- Bitstream offers on FTTx architecture can provide the same type of services using Ethernet at the access plus backhauling to Ethernet switches at different levels or the IP level. Ethernet services allow more features such native multicast (e.g. of TV channels).
- Bitstream access at MDF may become more important.
- A characteristic of Market 12 products is likely to remain that the competitor accesses the wholesale service at layer 2 or layer 3 of the communication protocol stack, which consists of a well defined stream allocated by the incumbent (a VP/VC in ATM scenario or a VLAN in a Ethernet scenario).
- When carrying out a substitutability test between Markets 11 and 12, a relevant factor is that bitstream access by the competitor at layers 2/3 reduces the freedom of the competitor to control quality parameters, compared to the LLU case, where the authorized operator gets access to the physical line (layer 1 access).

FTTCab: Wholesale access products

- The main barriers are
  - Colocation at the street cabinet;
  - Backhaul between the Street Cabinet and the operators' networks.
- Therefore the following adjustments to wholesale access products may be required:
  - Street cabinet unbundling may become more important: Sub-loop Unbundling being part of Market 11 implies an access obligation to provide it in all Member States;
  - Unbundling the local loop ending at the street cabinet implies the need for colocation in the street cabinet. Colocation could be imposed as an ancillary service obligation to SLU, provided it is technically feasible taking into account the relevant constraints;
  - Complementary products such as backhaul services in the middle mile from the cabinet to the operator's node and/or duct sharing are necessary.
  - Backhaul could be considered:
    - as an ancillary service to Market 11 to the shortened local loop or SLU;
    - as a wholesale terminating segment of leased lines (Market 13);
    - or a separate backhaul market could be defined.
  - Duct sharing could be imposed as an ancillary service to Market 11.
  - Wholesale bitstream offers (Market 12) may have to be enhanced to allow for the provision of high quality services and adapted to changes in the SMP party's network.

FTTH/FTTB: Wholesale access products

- The main barriers for FTTH/FTTB deployment are:
  - Civil engineering cost (horizontal barrier), and

  - o In-house wiring (vertical barrier).

- Fibre has to be included in Market 11 in order to allow the imposition of an obligation to unbundle the optical local loop (if SMP has been assessed in this market). This requires a change of the Recommendation but is in line with the definition of the AD.
- NRAa may also look into other possible wholesale products or ancillary services such as duct sharing, which may be relevant for the point-to-multipoint PON scenario
  - o Under the SMP framework an ancillary service on a widened Market 11 (including fibre loops) or alternatively a separate market for ducts used for telecommunications services;
  - o Symmetric regulation to be imposed on all operators based on Article 12 FD could be strengthened, to ease facility sharing including e.g.
    - An obligation to negotiate sharing of facilities under reasonable requests;
    - A settlement procedures before NRA in case of refusal;
    - allowing MS to intervene in particular for promoting fair competition;
    - imposing the setting up of extra facilities.

Ladder of investment

- Given the increasing importance of scale in the deployment of NGA networks and the new technologies that can be used to deliver these innovative services, we may witness a shift of the enduring economic bottlenecks, possibly resulting in a change of the most suitable access point(s) for the promotion of competition. The level in the network where regulatory remedies could be applied to NGA networks may differ substantially from the current copper-based generation broadband access network, as the economics of NGA networks are likely to vary across different technologies and different geographies and Member States.
- These effects of NGA deployment on the current regulatory environment will need to be assessed by NRAs taking account of national circumstances. Therefore a number of different wholesale products on different rungs of the ladder are required to complement each other.
- However, the principle of promoting competition at the deepest level in the network where it is likely to be effective and sustainable is still appropriate for the regulation of enduring economic bottlenecks in NGA networks. Where it is practically and economically feasible to promote infrastructure based competition, this should be the aim of NRAs. In those instances where replication of access is not considered feasible, promoting service competition is an important goal for the NRA.
- Investing further requires complimentary backhaul and/or duct sharing products.
- Being confronted with reconfiguring or phasing out of the SMP operators' MDFs in the FTTCab Scenario, the alternative operator can either climb up on the ladder, by further investing to access the street cabinet, or remain at the MDF or the closest aggregation node and use Wholesale Broadband access.
- In the case of phasing out MDF access, the importance of LLU as a means to derive competition may decrease compared to WBA, especially if alternative operators are not able to roll-out their networks towards the street cabinets. Therefore, WBA at the core-node, DSLAM, or even at lower levels, may gain importance. In order to maintain the benefits of infrastructure competition based on LLU, the design of the WBA product might need to be enhanced to allow alternative operators maximum control of quality parameters possible.

- In the FTTH/B scenario, the operators would roll-out fibre up to the building or house (own infrastructure level).

It is important that infrastructure and service competition are not seen as opposed to each other, but are linked through the ladder of investment allowing competitors, through a sequence of regulated access products that are consistently priced to invest in a step-by-step manner in own infrastructure. Service competition based on regulated access at cost-oriented prices can be (and in general is) a vehicle for long term infrastructure competition. Therefore, regulators should impose remedies that enable the new entrants to reach a point of the investment ladder which makes economic sense and which tends to maximize the extent of economically efficient competing infrastructure.

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Annex 1: Fact Finding[93]

i. Time scale for NGN development

Q1 Will NGNs be implemented at the same time for the core and access networks or one after the other?

NRA answers:

Most countries state that the implementation of NGNs begins/ has begun in the core and continues in the access networks (CH, FI, FR, GE, IT, NL, NO, PT)

PT mentions that some competitors are investing both in new core (IP/MPLS) and ADSL (IP-based) access networks at the same, as they build their dual/triple-play offers aiming at national coverage. UK also refers to parallel implementation.

RO assumes that NGN core network will be implemented *after* implantation of access network.

No specific information on this issues are available in AT, BE, GR, ES.

Stakeholder answers:

According to ECCA most non-incumbent operators will first establish core networks with NGN capabilities based on IP.

ECTA argues that in most jurisdictions, there is no clear correlation between NGN core and NGA implementation plans. Some incumbent operators progress the IP core part (eg BT, FT, Telefonica), others focus on NGA first with traffic conveyance over a legacy IP network (eg Belgacom, TDC, DT).

According to ETP the sequence of developing the functions core, access and service control, depends on obsolescence of existing infrastructure, competitive pressures, willingness to bring new services to the market.

ii. Economic and Regulatory Aspects with regard to NGN

Q17 What are the relevant bottlenecks (non-replicable assets) in NGNs possibly preventing competition?

NRA answers:

The access network is commonly perceived as the main relevant bottleneck (GR, CH, NL, NO, FI, GE, IT). AU mentions that information on NGN deployment plans is not mature enough to draw conclusions on possible bottlenecks. However, when incumbent extends the reach of its fibre network, alternative operators' investment in colocation and unbundling at MDFs may become stranded, when. Furthermore, alternative operators may be faced with huge investments when they have to connect to a large number of GDFs (Greenfield Distribution Frames or Street Cabinets) in order to compete with the incumbent.

93 Questionaire sent by PT-NGN to NRAs on April 3, 2006, distributed to stakeholder associations on May 24, 2006. Answers from NRAs and Stakeholders received by end of April 2006 respectively July 7, 2006.

Stakeholder answers:

ETP refers to the last sentences in the last paragraph of section 3.2 of the ETP report read: *"Although bottlenecks might emerge, it is too early to determine where and if they really will become an obstacle to a competitive market. General competition law may be sufficient to deal with these cases."*

EuroISPA and ECTA on the other hand do identify several bottlenecks.

According to EuroISPA in general relevant bottlenecks are ducts, street boxes, local authority permissions for street boxes and, fundamentally, the economics of replicating infrastructure at this level of capillarity. Bottleneck issues will therefore give to the incumbents the opportunity to restart a pre-emption campaign as it happened with the first launch of xDSL services. EuroISPA mentions the situation in DE, where the termination market problems will maintain; as traffic can be handled via Bitstream wholesale products there is a high risk, that incumbents will curb the quality of Bitstream products to harm VoIP as long as they maintain on PSTN; QoS guarantees are needed. Furthermore EuroISPA refers to the Strategic review of Ofcom (UK), in which Ofcom concluded that access to copper was an enduring economic bottleneck. Operators would also state that all the other elements needed for Local Loop Unbundling are enduring bottlenecks – eg equipment housing and backhaul. Backhaul fibre in particular should be made available to third party operators.

ECTA menstions the following bottlenecks:

1. Access is still the key bottleneck regardless of the physical medium used in this part of the network. This will not change following the core network upgrade. For access networks, increasingly, fibre will replace copper and therefore NRAs will need to adjust remedies accordingly. For example, Ofcom and many other NRAs are currently pursuing LLU as the solution to the access bottleneck, but this may not be future-proof.
2. In the event that there is volume-based pricing, another bottleneck may develop in backhaul services (the “middle mile”). Since NGNs allow all traffic to be carried over a single network, they accentuate the economies of scale and scope inherent in transmission networks. Since incumbents generally carry more traffic across a wider variety of markets, they will tend to benefit more from this phenomenon than altnets. Perversely, this increased potential for scale based cost savings may create non-replicability (i.e. a natural monopoly) in NGN backhaul;
3. Bottlenecks may start to build over access to the intelligence and user-information contained in the NGN; sometimes referred to as Network Hooks. An example of this would be gaining access to location data which might be essential to the provision of competing services. This also draws attention to the fact that the bottlenecks need not be confined to the incumbent’s network.
4. Possibility for the incumbents to exploit the complexity (deriving from a number of not standardised technologies, all able to deliver the IP services, e.g. VoIP) of the protocols, in order to deny interoperability with alternative networks. With this regard, absent any specific regulation, incumbents could easily exploit networks effect and network externalities.
5. Bottlenecks may develop through the use of proprietary software and application programming interfaces. Use of proprietary standards and application interfaces may impose unnecessary development or software licensing costs on competitors. Once again, this points to the fact that bottlenecks in NGNs may develop in areas beyond the scope of traditional telecoms regulation.

6. In the event that retail markets are deregulated, or if there are insufficient controls against anti-competitive behaviour in these markets there will be a serious risk of foreclosure strategies including bundling and discriminatory pricing (eg free on-net calls), which inhibit the development of competition and allow the incumbent to leverage its dominance as the technologies are upgraded.

Q18 Which competition effects/problems already have gained / will (presumably) gain relevance (leveraging of market power, foreclosure strategies, other) and what are conceivable strategies for NRAs to cope with these problems?

NRA answers:

For most NRA's it is too early to comment on current effects, since in most countries NGN is in a too early stage. NL is facing uncertainty in the market with consequently delay of LLU-investments by OLO's till NGN-plans by incumbent are worked out and communicated. GR noticed a possible hindrance in competition based on LLU, with possible leverage of market power from the wholesale access markets to the wholesale transmission markets. Both NL and GR understand the importance of promoting/facilitating the introduction of alternative wholesale access products.

Stakeholder answers:

According to ECTA clearly a pro-active approach is needed by NRAs to tackle potential issues arising from the previously identified bottlenecks. Other problems may be caused by the actual migration to NGNs. In the UK, as the 21CN project is run by and for the incumbent, there is potential for abuse and the establishment of unfair advantage. No serious issues have yet been escalated to Ofcom for resolution but there are numerous examples of practices that have been challenged by altnets; e.g. the communications strategy being adopted by BT to inform end customers of the migration plans. Altnets are concerned that BT may use this as a mechanism to market its new services to the customers of its competitors.

Foreclosure Strategy leveraging and all kind of bundling of servcices will become more and more important. Telekom Austria announced its (new) strategy to bundle all ressources available in its new holding structure in order to achieve the best possible synergies from broadband, fixed line and mobile services.[94]

EuroISPA also foresees leveraging problems for IP-TV services that eg. the Italian incumbent is going to offer. Interconnection and Access issues should be regulated by NRAs as soon as possible to prevent leverage on market power by SMP operators.

Q9 If the incumbent/the competitors has/have plans to adjust their respective access network: how do these plans look like (e.g. what technologies will be used: VDSL, VDSL2, Fibre, Wireless technologies)?

Current state of NGN access implementation (e.g. investments made, degree of realization of investments planned, choice of suppliers, geographic limitations)?

- **Public announcements, time tables, publications?**
- **For how long will there be parallel operation of copper line and fibre based networks?**

94 For a more detailed discussion of these issues, ECTA refers to the white paper on this subject prepared by ECTA.

NRA answers:

Since most operators implement the NGN core network first, adjustments in the access network are in most countries limited to plans. In most of the countries the incumbent plans to roll out fibre closer to the premises, but still using the existing copper lines for the "last mile" (RO, NL, FI, ES, CH, GE). In Finland in some regional area's copper lines may be replaced by fibre or wireless technologies, also depending on the density of the population, and the different incumbent per region. In Spain the incumbent is doing some FttH trials in outskirts of Madrid. In NL the incumbent has publicly announced to connect households in newly built residential area's with fibre from 1-1-2007 onwards.

Investments in xDSL are planned (BE, NL) or being made (FI, IT). In most member states there is no information about investment plans at this stage as yet (RO). Public announcements have been done by few operators, e.g. Elisa Oyj (FI), Swisscom (CH), KPN (NL), DT (GE). The latter two with the more detailed time schedules.

As stated above, in most cases copper lines will only be replaced up to a certain distance to the premises. Not much information is available about parallel operation of copper and fibre. In NL parallel operation is planned during the migration period (3-4 yrs).

In some countries wireless may become one of the alternative options. FI, ES, CH (Sunrise), GE, IT are in different stages towards a wireless access network.

Stakeholder answers:

According to ECTA the broadband debate in most jurisdictions has focused on the technology used (mostly on Fibre alone or, in combination with VDSL). Other technologies – ADSL2+, Wireless Broadband Access – play no more than a niche role.

According to ETP a parallel operation of copper lines and fibre-based networks will be a reality for quite some time. It would be premature to believe that the access network in its entirety will be replaced by, for example, fibre. As a matter of fact, the deployment of Next Generation Access will depend on specific user demand and needs, business cases and the like. ETP believes, therefore, that a heterogeneous environment of access technologies where copper will have its relevance, will persist.

ECTA and EuroISPA describe the developments in some countries.

In the *UK* a variety of access networks exist, including wireless, ADSL, ADSL2+, cable. The majority of access investment is currently in local loop unbundling. BT's efforts in the UK are focussed on its core network. It has undertaken to retain the existing PSTN local access.

In *DE* VDSL will be restricted to the biggest 50 cities. The rest will maintain on ADSL and ADSL 2+. Public announcements made (hybrid FTTC plus VDSL), investment 3bn EUR. but investment announced to financial analysts only around 300 mEUR, implementation started in 10 larger cities.

The incumbent's NGN programmes in Belgium and the Netherlands explicitly include NGN access.

At the end of 2005, Belgacom (*BE*) had equipped 5203 street cabinets with VDSL(1) out of a total +/- 26000 street cabinets in Belgium. There is no information (public or subject to NDA) on which street cabinets have been equipped. Belgacom services based on VDSL(1) launched commercially in November 2004. Belgacom's 2005 investment in infrastructure for the "Broadway" project amounted to €87.4 million (in addition, investment in TV services amounted to €198.4m in 2005).

In March 2006, KPN (*NL*) announced a VDSL(2) roll-out, to be achieved in the 2006-2010 timeframe (pilots in 2006, commercial roll-out 2007-2010). KPN will replace its circuit-switched exchanges and MDF locations with 4 core network locations, 193 metro nodes and fibre (equipped with Ethernet/MPLS) to 28.000 street cabinets. FttH rather than VDSL(2) will be used for Greenfield locations.

Telekom Austria (*AT*) announced in 2005 that they would invest 700 Million Euro in NGN if they were granted regulatory holidays.

In *IT* the incumbent has plans to migrate to VDSL in a couple of years, but is investigating also the EPON technology as a better upgrade for access network. Wireless access (WiFi, GPRS/UMTS) is at the moment implemented and experiments are being carried out with Wi-max at 3,4-3,6 GHz, and in DVB-H at UHF-band. However, copper line is still far dominant over fibre so copper access will probably operate in parallel with fibre for many years.

Q10 How might the incumbent´s plans influence current wholesale access models?

NRA answers:

Since, in most situations, the fibre will be extended closer to the end-user more enhanced products may be provided (higher speeds, diversified services). Access to the incumbent's copper access network requires more investments to reach a smaller customer base. Therefore mostly influenced is the LLU wholesale access. (BE, RO, NL, GR). In CH LLU is not seen as influenced market. WBA is/ will be offered in BE, NL.

According to Norway the new network structure is influencing some wholesale services, in particular interconnection and backhaul transmission.

No information is available on this issue from PO, ES.

Stakeholder answers:

In answer to this question ECTA and EuroISPA describe the developments in some countries.

BE: Belgacom has refused to provide VDSL-based bitstream access (in spite of unequivocal regulatory obligation under 'old regulatory framework' (Royal Decree on Public Networks requires Belgacom to provide bitstream access without distinction between technologies). Discussions in Task Group Spectrum Management (xDSL interference) have led the NRA to require Belgacom to reduce the power output of VDSL(1) to protect other xDSL technologies utilised by altnets (especially SHDSL and ADSL2+).

NL: Since KPN announced the closure of MDF-locations, KPN has proposed co-trenching, sub-loop unbundling and Wholesale Broadband Access as substitutes for MDF access (local loop unbundling). OPTA consultation asked interested parties whether these are considered effective substitutes (closed 20 June 2006 – reactions (mostly in Dutch) available on www.opta.nl).

DE: The impact is expected to be huge, not least as one of the motivations for NGN upgrades is to move to a situation where no access needs to be given to competitors. Possible that DTAG could launch voluntary offer at unattractive terms to pre-empt access obligations

IT: The incumbent has planned to remove in a few years most of the Central Offices (to gain from the real estate business) where altnets today rent space for their equipments and rent the local loop. VDSL modems have to be put into the street boxes that are small to host many operators, rising the difficulty for altnets to gain access to the sub-loop.

UK: There are concerns that if BT rolled out fibre to street cabinets (and ran VDSL technology for example) it may undermine other operators LLU investment as they may not be able to compete for technological reasons, and/or other operators will not have the scope and scale to make similar investments.

Q11 Possibility of alternative wholesale access models (subloop unbundling, access to the multi service access nodes (MSANs), "fibre-sharing"? Economically and technologically viable? Incentives to provide access voluntarily?

NRA answers:

In RO the new network topology allows for access to the "Optical Network Unit" (ONU) of the incumbent, which can be compared to access to the local loop. ANRC is studying possibilities for the incumbent to provide backhaul transmission services, fibre-sharing and duct-sharing as being viable options for access to ONU. In FI and NL subloop unbundling is possible and in AU this is already available. In CH LLU is still regulated even though additional commercial wholesale offerings are possible. PO, ES, BE, GR, UK, GE can not provide information on this issue at this stage, since it all depends on the exact network architecture and technologies used.

Stakeholder answers:

In most cases roll-out to street cabinets is not considered economically viable according to ECTA and EuroISPA. For example in *Germany* whilst there are 7,800 MDF sites (not all of which are viable for competition), there are as many as 300,000 street cabinets. In the *Netherlands* KPN has proposed co-trenching, sub-loop unbundling and Wholesale Broadband Access as substitutes for MDF access (local loop unbundling). OPTA proposed that KPN could offer street cabinet sharing and KPN could offer to sell (not lease) backhaul fibre.

In the *UK* altnets would like to be able to access BT's fibre to build their backhaul networks. Currently operators are reliant almost entirely on the incumbent to provide their backhaul. If the incumbent are using their fibre networks for their own backhaul in their own NGN then they have an unfair advantage. In addition, MSAN access has the potential to undermine LLU investment depending on its pricing.

In Italy the access network is mainly based on incumbent resources. The competition today is based on LLU and a sort of bitstream, but tomorrow when the incumbent will migrate to VDSL and FttH, bitstream will be even more important, because it is going to enable alternative operators that do LLU to provide immediately full geographical coverage where the incumbent has deployed new NGN-based services. Moreover, some incumbent central offices do not have enough physical room to host DSLAMs or other network parts from LLU operators. For these reasons, wholesale offers should give full access to multicast services and local caches; otherwise competitors could not be able to compete on video services and any other kind of multicast or local-cache-based service. Wireless technologies can't compete in bandwidth with copper and fibre.

Annex 2: Country Case Studies

A.2.1 Austria

In Austria no plans regarding the implementation of infrastructure for Next Generation Networks purposes have been officially confirmed by operators so far. However, some indications for developments under way may be worth mentioning.

In [1] Telekom Austria's managing director of platform and technology management, Helmut Leopold, is quoted declaring that the Austrian incumbent is planning a major restructuring of its access network. According to this article, Telekom Austria plans to roll out a fibre-to-the-curb (FTTC) infrastructure in cooperation with various municipalities and utilities. This roll-out supposedly should include the implementation of 20 - 30.000 fibre nodes significantly shortening the copper local loop to 600 - 800 m subsequently allowing the deployment of services with a minimum data rate of about 20 MBit/s. As mentioned above, there is no official confirmation or announcement of Telekom Austria with regard to this issue.

Regarding services to be offered on an NGN access network, Telekom Austria recently launched a triple play product comprising telephony, broadband Internet and TV services [2]. An enhanced access network infrastructure as described above could significantly promote the success of the incumbent's triple play offerings.

Vienna utility operator Wienstrom in recent years performed trials offering fibre-to-the-home (FTTH) services to end customers. Meanwhile, Wienstrom seems to plan a withdrawal from the retail market as they state on their website [3] that they want to concentrate on wholesale services in the future. The Wienstrom FTTH infrastructure should be offered as an open access network to competing service and content providers according to [3]. Other utility operators like Grazer Stadtwerke [4] have begun to offer triple play services based on FTTH infrastructure as well. In addition to retail broadband services, some local operators like Infotech Ried [5] also start to distribute (local) TV services based on their own platform; in parallel, they have developed system solutions for carriers, service providers and wholesale operators [6] to build and operate an IPTV platform based on a multi-access broadband Ethernet network.

[1] Gallagher, R.: Telekom Austria eyes fibre to deal body blow to unbundlers, Telecom Markets - Telecoms and Broadband Network Strategy & Regulation, Issue 530, Informa Telecom and Media, October 3, 2006.

[2] Cp. http://aonDigital.tv, 28.10.2006.

[3] Cp. http://www.blizznet.at, 28.10.2006.

[4] Cp. http://www.24entertainment.at, 30.10.2006.

[5] Cp. http://www.infotech.at, 30.10.2006.

[6] Cp. http://www.ocilion.com, 30.10.2006.

A.2.2 Belgium

The plan to upgrade the Belgacom access network to higher speed is named Broadway. The main objective is to compete against cable TV with iDTV and not to replace all the existing network; at planned term PSTN/ISDN, ADSL and VDSL will coexist.

For the Broadway project (evaluated at 300 million euros), Belgacom is upgrading its access network progressively to a combined copper and fibre optic network**.** This upgrade includes placing additional optical fibre between the local nodes and the distribution frames. Belgacom is planning to run the optical "fibre to the curb" in the major Belgian cities. This Broadway project is first being rolled out in the most densely populated areas. Today appreciatively one third of the street cabinets were equipped with optical fibre.

On 2 November 2004, Belgacom launches the first commercial services of its Broadway project. Through VDSL investments in the network, the Broadway project will make it possible to provide new value added services.

At this date, VDSL was available for data and internet usage: Belgacom VDSL Boost for residential customers and SME's, and Belgacom VDSL Office for large companies.

At the end of 2005, television on ADSL was launched both on ADSL (only one TV channel) and VDSL.

Cable TV have announced the launching of a 100Mbps offer at short term, that is increased the strategic interest of Belgacom for VDSL2.

However VDSL causes degradation at ADSL services; to avoid this, the power transmission of VDSL must be reduced with as consequences the reducing of the downstream capacity. VDSL was thus frozen in waiting VDSL2, and ADSL2+ was launched to extend TV on ADSL coverage during this period. However ASDL2+ permits to receive simultaneously 2 TV channels which is too low in comparison with the cable that can provide all channels together. Generally, it is estimated that at least 3 channels must be available (living, bedroom and recording).

The specific issue at stake is the use of the 1.1 – 2.2. MHz band of the copper network (which is used by both VDSL and ADSL2+), and whether exclusivity should be granted to one xDSL technology (or another) to avoid major signal degradation, and what the effects would be on the development of competition if particular options are chosen.

The BIPT Communication has imposed following deployment rules:

- Belgacom is authorised to roll-out VDSL in the 1.1 – 2.2. MHz band, using ETSI frequency plan 998, and using the DMT (discrete multitone) modulation. The BIPT also expresses its preparedness to consider a flexible frequency plan ("Fx") which would deviate from ETSI frequency plan 998, subject to its explicit approval.

- Belgacom must, however, anticipate in good faith on developments that are considered by the BIPT to be within the realm of the reasonably possible in the future, in particular the possible development and commercialisation by other operators of services based on ADSL2+ and Enhanced SDSL.

- The BIPT reserves the possibility of authorising, in the future, the utilisation of both VDSL and ADSL2+ in the 1.1 – 2.2. MHz band. The BIPT recognises, and states, that this would inevitably require Belgacom to adapt its VDSL-based services, and that Belgacom can choose to do this by reducing the capacity utilised by VDSL (in terms of the utilisation of the copper spectrum) or by ensuring co-existence of VDSL (deployed from street cabinets) and ADSL2+ (deployed from MDF) in terms of power output/signal strength.

It exists also a demand from new entrants to use internal cabling of apartments building to provide VDSL services from DSLAM installed in the basement of the buildings with fibre or leased line access. BIPT has launched a consultation to determine the best way to process such usage; a first consultation about a full unbundling at the level of the building distribution frame has proved that is not feasible (too complex).

VDSL2 is included in markets 11 and 12 in market analysis; backhaul SDH and Ethernet is imposed in market 13 up to the street cabinet.

A2.3 France

Introduction

This document is an overview of the current plans to roll out higher-bandwidth access in France. The main drivers for high capacity requirements are new services such as multi channel TV via digital video broadcasting but also the need to increase the average revenues (ARPU) by offering new services.

This report summarises the main options offered on the French market to face this forecasted capacity issue on the access segment.

DSL development

In the last years, most of operators focused on DSL technology to increase bandwidth access on the existing incumbent copper local loop. Currently ADSL2+ offers up to 24 Mbps downstream and up to 1 Mbps upstream bandwidth. Thanks to the bitrates available with DSL technology, internet service providers have been able to launch their triple play offers at the end of 2003. Currently, from a total broadband market of 11.1 million customers, 10.5 million use DSL and 600 000 use cable.

In DSL technology, bandwidth mainly depends on the length of the copper loop, from the DSLAM to the end user premises; only the end users who are near the MDF can benefit of the higher bandwidths.

This is particularly true with the VDSL2 technology, which has been recently normalised by ETSI, and whose introduction on the French local loop is currently under study. Theoretically, VDSL2 may deliver up to 100 Mbps downstream. However, the effective bandwidth an end user would actually have depends on the length of the copper loop from the DSLAM. For example, if the VDSL2 signal is introduced at the street cabinet (FttCab) or at the bottom of the building (FttB), the average downstream bandwidth could be respectively 30 Mbps or 70 Mbps.

DSL technologies focus the non-replicable copper local loop owned by the incumbent France Telecom. Other solutions do exist to offer very high bandwidth access (higher than 50 Mbps) on alternative networks, such as fibre or coax cable-TV networks. Wireless technologies, like Wi-Fi or Wimax may not be able to follow very high bandwidth demand as many users share their theorical high bandwidth speed.

Regarding coax cable-TV in France, current coverage is 30% of the population (compared with 95% in DSL), mainly in big cities. Numericable, the major national cable company in France (recently merged with the second cable company UPC-Noos) is planning to improve its network in order to offer 50 Mbps access. However, until now, the market is driven mostly by DSL operators.

In the rest of this document, we will focus only on the process towards fibre connections which culmination is fibre to the home (FttH). Optical fibre share is currently less than 1% of the broadband market.

Fibre development

Until now, fibre rolling out of alternative operators and local authorities were concentrated at the backhaul level in order to link unbundled MDFs. For business customers operators have deployed MAN in the main cities (Paris, Lyon, Marseille and Lille) and provide fibre to the office (FttO) access to their major business customers' premises.

Recently, the three main French DSL operators announced plans to roll out FttH networks in Paris and in the main cities.

France Telecom has officially plans to roll out FttH G-PON in Paris and several main cities (Marseille, Lyon, Lille, Toulouse, etc.)

Offers: offer at 50 euros per month for 100 Mbps symmetric

Investment: 280 million over 18 months

Iliad (Free) recently announced (Sept 06) a major programme to rollout Point-to-Point fibre to the home (FttH) in Paris and suburbs; Free wants indeed to shift from a LLU model to an asset-based model. Offers will be launched in spring 2007.

Iliad bought CiteFibre in October 2006. CiteFibre started activities in November 2004 and uses point to point fibre to the home (FttH).

Offers:

- Same price as current DSL triple play offer (30 euros per month) for 100 Mbps down and 50 Mbps up. The point-to-point technology guarantees the whole bandwidth for the unique end-user.
- Fibre rent to alternative operators (negotiated on a commercial basis)
- Objectives: switch to fibre 600 000 from its 2 million existing DSL customers
- Investment: 300 million euros in 2007, 1 billion euros up to 2012

Economy: total cost is 1500 euros per sub; according to financial analysts, an important incentive is the reduction of costs towards France Telecom by switching existing unbundling connections to fibre-owned network.

Neuf Cegetel has also announced recently its FttH plans, investing 300 M€ over 2 years.

Neuf Cegetel bought Erenis in March 2007. Erenis started activities in October 2002 and uses fibre to the building (FttB) combined with its own copper loop within the building to reach to the end user premises (with VDSL technology), offering major bandwidth improvement up to 70 Mbps.

UPC/Noos and *Numéricâble*, the main cable operators have recently merged. The operator (9 million plugs) has begun fibre deployments, consisting in reducing the size of the clusters (FttLA). Massive deployments are announced for the forthcoming years (2007-2008).

Offers: 100 Mbps downstream

Investments / economy: about 250 € per plug

Issues related to fibre investments and competition

Costs for fibre implementation remain quite high, as they are concentrated in civil engineering works and wiring inside buildings. Sharing, especially using existing infrastructures (sewer system in Paris ducts) could change considerably the economic equation.

Above all, uncertainty remains regarding additional income generated by a demand for higher bandwidth services available on fibre. The main pay TV competitors have recently merged and the concentration of the content sector decreases the ability of the telco sector to extract value from the contents.

France Telecom has still not made major announcement since the global economy of fibre does not appear obvious to the incumbent. According to financial analysts, building a new local loop has less interest for France Telecom unless it avoids a loss in market share or revenues. France Telecom fibre business model should not also be similar to DSL operators, partially based on costs reduction from unbundling removal. France Telecom could also be in a more defensive situation: the incentive would be a limitation of the market share loss and the wholesale revenue loss associated with an hypothetic massive switch from DSL to alternative fibre networks.

Regarding access to Fttx networks, Iliad announced a wholesale offer for alternative operators. More generally, the technological choice on fibre might affect future unbundling possibilities. Point-to-point fibre connection to the premises seems to enable an easier unbundling than PON connection. The solutions for competition in the latter case would be bitstream or unbundling at the building level. Some incumbents worldwide have already decided to develop PON architecture.

Action of Local Authorities

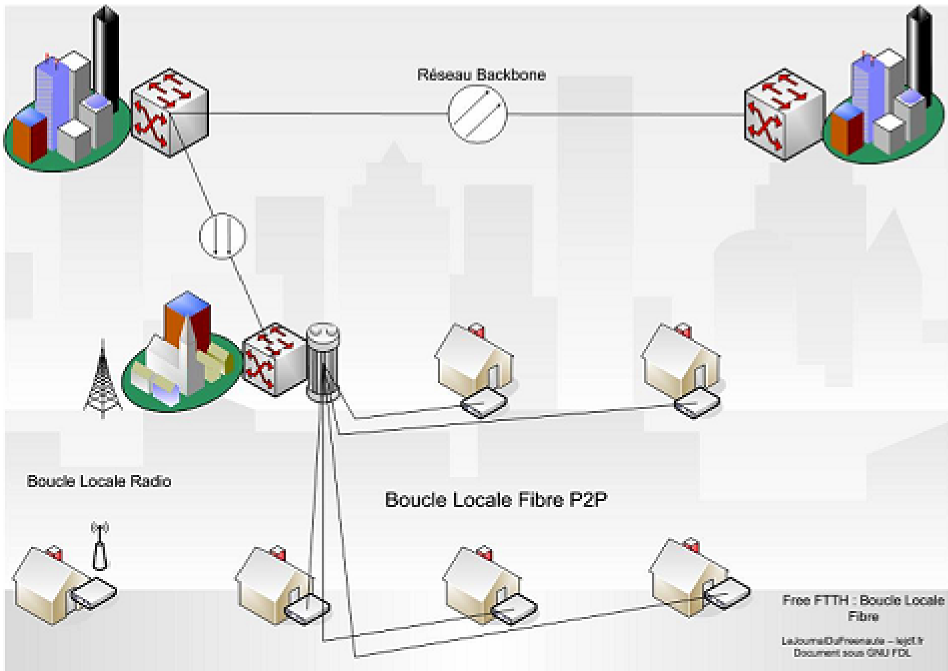
In the past three years, some local authorities launched public initiative backhaul networks projects in areas with lack of private initiative and competition, in order to ease the arrival of alternative operators with local loop unbundling.

Adequate intervention of local authorities is likely to facilitate the rolls-out. Their role of “facilitators” could be decisive:

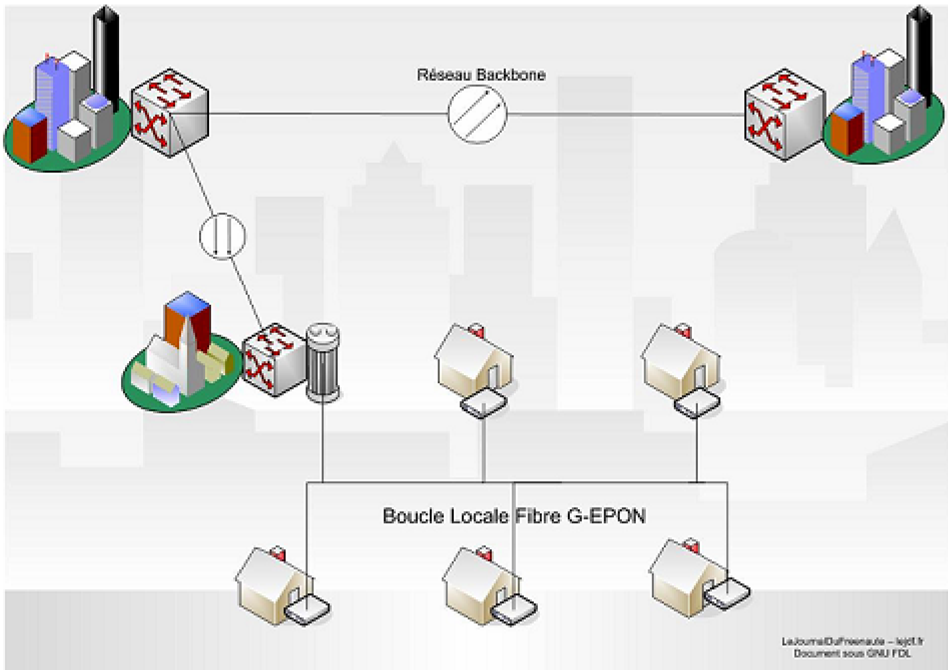
- encourage the sharing of ducts when granting rights of way
- lays ducts and then rent them to operators
- avoid inefficient duplication of basic infrastructures (ducts, even fibre) on reduced geographical areas, which can be shared among operators
- have a lever effect on private investments
- promote the choice of a common optical loop topography by operators
- facilitate negotiations with property owners
- ensure the fair opening of the new optical loop

Fibre technologies

- **Point to Point :**



- **PON**:



Source: http://www.journaldufreenaute.fr

<u>Different types of PON:</u>
APON – ATM PON (155M to 622M) - UIT G.983
BPON - Broadband PON (155M to 1.25G) - UIT G.983
EPON or GE-PON – Ethernet based PON (1.25G) - IEEE 802.3ah
GPON – Gigabit PON (622M to 2.5G) - UIT G.984

Figure A-1: Fibre technologies: Point to Point and PON

A.2.4 Germany

In the following some developments in access networks in Germany are described. First the plans of Deutsche Telekom to deploy VDSL technology in 50 cities and ADSL2+ in 750 cities are illustrated. Subsequently the fibre roll-out of Netcologne, an alternative regional network operator is explained. These projects *might* be summarized under the heading “NGN access network”. A common feature of these developments is the extension of fibre network infrastructures towards the end customer.

BNetzA is consulting on a remedies decision with regard to market 11, where duct sharing between the cabinet an MDF is imposed as an ancillary service.

Deutsche Telekom

In September 2005 Deutsche Telekom announced its plans to extend its fibre infrastructure to the street cabinet in order to offer VDSL products. Deutsche Telekom intends to adopt a two-step approach implementing fibre infrastructure in 10 big German cities[95] in a first step and additional 40 cities in a second step. The investment for the VDSL infrastructure projects amounts to € 3 bill (with € 500 million of these for the first stage of the project).

VDSL offerings require a hybrid infrastructure existing of copper and fibre with copper being used from the subscriber distribution interface to the street cabinet and fibre from the street cabinet to the main distribution frame. Thus, VDSL infrastructure constitutes a fibre to the curb approach. Copper circuits in the distribution cable segment are dedicated whereas fibre circuits in the feeder cable segment are shared between users. DTAG uses VDSL 2 as transmission technology using the frequency spectrum up to 30.000 kHz.

By shortening the copper infrastructure (up to the street cabinet instead of the MDF) it becomes possible to realize transmission speeds of up to 50 mbit/s upstream (5 mbit/s downstream) with VDSL access (for distances of 1.000 m or less from the street cabinet to the customer).

Until end of 2006 DTAG could reach approximately 6 million households in the 10 cities.[96] All together 50 cities shall be deployed with VDSL technology by 2008. Besides this VDSL roll-out Deutsche Telekom envisages to offer ADSL2+ in 750 by the end of 2007. Thereby it is intended to further push IP-TV. Deutsche Telekom plans to have an IP-TV coverage of 17 million homes in 2007, either based on VDSL or ADSL2+ coverage.[97]

In the following, Deutsche Telekom’s triple play products based on this VDSL infrastructure are illustrated:[98]

Deutsche Telekom offers two product bundles *“T-Home Complete Basic”* and *“T-Home Complete Plus”.* Both require a telephone access line (analogue or ISDN). The one-off price for the hardware (media receiver, router, VDSL modem, VDSL splitter) is € 99,95.

95 Berlin, Hamburg, Hannover, Leipzig, Frankfurt , Düsseldorf, Köln, München, Stuttgart, Nürnberg.

96 According to Deutsche Telekom 10.000 km of fibre have been deployed in the feeder segment until June 2006 and 14.000 street cabinets have been upgraded with Outdoor-DSLAMs to enable VDSL.

97 See Deutsche Telekom Presentation Investor’s Day (March 1 2007): http://www.telekom.de/dtag/cms/content/dt/en/24690

98 http://www.t-home.de/c/74/16/97/7416970.html

"T-Home Complete Basic" *or* *"T-Home Complete Plus"*	*"T-Home Complete Basic"* € 19,95 (month) Including: Internet flat rate IP-TV*	*"T-Home Complete Plus"* € 29,95 (month) Including: Internet flat rate IP-TV* Premium TV channels
VDSL access (25 mbit/s) / VDSL access (50 mbit/s)	€ 34,99 / 44,99 (month)	€ 34,99 / 44,99 (month)
Telephone access line (at least an analogue access is required	€ 16,37 (month)	€ 16,37 (month)
Total	€ 71,31 (month) with VDSL 25 € 81,31 (month) with VDSL 50 + € 9,95 (month) for telephony flat	€ 81,26 (month) with VDSL 25 € 91,26 (month) with VDSL 50 + € 9,95 (month) for telephony flat

* IP-TV including e.g. basic TV channels, video recorder function, access to an video library (video on demand)

Netcologne

In July 2006 Netcologne[99] began constructing a fibre to the home network in Cologne. Based on this network Netcologne offers access with up to 100 Mbit/s. Offers are available since December 2006. The first phase of the infrastructure roll-out covers an area in the city of centre of Cologne. It is intended to deploy this network in further parts of the city in 2007 covering approximately 9.000 households and to cover the whole city in the next 5 years with a focus on multi dwelling units and industrial buildings.[100] Netcologne intends to use existing in-house wiring.

Netcologne offers 3 bundles with different access speeds. All bundles comprise a flat rate for telephony and Internet.

- Access up to 10Mbit/s: € 39,90 (month);
- Access up to 50Mbit/s: € 44,90 (month);
- Access up to 100Mbit/s: € 49,90 (month);

Netcologne plans to invest € 250 million over the next 3 threes.[101] Making investments in its own fibre access network enables Netcologne to save charges to Deutsche Telekom for the the local loop. According to press articles these costs amount to approx. € 30 million p.a. It is assumed that Netcologne which is owned by an energy utility may use the pipes owned by this utility to run fibre through thus saving substantial costs of digging its own trenches.

99 Netcologne is a city network operator providing services over its own infrastructre in Colonge and surroundings.

100 http://www.netcologne.de/presse/nc_presse_meldung_16808.php

101 http://www.netcologne.de/presse/nc_presse_meldung_13244.php

A.2.5 Greece

In early 2006, EETT has established, a Colocation Group whose efforts are devoted to solve any problem regarding colocation which arises between OTE and all interested operators.

As a result the number of sites where physical colocation is offered was increased from one (1) in October 2005 to thirty (30) at the end of October 2006 while distance colocation is now offered in forty-eight (48) sites. In addition, under the coordinated efforts of EETT, the Greek incumbent has committed to implement an ambitious colocation program that will increase the number of sites with physical colocation up to one-hundred-fifty (150) by Q3 2007. When this program is implemented the alternative operators will have increased significantly the percentage of their access to the incumbent's customer base on a national scale.

At the same time the number of unbundled local loops exhibited a steady increase (150% from 9/2005 to 9/2006) although it still remains a small fraction (0.24%) of the total number of main telephone lines. The number of LLU lines is expected to grow significantly next year as the number of colocation sites increases.

In addition to the above, EETT estimates that the new reference offers for the local loop unbundling and the bitstream access of the Greek SMP in markets 11 and 12 (which is the incumbent), will accelerate the infrastructure investments even further as well as the competition in the Greek telecommunication market. The above mentioned reference offers have been recently received by EETT for approval and the associated documents are published for public consultation.

Recently, July 2006, EETT has conducted an auction for a fixed wireless access license (Wi-Max) at 3,5GHz zone. The license has been obtained by an alternative operator at the auction price of 20.475.000,00 euros. The contractor is obliged to develop the required infrastructure for the provision of broadband services in seven geographical zones of the country, within a 4-year timeframe, and to achieve population coverage of at least 20%, in every zone.

In addition to the above mentioned actions, there are several active public funding projects, co-funded by the European Fund for Regional Development (EFRD), to support information technology and telecommunication investments. These projects mainly focus on the development of telecommunication networks for the public sector to support e-government and e-health operations. Several projects are in the field of wireless access (Wi-Fi) for the private sector and for municipal wireless access networks. The major project for broadband development in regional areas of Greece is a project entitled: "Funding of private-sector companies for the development of broadband access in the Regional Areas of Greece" which is part of the Operational Programme "Information Society". The project involves the development of broadband infrastructure and the provision of broadband services outside the urban areas of Athens and Thessaloniki. The total budget of the project amounts to 210.000.000,00 euros, of which 50% is public spending and 50% private participation. The project has been included in the Operational Programme Information Society of the 3rd Community Support Framework and is co-funded at 70% by the European Fund for Regional Development (EFRD) and at 30% by national funds.

In general, the development in broadband access in Greece, is characterized by an increased interest for private investments. As mentioned by the telecom providers in the 8th Info-com (Athens - October 2006) conference, many of them have a number of active or planned infrastructure investment projects, especially in the field of fibre optics ducting. These projects are located in the two main urban areas of Greece (Athens and Thessaloniki) and their aim is to develop alternative high speed backbone optical networks at the core level. It is important to mention that during the conference, many of the alternative operators who are actively involved in these projects, estimated too high CAPEX for fibre optics ducting investments and expressed their desire to cooperate with others in order to share the associated risk.

Despite the above mentioned evolution, as answered in the relevant fact finding questionnaire, the NGN and the IP interconnection does not seem to be a relevant problem today. EETT has conducted public consultation (June 2006) on VoIP with three questions related to IP interconnection. The opinion of all the market players, according to their answers, is that it is too early for the Greek telecommunication market to introduce IP interconnection, since both NGNs and VoIP services are in a very early stage of adoption.

A.2.6 Italy

During the meeting with the financial community held on 9 march 2007 Telecom Italia has announced its plans for the transition towards the NGN access network.

The main points of such a plan can be summarized as follows:

- Introduction of FTTB or FTTC architecture, based on G-PON technology and VDSL2 from the Cabinet to the home. The above mentioned network innovation should be carried out gradually: the coverage will pass from 0,2% in 2007 to 5% in 2009, corresponding to 20 main cities. The coverage should reach 65%, corresponding to 1140 cities, in the long term.
- Adoption of FTTH in specific cases;
- Extension of ADSL2+/3-play coverage from 51% in 2007 to 67% in 2009. The ADSL2+ coverage should reach a value close to 100% in the long term, with the introduction of about 8000 IP DSLAM.
- A Capex of about 500 mln Euro is foreseen in the first phase (2007-2009). A Capex of 6,5 Bln Euro is foreseen for the full project.
- Implementation of a full IP network.
- Costs/Capex reduction thanks to efficiency of network (migration towards a single IP platform and reduction of the number of local exchanges)

Other Key Project Figures:

- 75.000 street cabinets, out of 145.000, equipped with VDSL2
- 1.600 COs (Local Exchanges) releases/compatted
- 60.000 Km of new fibre optics paths

A.2.7 The Netherlands

At the end of 2005, KPN announced that over the next few years it wanted to migrate its network to a so-called ‘Next Generation Network’ (hereinafter: NGN). The migration to an NGN is intended to give KPN a cost-effective broadband IP network that will allow it to provide tomorrow’s electronic communications services. KPN’s plans include the realisation of unbundled access at the sub-network level, also known as the street cabinet level. To this end, that section of the access network to the street cabinet box is to be provided using fibre optics. KPN also wants to phase out the functionality of the main distribution frames (MDFs) and phase out a large number of so-called ‘MDF locations’. These locations and this functionality will become superfluous in KPN’s modernised network. KPN is calling this operation the migration to ‘All-IP’.

OPTA published its market analysis decisions on LLU and WBA on 21 december 2005. In these decisions OPTA finds the following:

- The retail market for broadband internet access is effectively competitive. KPN (market share at the time 44%) is disciplined by competition from service providers using CTV networks (market share at the time 40%) and from (service providers using) alternative DSL-providers. The latter parties use LLU (market share at the time 16%).
- The wholesale market for low quality wholesale broadband access is effectively competitive. Both cable operators and alternative DSL-providers compete intensely with KPN. Service providers can purchase wholesale broadband access from KPN (voluntary offer of KPN), alternative DSL-providers and in some cases cable operators. Indirect pricing constraints discipline competitors in the retail markets.
- The wholesale market for unbundled access to the local loop is not effectively competitive. This relevant market does not include CTV networks due to the fact that CTV-networks do not provide an equivalent to the local line and due to the absence of direct and indirect pricing constraints. KPN has significant market power. Proposed regulation includes access and price regulation.

These findings are based merely on the regulation and large coverage of LLU. In the framework of All-IP, KPN intends to restructure its network in such a way that a significant part of the regulated service provision in the market for unbundled access, namely MDF access, will be phased out. In light of a number of other developments, OPTA views this intention as sufficient motivation for conducting new market analyses in the short term in order to determine what (potential) competition problems (could) arise in the various relevant markets and what other access options there must be in such a case to mitigate the effects of phasing out MDF access. Only a new market analysis can indicate what is required to maintain actual competition in the underlying markets or, if that proves impossible, to address the potential competion problems caused by the creation of a postion of significant market power. OPTA has announced this in its position paper on All-IP, which was published on 3 October 2006.

In this position paper OPTA elaborates on a fully fledged alternative for MDF access. The starting point is that a fully fledged alternative replaces the connectivity from the sub-network to the networks of other suppliers. An MDF access customer currently purchases this connectivity from KPN. Ideally other suppliers will realise this connectivity, just as KPN does, by installing their own infrastructure or purchasing this connectivity. However, OPTA foresees obstacles to further rollout, given the speed and the scope at which other parties must realise this. OPTA does not see any clear authority in advance for imposing collective cable installation or installing extra capacity in cable channels.

The fully fledged alternative for the current applicable obligations could consist of the following components:

- A regulated offer from KPN for unbundled access to the sub-network, as well as the related facilities such as co-location at the street cabinet for purchasing Subloop Unbundling (SLU).
- Phase-out conditions for the withdrawal of MDF access already granted. OPTA expects these conditions to be part of the ultimate set of new obligations.
- A regulated WBA offer from KPN for the areas where KPN does not yet offer SLU and/or SDF (Subloop Distribution Frame) backhaul and the MDF locations are phased out.
- A regulated offer for the delivery of glass fibre and/or glass-fibre routes by KPN, as

well as the related facilities such as co-location on the Metro Core Locations and the street cabinet for installation and delivery of backhaul by third parties. and/or

- A regulated offer from KPN for SDF backhaul, as well as the related facilities such as co-location on the MCL and street cabinet for purchasing backhaul from KPN or delivery of backhaul by third parties.

Alternative (access) infrastructures, such as CTV and fibre networks will obviously taken into account in the new market analysis decisions. OPTA plans to notify its concept market analysis decision on LLU, WBA and leased lines in Q2, 2007.

A.2.8 Portugal

Current status

The number of loops unbundled by alternative operators has reached 172 thousand in the third quarter of this year, an increase by 18% compared with the previous quarter and 139% from the beginning of 2006. These figures demonstrate the increasing dynamism of the national electronic communications market, and the clear investment made by operators other than PT as regards offers with a more direct access to end customers. They also convey an improvement of regulatory conditions operated by ANACOM, which has clearly led to a decrease in barriers to the access to the basic telecommunications network.

In parallel with the increase of the number of unbundled loops, the number of operators interested in reaching the end customer directly, amounting currently to six is growing as well.

Likewise, the number of exchanges where operators are co-located has increased, reaching now 190 exchanges, corresponding to a potential coverage of about 50% of the local loops.

PT Comunicações (PTC), the fixed historic operator, is actually upgrading its access network to offer ADSL2+ nationwide (100% coverage with ADSL is guarantied from the middle of 2006). PT Group companies, PTC and TVCabo (cable operator) are currently offering dual-play offers, respectively voice+broadband and broadband+TV. They are, however, currently upgrading their networks to offer triple-play services.

The ADSL2+ spread out was initially boosted, in early 2006, by the new 16 Mbps and an IP-TV offer from an alternative operator/ISP, Sonaecom/Clix, supported in LLU. Currently, this operator has two broadband access offers, 12 Mbps and 24 Mbps (downstream) and it's developing its IP-TV commercial offer.

There also other alternative fixed and cable operators offering triple-play services. ARTelecom, a fixed operator using a Broadband FWA solution, is developing its operations in the main areas, Lisbon and Porto, where the biggest alternative cable operator, Cabovisão, is more focused on the other regions (where TVCabo has already a very strong presence).

Publicly available information by PT Group

Detailed information on the technological evolution of the PT Group networks is scarce[102], being the main source the PT Innovation[103], according to which, its "mediaDSLAM"[104]

102 In July of 2005, Alcatel announced that PT Prime (business retail division of PT Group) had selected it for the implementation of a new generation IP network (NGN).

103 Company of PT Group that is dedicated to the R&D of hardware and software solutions for electronic communications, including DSLAM, transmission systems or IN.

104 According to PT, the first prototypes should be available during October. Until the end of the year, the solution will have to be stabilized and the first commercial units will be launched in the market in the first months of 2007.

equipment will allow, in the short term, to increase the bandwidth of the copper line for speeds of the order of 100 Mbps. In accordance with the press release, of September of 2006, this new solution will support a widened range of new advanced services in the existing infrastructure and with VDSL2 technology, exceeding the possibilities of triple-play (voice, data and video): beyond extreme-fast Internet access, several channels of conventional digital TV and high definition (HDTV)[105], fixed telephony and VoIP.

One still notices that, in accordance with an announcement of July of 2006, TVCabo announced the future upgrade of its IP-NGN platform to offer in the near future a bandwidth up to 100 Mbps to its customers, thus offering very high speed broadband access, voice over IP[106] and video contents in high definition (HDTV).

In a NGN workshop, organized by ANACOM in October[107], and with the presence of some of the most active players (main fixed operators and all three UMTS/3G mobile operators, and manufacturers), PTC mentioned that its strategy will continue to privilege the use of equipment and solutions normalized, in the scope of the ETSI/TISPAN in the case of NGN - IMS as architecture, and the access concept of the ITU-T's Recommendation G.902[108].

Currently, PTC's access network is constituted by 90% copper and 10% fibre, where it exists:

- Predominance of the copper for residential access;
- Low levels of optic transport and wireless use;
- Several units for specialized services (MUX for voice PSTN and for TDM data, DSLAM, VoIP and VoInternet, IP Data);
- ATM aggregation.

According to PTC, its access network will evolve to be "future proof", with strong optical-fibre dissemination, foreseeing that in the medium-long period will be constituted by 50% fibre and 50% copper.

The drivers for the development of its access network are basically the innovations at the services' level (as much for residential customers as for enterprise), as to the level of mobility. It is foreseen, in this development of the access network: (i) Introduction of IP technology; (ii) Increase of the level of QoS, modern O&M systems and evolved management/provisioning systems; (iii) Control of the Spectrum Management in the copper cables; (iv) Increase of the capacity in the access; (v) Solutions for path protection (fibre) and radio solutions; (vi) New solutions of aggregation: ATM → ATM + Ethernet → Ethernet; (vii) Introduction of FTTB solutions for operators and non-residential customers; (viii) Reinforcement of the primary distribution in optic fibre; (ix) Remotisation of equipment (micro-coverage); (x) Introduction of multi-service units (MSAN).

Thus, according to PTC, a restructuring of the architecture of the access networks will occur – the gradual disappearance of the TDM and access SDH and the growth of the FTTx solutions -, with the adoption of new multi-service units (new generation DSLAM and/or MSAN) and the introduction of new xDSL, FTTx and GPON technologies, with a predominance of Ethernet and IP/MPLS technologies and with a centralized control:

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105 Currently under trials. The fixed division, PT Comunicações, does not have commercial (IP)TV offers.

106 Currently under trials. TVCabo does not have a commercial voice service.

107 It was seen by ANACOM as an opportunity to trigger national discussion on the technological and standardization options available, international experience of migration from current networks and the potential impact on regulation.

108 "*An implementation comprising those entities (such as cable plant, transmission facilities, etc) which provide the required transport bearer capabilities for the provision of telecommunication services between a service node interface and each of the associated user network interfaces*"

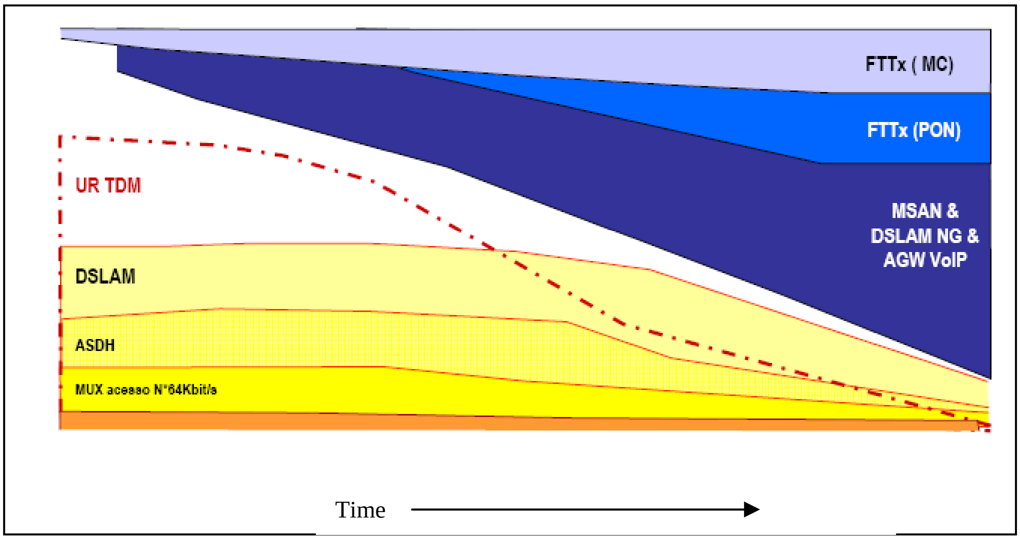

Figure A-2: Evolution of access network in the medium-long term (source: PT Comunicações, 2006)

PTC also mentioned that the average traffic for customer has increased, derived from the increased number and requirements of applications and services used by the consumers and that there is also a bigger pressure on the upstream traffic (for P2P, backup, etc.), foreseeing in the future a more symmetrical use of the networks and with multiple applications and users in simultaneous in each site/home.

Hence, the gradual use of fibre optic in the access will be extended to the house (or building) of the customers, when, in the future, the requested (symmetrical) bandwidth could not be satisfied with xDSL.

The evolution of the access network

In this transition phase, when the international implementations of new solutions and architectures are still in a test phase, PTC is still analyzing and evaluating the technical and technological aspects, as well as the organizational, commercial and financial aspects. It considers that is not possible to establish already a definitive strategy, economically and technically rational, on the development of the access network, namely on the level of the optical-fibre incorporation and the possible use of street cabinets.

However and nonetheless the dimension, complexity, dynamics and cost of the perceived changes, this company considers that there will be a gradual migration for a convergent next generation architecture, with the gradual introduction of new access platforms that will be simultaneously Ethernet aggregation and multi-service access nodes (MSAN).

Hence, having into account the probable increase of the traffic in the broadband access, PTC is evaluating the technical solutions (e.g. FTTN, FTTB) that may have a direct impact in the structure of the network, namely with the creation of new nodes/MDF/PA[109] where and when the demand emerge. In this initial phase, PTC does not have specific and definitive plans for the development of its access network. Nonetheless, for the year of 2007, and following an "*evaluation still preliminary and not stabilized*", PTC foresees the creation of only a few hundred new PA, affecting less than 1% of the total copper lines.

109 Point of Attendance (PA) is a technical node of the network that encloses one specific geographic area with capacity to support voice services and ADSL, whose evolution depend on the development of the network, namely on (i) questions of demographic nature, (ii) urban development, and (iii) actions associated to the offer and quality of the services (e.g. support of one or some services, as voice, ADSL or leased lines).

As noted previously, the number of exchanges where operators are co-installed has increased to around 190 exchanges (around 11% of the total), corresponding to a potential coverage of about 50% of the total of loops. However, to approach 100% of the loops is necessary for the LLU operators to be co-located in about 1.500 of the 1.700 MDF theoretically "still available" for unbundling. The following figure shows the growth of the potential coverage of active loops with the number of MDF and it is possible to verify that to reach coverage of 80% or 90%, an operator need to be co-located in about, respectively, 520 or 840 MDF:

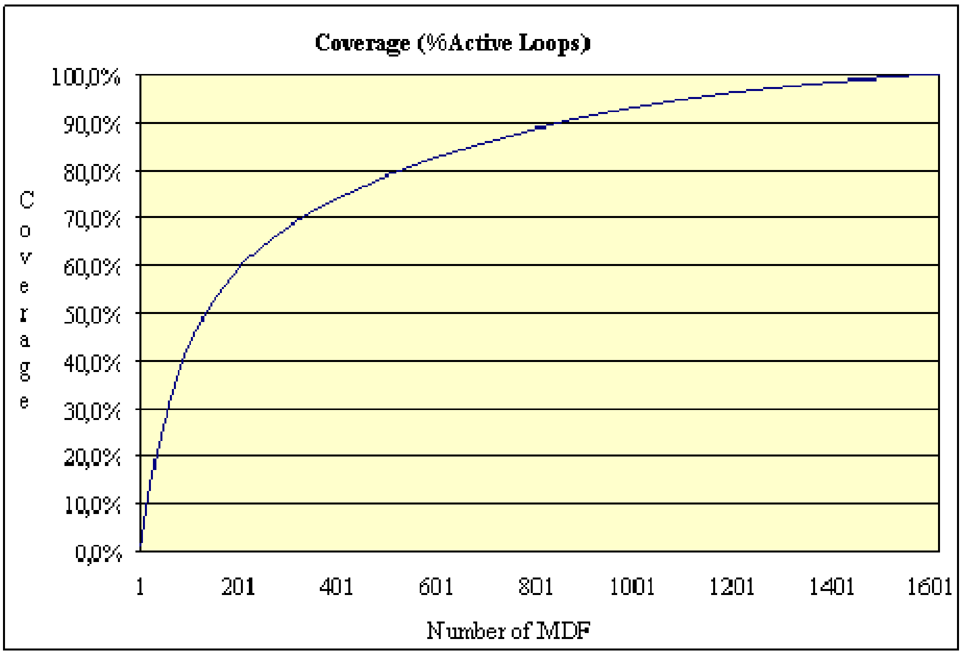

Figure A-3: Operator (LLU) coverage (in % of active loops) according with the number of MDF.

Moreover, the majority of MDF are located in small buildings, remote units or even street cabinets. In these cases, the only form of co-location will be, probably, in an exterior space, which will cause increased costs to the operators. At this moment, it is not possible to affirm that they would recoup these costs, in case that they decide to advance for a broader covering. On the other hand, it might not be interesting for the operators to be co-located in nodes/MDF with reduced potential capacity (in the order of the tens of loops), being more efficient to use the bitstream offer (with 100% of national coverage for ADSL[110]) to offer its services. It should me noted, however, that the bitstream offer "only" allows broadband access, not being specifically suited to offer triple-play services at a wide scale[111].

This problem could be aggravated in the case of PTC, intending to introduce advanced xDSL technologies (e.g. VDSL2) across the territory, install or upgrade hundreds or even thousand street (or building) cabinets, i.e., dislocating the first aggregation node closer to the final user. In these conditions, it does not seem economically efficient that the operators have conditions to offer similar coverage, i.e., be co-located in all the access points/cabinets.

Nevertheless, in the short term, and having into account the forecasts for the short term evolution of the MDF/PA , that the future strategy for the evolution/migration of the network is not yet clear and its concretion will never be immediate, in the short and medium term, it is not foreseen that the access network architecture can be substantially modified, potentially affecting the competitive conditions on the access to the network by the LLU operators.

110 PTC is currently upgrading its xDSL offers with ADSL2+, aiming approaching national coverage in the short term.

111 Although an ATM aggregation offer is available, with QoS guaranties.

A.2.9 Romania

NGN migration

As in most of the EU countries, the traditional TDM networks in Romania are gradually migrating towards IP-based Next Generation Networks (NGN). Although it is not clear today how the NGN networks will look like in detail, the strategies already employed by the incumbent operator may provide some useful indications. In 2005, Romtelecom made public its investment plans to migrate to a packet switched network, but did not disclose detailed information on the planned migration.

According to newspaper articles, the incumbent might invest half a billion euros over a three years period for the migration to NGN (with no details on the investment allocation between NGN core and access). In addition, there are indications in the media that Ericsson and Alcatel are the chosen vendors for the migration to NGN.

As a part of transition to NGN, the incumbent plans to extend core network closer to the subscriber:

- National and main city IP-MPLS backbones (deployed);
- Fibre optic local rings connecting remote concentrator units RCU/optical network units ONU (multi-service access nodes) to the local exchanges Lx (in progress).

In relation to the access network, the incumbent plans to reduce the length of local loops to less than 1km (especially by deploying ONUs), to increase the number of broadband enabled lines (upgrade completed in the major cities), and to increase the number of ADSL lines.

There are no major plans for replacing the copper last mile to the end-user with fibre optics.

Regulatory aspects

The main advantage of the new access network architecture is that both the incumbent and the alternative operators have the possibility to provide enhanced products (higher speeds, triple play etc.).

However, the access to the incumbent copper access network (LLU) becomes problematic as it increases the number of access nodes and simultaneously decreases the number of subscriber lines per access node. Furthermore, the access to street cabinets posses technical and operational issues like installing the HDF and the DSLAM, ensuring the backhaul service, obtaining the necessary approvals from the local administration.

In 2006, considering the fact that some of the RUO provisions didn’t comply with the ANRC LLU regulation and the slow take-up of the LLU services, ANRC revised the general LLU framework. ANRC imposed on Romtelecom specific obligations regarding the announcement of planned changes in the access network:

- to notify the alternative operators any modification of its network that might affect the retail services offered by the alternative operators, including the removal of an MDF, not later than 12 months before carrying out that modification.
- to publish and to update quarterly the plans for modernization of the access network (including deployment of ONUs) at least with 12 months before proceeding to modify of the access network. This information must be updated quarterly.

Also in 2006, ANRC established a working group for LLU issues. The WG main task is to identify feasible solutions for wholesale access to ONUs. The WG studies various possibilities for viable access to ONU (regulated backhaul transmission services, dark fibre and duct sharing) and alternatives (such as regulated bitstream services).

Broadband market snapshot

The Romanian broadband market shows an interesting feature: the mobile access (CDMA/EVDO, EDGE and 3G) had the largest market share over time, followed by coaxial cable and lately UTP/FTP cable (also called “neighborhood networks”).

The most common support for providing fixed high-speed access to Internet is coaxial cable. According to the data available at 30th of June 2006, there were 328.426 subscribers. The share of cable modem in the broadband market, which reached 27.7% in mid 2006, has considerably increased during the past years. The modem cable had a growth of 113% in the last year becoming one of the most mature and affordable services in the market.

The DSL part of the retail market is dynamic in Romania with the number of subscribers increasing by 516 % in the first 6 months of 2006. Still, the penetration rate of DSL in the total broadband access is about 3.8%, situation caused mainly by the competition from the cable operators, the late introduction of DSL services by the incumbent (in May 2005) and also of the LLU services (as a result of the regulatory measures, RUO was published in September 2004, but the first LLU contract was signed in March 2005). Furthermore, regulated bitstream services are not available yet.

A.2.10 Spain

Spain has a fixed telephone network with over 18 million lines in service, which represents a penetration rate on the total population of 41%. The number of users with broadband internet access amounted, in February 2007, to 6.9 million (residential and businesses, which represents a penetration of 15.6% on the total population), 21% of them via cable operators. In February 2007, over 1 million users had an unbundled local loop. Telefónica, the incumbent operator, has a network with around 17 million copper pairs installed with over 16 million in service.

Telefónica has made public announcements regarding deployment of a new generation network to enable new services. In those announcements, the availability of higher bandwidth is seen as a driver for convergent services, speeding the evolution towards an “all IP” network and opening new services to end customers. This will be supported on the one side by an evolution of the IP network (a single IP network for fixed and mobile services, based on a common backbone and IMS), also progressively substituting the ATM network by an ethernet aggregation network for xDSL services. And on the other side by an evolution of the access network, which would need to be evolved in three variants: VDSL from the CO (for customers in the neighbourhood of the CO), VDSL from a street cabinet (ie, FTTN, for those cases where it is possible to install street cabinets, as the existing network is not based on a SC architecture) and optical access (FTTH, for the rest of cases). The objectives, presented by Telefónica in the Fifth Investor Conference in Valencia (May 2006), include bandwidth of at least 25 Mbit/s for more than 40% of the population by 2009.

Telefónica held in 2005 a limited FTTH trial based on PON in the outskirts of Madrid. Recently, a new trial, covering FTTx/VDSL2 and FTTH, has been announced for Madrid and Barcelona (starting from 16th April). Although alternative operators requested to stop it due to potential interference risks and lack of participation, discussions suggested by CMT have led to a process of information sharing in mutual agreement for the trial.

Regarding the regulatory status of the new generation network and technologies, the current definition of market 12 covers also VDSL, as it is included in the reference market. Market 11 covers access to metallic loops and subloops. The OBA (reference offer for access to the local loop) includes VDSL within the allowed signals in the local loop altough to a default penetration rate (2/25) that is to be revised in the future allowing a higher introduction of VDSL2 signals per basic copper cable (25 pairs).

The CMT is preparing a public consultation on NGA, likely to be launched in May. The target is to get feedback about how to improve conditions in order to promote a sustainable competition, fostering efficient investments.

A.2.11 Switzerland

The Swiss NRA (OFCOM/BAKOM) organized a NGN workshop in September with most of the NGN scene actors (operators, manufacturers). One of the aims was to draw up the "state of the place" in order to prepare a future regulation in harmony with the most advanced developments in this domain. Some important points have been highlighted during that meeting:

- All participants assumed that NGN will be implemented in Switzerland in the future (in 2 to 3 years). This will be a matter of IMS-based approaches, but Soft Switch solutions can also be used. Development through VDSL will be accelerated particularly in the area of access networks. All providers have corresponding plans, but these differ in terms of their implementation strategy.
- The “digital lifestyle” is supported by NGN through the integration of communication and media. The implementation of NGN functions on terminals is a key- issue. Simplicity of use and mobility of services allow customers to use services and content flexibly. In this context, guaranteeing price transparency regarding the use of different access technologies is
- The participants assume that new market opportunities will exist for service providers at the services level as a result of NGN, if services (VoIP, IPTV, multimedia, etc.) can be offered countrywide and independently of individual networks. In this context, the expectation was also expressed that the regulator will configure the legal framework for NGN in such a way that bundling effects with regard to independent access to services will be prevented. However, stimulation of competition at infrastructure level is not expected.
- The regulator must ensure effective competition. The participants do not expect any “regulatory holidays” such as are being demanded in other countries with regard to NGN, but are in favour of an approach whose aim is self-regulation by the market.

The incumbent (Swisscom) is actually upgrading its access network very quickly to offer VDSL in urban centres, then in rural areas. Street cabinets are upgraded at large scale with DSLAMs adapted for that new technology.Trial VDSL accesses are offered in Zurich, and the VDSL product may be offered in the incumbent portfolio very soon. The Swiss operators actually favour the migration from ADSL to VDSL on copper rather than to develop large FTTH networks. But other actors (power companies, industrial services providers) actively deploy fibre access networks.

The VDSL spread out is boosted by the new IPTV offer from Bluewin, the incumbent ISP. Bluewin TV's basic package covers over 100 regional, national and international television channels and more than 70 radio channels. Customers will also be able to choose from a range of exclusive sporting events which can be called individually. Trips to the video shop will no longer be necessary: the video-on-demand store contains over 500 films available at the touch of button 24 hours a day. The monthly fee for the basic offering is €46. This includes a wide range of content (TV and radio programmes) and a selectable language package (German, French or Italian). The set-top box provides customers with over 100 hours' recording capacity. To receive this IPTV, customers need a broadband Internet connection. Content is broadcast to conventional TV sets in the customary quality via the set-top box which is connected to an ADSL or VDSL modem.

Wholesale VDSL offers will not be offered in short term as LLU will only come in force at the end of Q1 in 2007.

Annex 3 Summary of Buisness Case Studies

A.3.1 Analysys: "The business case for sub-loop unbundling in the Netherlands"[112]

Focus of the study

OPTA presented in its All-IP position paper[113] a possible equivalent alternative for MDF access, when MDF access will be phased out.[114] To get some more information about the economic viability of this alternative, OPTA has commissioned Analysys to investigate the business case for providers using sub-loop unbundling (SLU) and/or wholesale broadband access (WBA) following the implementation of KPN's All-IP network.

Analysys describes the market context in the Netherlands as follows: "*At March 2006, DSL accounted for just under 60% of broadband lines in the NL, cable accounted for just over 39%, and FttB accounted for around 1%. Within the DSL market, KPN holds an approximate 80% market share since its acquisition of Tiscali.*[115] *The three main alternative providers are bbned (DSL market share ca. 8%), Tele2/Versatel (DSL market share ca. 8%) and Orange (DSL market share ca. 4%). Currently, all these operators predominantly rely on LLU at the MDF to deliver service, and can reach 50-70% of the population by this means.*"

Analysys relied on a number of data sources: the current wholesale offers of KPN[116]; interviews with several market parties; data from OPTA; third-party demand forecasts; economic data from EIU; internal estimates for technical parameters and unit costs.

Assumptions

The main assumptions, on which the Analysys study is based, are 1) Providers have already deployed LLU and borne the associated start-up costs; and 2) KPN plans to sell off its existing exchanges, meaning that LLU at the MDF is no longer available.

Results

Analysys identified a number of conclusions:

- Based on the current wholesale offers of KPN the use of SLU by an alternative provider is not economically viable as an alternative to continuing use of LLU, except under certain conditions. Analysys estimates that a business case for SLU with similar economic viability to that of continuing use of LLU for 60% of the population would require both:
  - a market share greater than 55% of all broadband lines (including cable) in areas served
  - Analysys' highest estimate for incremental revenue (an increase in ARPU across all broadband users of €10 per month by 2016)
- For an alternative provider with a 10% market share of all broadband lines in areas served, Analysys estimates that it may be economically viable to deploy

112 This Analysys study (in English) can be found on the OPTA website at www.opta.nl (subject: All-IP).
113 An English translation of OPTA's Position Paper All-IP of 3 October 2006 can be found at www.opta.nl.
114 The presented equivalent alternative consists of regulated provision by KPN of unbundled access to its sub-network and SDF backhaul, and the temporary regulated provision of WBA to facilitate the further roll-out in those areas in which KPN does not yet offer SLU and/or SDF backhaul.
115 N.B. The Dutch NCA has not yet given permission for the acquisition of Tiscali by KPN.
116 The wholesale offers of KPN are published on the KPN website at www.kpn-wholesale.com.

SLU to around 1000 of the largest street cabinets in the dense urban areas, provided that:

   - the tariffs for SLU line rental, co-location and links to the street cabinets are reduced significantly (Analysys tested 50%)
   - an increase in ARPU of around €9 per user per month can be achieved for the entire period, which is considered reasonable if business customers are targeted.

- The strong local economies of scale effects that are evident in deployment at the street cabinet level mean that even if such significant cuts of 50% in KPN's tariffs were to be realised, the use of SLU would still not be economically viable as an alternative to LLU to reach the mass market, unless is assumed for example:
   - a market share of 25%, together with an increase of ARPU of €5 per month
   - a market share of 16%, together with an increase of ARPU of €10 per month
- The current offer from KPN for WBA is also unlikely to be economically viable as an alternative to continuing to use LLU to reach the mass market regardless of the market share, even with the highest estimate for ARPU increase.
- The prices which affect the viability of an alternative operator's business plan the most are those for the line rental, SDF co-location and SDF-MDF link. Furthermore, Analysys' assessment of the cost of building a competitive network to provide backhaul to street cabinets indicates that unless very substantial revenue streams can be generated from services other than SLU backhaul, then it will not be possible for a third party to provide such backhaul at prices at the same level as, or below, the current offer of KPN.

A.3.2 ARCEP: Case study FTTH

The case study regards the City of Clermont-Ferrand (France):

- 67 000 households
- 3 200 inhabitants / km²

The following hypotheses were assumed :

- a private operator deploys a fibre access network in the city
- as it is a urban area, poles can't be used
- penetration rate: 25% of the households covered are supposed to subscribe the service
- profitability criterion: the net present value of the investment must become positive within 15 years, with a 10% WACC and a 33% tax on benefits

Scenario 1

The operator does not have access to any ducts and must open trenches everywhere he deploys. The cost of the civil works is supposed to be 75 euros per linear meter. This cost is rather optimistic (normal cost in urban areas is closer to 120€/lm) because the operator is supposed to mutualise with other operators or other works, and can use smart digging technologies. In this scenario, a private operator will only cover 1% of the area, and 13% of the households.

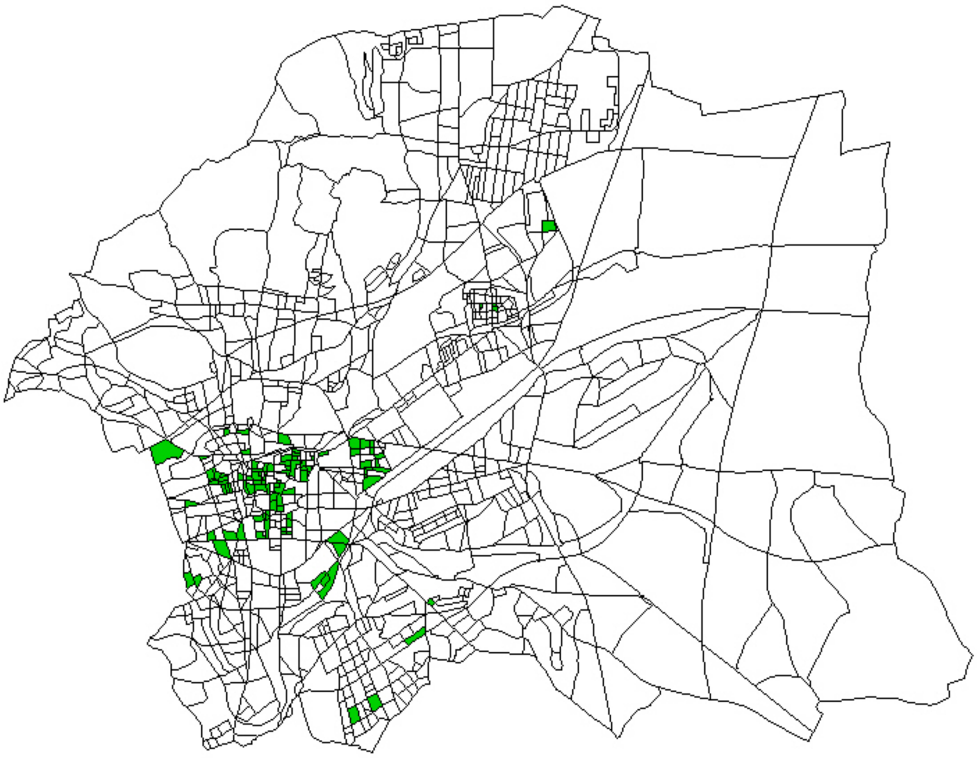

Figure A-4: Clermont-Ferrand, Scenario 1 (source: AVISEM)

Scenario 2

The operator has now access to a network of ducts covering the whole city. The owner of the ducts may be for instance the incumbent or a cable operator, or event the local authority. The location price is 2 euros per year per linear meter.

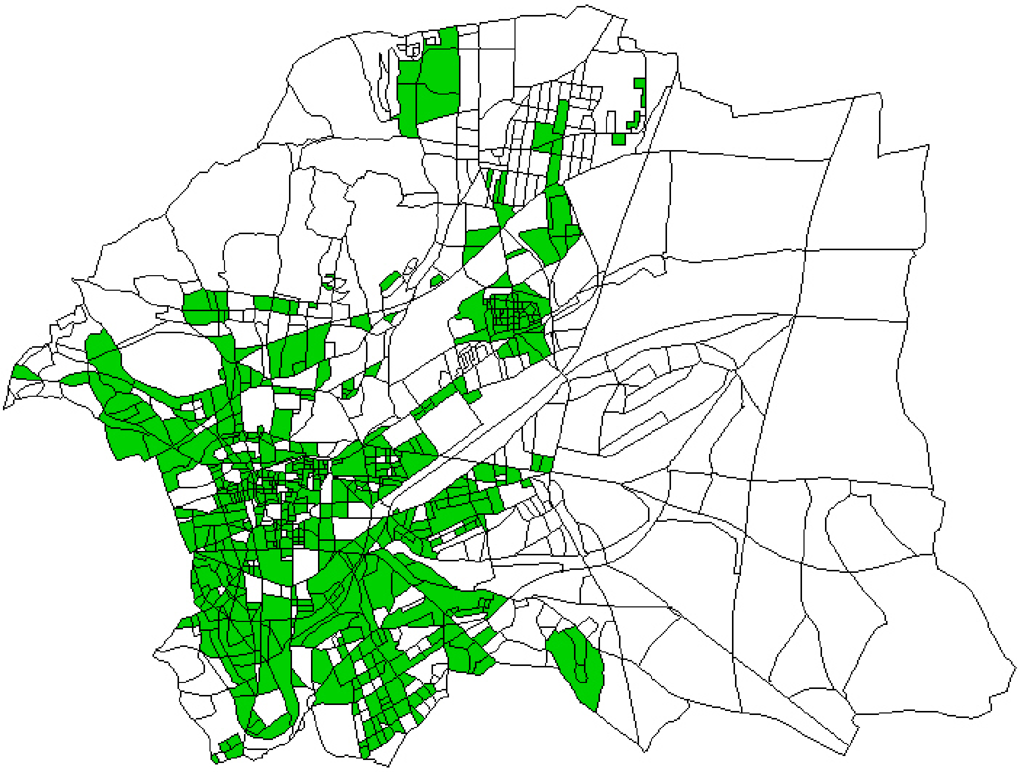

Figure A-5: Clermont-Ferrand, Scenario 2 (source: AVISEM)

In this scenario, a private operator will cover 21% of the area, and 79% of the households.

A.3.3 JPMorgan: “The Fibre Battle – Changing Dynamics in European wirleline”

Focus of the study

Considering the VDSL initiatives by incumbents in some European countries the study analyses the economic rationality of possible responses to competitors confronted with an incumbent’s VDSL deployment, in particular focussing two options, either replicating VDSL infrastructure or bypassing the incumbent with FTTH. The results depend largely depend on the assumed market share of the competitor and vary according to the characteristics of the country or area analyzed (relation number of SC to CO, density).

(I) VDSL

Assumptions

The study assumes a typical average European broadband market with:

- Incumbent upgrading 50 % of the country to VDSL, the metropolitan markets;
- VDSL roll-out cost of € 200 per household covered;
- Willingness to pay at least € 10 per month for extra speed and services (= premium market) is estimated at 25 % of the overall broadband;
- 60 % reach of ADSL2+ in VDSL coverage area.

Results

For a market such as the Netherlands with 21 SC per CO the additional monthly costs per subscriber of VDSL compared to ADSL deployment account for € 10/month/customer (€2), assuming an unbundled operator with a 5 % market share (30 %).[117] The results differ significantly depending on the relation SC to CO. With a 10% market share the additional costs in France (10 SC per CO) amount to €2,6 compared to €12 in Germany (40 SC per CO). A German operator would have to have a market share of +40 % to achieve a similarly low additional cost as in France.

The study concludes that in a typical market, at least double-digit market shares and a large premium market would be required to justify a new entrant VDSL deployment whereas **low market share operators would have no VDSL business case**. For an average new entrant operator in a country with average network topology **VDSL would most likely be a loss maker.** Even a market share of 40 % would not justify VDSL investment, unless there was an increase of ARPU.

Moreover JP Morgan states: “unless regulation forces the incumbent to provide access to its street cabinets, the **option of deploying a VDSL network of their own may not be available to all or most of the LLU operators active today**, implying a serious ‘replicability’ issue”. The **costs for backhaul** from CO to SC are estimated to range from € 0,19 (if 100 % ducted) to € 1,55 per month and customer (if no ducting). The respective costs for a typical competitor would be € 6 as costs are spread over fewer customers and because he would

117 Assumptions: Average costs of street cabinet incl. Installation: € 10,000. Energy costs per month and subscriber at SC 100% higher compared to CO, due to outdoor location and more challenging air conditioning requirements. Costs of maintenance/customer provision at SC: + 100 %. Cost uplift due to higher unbundling/backhaul charges are not considered. No access to incumbent’s street cabinets.

incur the full costs of digging. This would be even worse in countries with fewer customers per SC and a greater distance CO to SC.

(II) FTTH

Assumptions

Cost estimates for FTTH are in a range of €500-2000 per subscriber connected. The following factors influence the profitability of an FTTH business case: Density of population, projected market share and availability of access to infrastructure (ducts), ARPU uplift resulting from FTTH. According to JP Morgan FTTH civil works account for 68% of FTTH deployment costs. The costs for deploying fibre are in a range of €70-100/meter in a metro environment unless there are existing ducts.

FTTH sensitivity scenarios:

a) Density:

Greenfield CAPEX costs per subscriber connected highly depend on the given density of population:[118]:

Density (Households/km^2)	*CAPEX*
10000	€2000
5000	€3000
≤2000	€5000

b) Market Share:

CAPEX costs per subscriber connected have a strong sensitivity with regard to changes of the wholesale market share. A 10% increase in market share (to 35%) would allow to break-even).[119]

Market share	*CAPEX*	*Payback period (years)*
25%	€2500	16
30%	€2100	13,5
35%	€1814	11,6
40%	€1600	10,3

c) Access to infrastructure:

Having access to infrastructure significantly lowers CAPEX costs per subscriber at a given level of market share. Thus, assuming that 50% of ducts and building-related costs can be avoided, CAPEX would drop from €2500 to €1500 (for a given market share of 25%) allowing the operator to break-even.

d) ARPU sensitivity:

An ARPU increase of €6/month would make the business case of the 25% market share FTTH operator profitable, whereas with a market share of 30% only an uplift of €2/month would be required.

118 Assumptions made: 25% market share, no access to ducts.
119 Assumptions made: No access to ducts, no ARPU gain from FTTH, €13/m LLU savings.

Results:

FTTH deployment may be a feasible reaction for competitors (mainly in metropolitan areas with a high density of population) when confronted with incumbent VDSL deployment. This **requires sufficiently supportive conditions** (market share, access to infrastructure). The following table shows how many distinct access infrastructure JPMorgan considers conceivable in different topologies:

Density	*Number of distinct access infrastructures*
High (Metropolitan areas)	3-4 (Incumbent copper, Cable, 1-2 FTTH)
Medium	2-3
Low	1-2 (Incumbent copper, Cable)

A.3.4 OVUM: "FTTCab: an investment assessment"

Focus of the study

The OVUM analysis is focused on the additional costs that operators may incur when moving from standard ADSL from the exchange architecture, to the FTTCab architecture utilising VDSL2 technology over the copper access.

Basic network assumptions

Based on a mixture of own experience and assumptions together with announcements from operators such as SBC, Deutsche Telekom and KPN, OVUM used the basic assumptions shown in the figure below to build a generic FTTCab solution, to materialize over a three-year period with a deployment to 10,000 nodes in year 1, and 15,000 nodes in years 2 and 3:

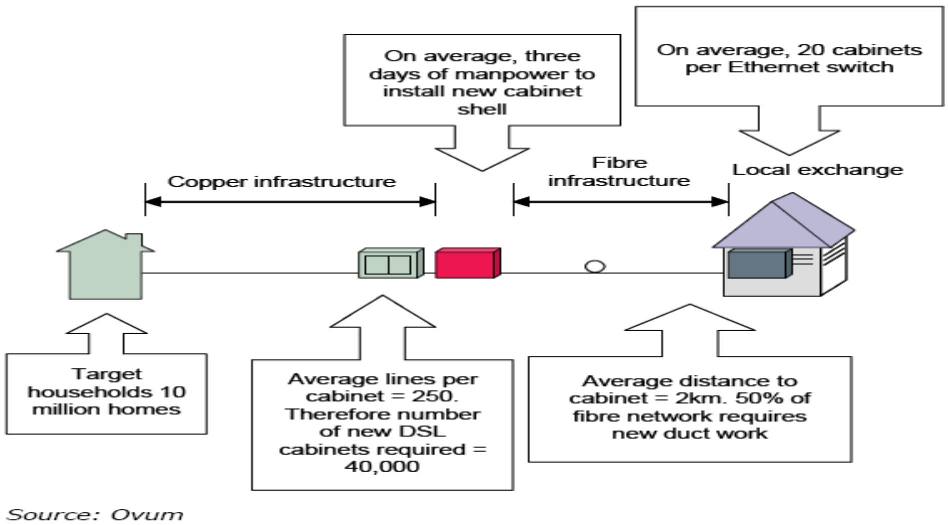

Figure A-6: Generic FTTCab solution

Cost assumptions (Capex) and comparison with ADSL from the exchange

Capex comparison (in $)	Unit cost	Cost per customer
DSLAM	12,000	24
DSL Port	35	35
Copper loop (per annum)	150	150
CPE	30	30
ADSL from the exchange		**239**
Local Exchange[120] - Ethernet switch	50,000[121]	7
Fibre infrastructure[122] - Fibre connection	60,000[123]	240
Cabinet[124] - Cabinet plus DSLAM	17,000[125]	68
Copper loop[126] (per annum)	170	170
CPE[127]	60	60
FTTCab[128]		**545**[129]

Results

Based on the network footprint and assumptions shown in the above figure, as well as the outlined costs, the initial investment required to deploy the cabinet network (before any customers connected to the cabinet) is approximately $3.8 billion before depreciation and the

120 Need for a new Ethernet aggregation device or switch, to handle 20 DSLAM cabinets. All existing local exchange (CO) buildings remain active and therefore no potential cost saving of local exchange reduction or the use of DSLAM as an aggregation device for remote cabinets has been taken into account by OVUM.

121 Opex costs for each Ethernet switch: Cabinet installation = $1,500 and Port integration = $150.

122 The cost of fibre infrastructure is the great obstacle for FTTx, as new optical fibre needs to be installed by blowing it through underground ducts. If they do not exist, a new duct has to be installed, and the civil engineering associated costs are higher (Note: other solutions such as aerial deployments using existing poles, or using underground sewage tunnels are often used where possible to avoid this expense). In this analysis, OVUM assumed a mixture of existing and new ducts.

123 Opex costs of fibre deployments: duct installation (per m) = $50; Fibre pull (per m) = $2 and Planning (per hour) = $50.

124 The existing cabinets are used as cross-connect flexibility points to join exchange-side and drop-side cables together, but are not suitable to house active equipment such as a remote DSLAM (they are not big enough, have no existing power supply, and are not sufficiently environmentally 'toughened'). Operators therefore either need to replace these, or install brand new cabinets alongside, using the existing cabinet to connect to the network.

125 Opex costs for the cabinets: Power supply (per line) = $5; Installation (per hour) = $50 and Copper connection (per line) = $100.

126 From the cabinet out to the customer, the model assumes that the existing copper plant can be used. It is assumed there is cost associated with running the copper access network and this would be an internal charge for a national incumbent or an external charge (sub-loop unbundling) for a competitive carrier.

127 It is assumed that self-installation is default from the start.

128 There are a number of other costs that an operator will have to face that are not covered in this research: additional cost of maintenance of the street cabinet, additional training, OSS upgrades, customer support and so on are all variables that are likely to change as operators move to new access solutions such as FTTCab but are difficult to predict however, and will differ greatly from one operator to another.

129 The costs on a per-customer basis from cabinet to household include the DSL port, the manual connection between port and copper loop, power, the copper loop rental and the CPE. All of these costs, with the exception of the copper loop rental, are one-off costs.

bulk of these costs are associated with the fibre network[130,131] (e.g., using aerial deployments for 50% of the fibre network would reduce the total fibre investment from $2.5 billion to $1.5 billion).

This investment scenario, covering a footprint of 10 million homes is a cost of $380 dollars per home passed, is not unrealistic according to OVUM, as Deutsche Telekom, for example, expects to invest €3.6 billion (approximately $4.8 billion) to cover 10.5 million households in Germany. If penetration was 50%, the cost per household would be double ($760). OVUM assumes that adding the cost of connecting the customer (copper loop rental, CPE, etc.) a total additional cost of $1,000 per customer is not unrealistic. Spread over three years this is an extra $30 per customer (after revenue sharing for content services) per month that the operator would have to find.

A.3.5 WIK: "Technische und ökonomische Aspekte des VDSL-Ausbaus – Glasfaser als Alternative auf der (vor-)letzten Meile"

Focus of the study

The study analyses the economic viability of rolling out fibre to the curb – as intended by Deutsche Telekom - applying VDSL technology in Germany. The focus is on the first phase of Deutsche Telekom's VDSL roll-out, with VDSL infrastructure deployment in 10 cities (in a second phase further 40 cities will be deployed. The study determines the break-even VDSL penetration rate just covering the average costs (per customer/month) from a given VDSL retail price. (34,99 €/month as assessed by DTAG). In a first step WIK identifies the investment and cost components necessary for implementing VDSL.[132]

Scenarios

Three scenarios are analysed the distinguishing feature being different types of roll out in the feeder cable as well as different cost allocation:

130 And a large proportion of this comes from laying new duct as the model assumes this will be required for 50% of the fibre network.

131 The investment required for the "cabinet to customer" part of the network is reliant on the number of households connected, rather than households passed. The ratio between households passed and connected will be essential to the network operator's business case. If the penetration is low, e.g. only 10% of the possible 200 to 400 customers are actually connected to the network, the cost per customer will be much higher.

132 They include the costs of laying fibre in the feeder cable segment (including costs for civil engineering works), distribution cable segment, VDSL modems, splitter, outdoor DSLAM, costs for enlarging street cabinets as well as operational expenditures, distribution and common costs. Expenditures for marketing or R&D are not being considered.

	Scenario 1: incremental cost operators‘ Perspective	Scenario 2: TS-LRIC	Scenario 3: Stand-alone cost
Usage of feeder cable infrastructure (joint/exclusive)	Joint usage		exklusive
Type of roll-out in feeder cable & cost allocation	Fibre is using existing spare capacities.	Fibre bears share of costs for ducting and trenching.	Dedicated physical infrastructure for fibre
Costs of laying fibre (€/meter)	€3	€202 (32% = €63,75 borne by VDSL)	€130
Other direct cost of VDSL-roll-out	VDSL-Modem, VDSL-Splitter, unbundled subloop, Outdoor-DSLAM	VDSL-Modem, VDSL-Splitter, unbundled subloop, Outdoor-DSLAM	VDSL-Modem, VDSL-Splitter, unbundled subloop, Outdoor-DSLAM
Retail cost	€4	€4	€4

Source: WIK

Scenario 1 only looks at the incremental costs from implementing fibre. Fibre is using existing spare capacities of ducts leading to low costs of €3/m for the fibre and its installation. The costs of joint production are explicitly not allocated to VDSL access lines. In scenario 2 (Total Service Long Run Incremental Costs) approx. 32 % of the costs for ducting and trenching are allocated to VDSL access. In scenario 3 (Stand-alone costs) VDSL access bears all costs incurred without considering share usage (as in 1) or economies of scope (as in 2). Thus, the costs for fibre per meter amount to €130.

Assumptions

The costs of efficient service provision constitutes the applied cost standard of this study. Moreover, WIK applies a FLRAIC approach (Forward Looking Long Run Average Incremental Costs). The cost of reconstructing streets cabinets (incl. Outdoor-DSALM, splitter) is assessed at €25.000 and a figure of 210 access lines per street cabinet is assumed for the 10 cities in the first phase of the VDSL roll-out. Furthermore, the analysis assumes a steady state thus neglecting the time path of penetration, which tends to result in an underestimation of the costs of VDSL implementation.

Results

The profitability of the VDSL roll out crucially depends on the demand for VDSL access. The figure below shows (for each scenario) the critical penetration rate where the average costs per month and customer are just covered from the assumed VDSL retail price (€34,99 € per customer and month).[133]

133 When calculating this break even penetration rate upfront costs or revenues from flat rates are not considered.

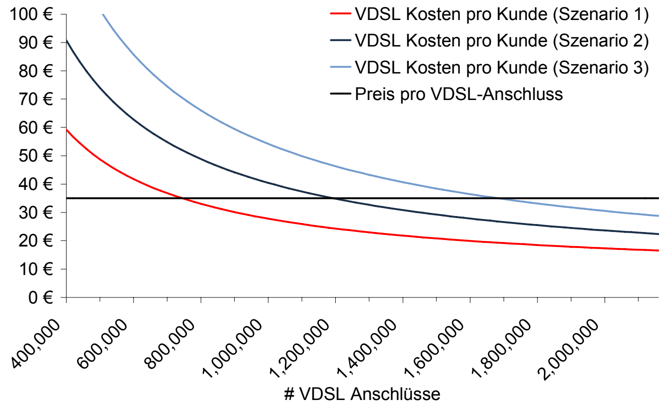

Figure A-7: Average costs of VDSL roll-out

Source: WIK

As the figure shows the critical number of VDSL access lines increases from scenario 1 to 3. In scenario 2 the average costs per user are covered with approx. 1.2 million VDSL lines (implying total monthly costs of €42 million). With a potential figure of approx. 5.5 million potential VDSL lines this implies a required penetration rate of 22%. Due to the assumed use of existing duct share capacities the respective VDSL penetration rate is lower in scenario 1 (760.000 VDSL line = 14%) and the total monthly costs amount to €26.6 million. Finally, the stand alone approach of scenario 3 results in the highest break-even penetration rate (1,7 million = 31%) and total costs of € 59,5 million.

The range of the critical VDSL penetration rate is to be primarily attributed to the different costs for the feeder cable segment as the costs for civil engineering works vary in the 3 scenarios analysed. The investment figures for street cabinets, outdoor DSLAM and splitter are the same in these scenarios.

Annex 4: Glossary

3G Third Generation

The next generation of Cellular Radio for mobile telephony. 3G is the first cellular radio technology designed from the outset to support wideband data communications just as well as it supports voice communications. It will be the basis for a wireless information society where access to information and information services such as electronic commerce is available anytime, anyplace and anywhere to anybody. 3G's technical framework is being defined by the ITU with its International Mobile Telecommunications 2000 (IMT-2000) programme.

3GPP Third Generation Partnership Project

The 3GPP was formed in December 1998 as a collaboration agreement bringing together a number of telecommunication standards bodies. These standards bodies are referred to as Organizational Partners. The original aim of the 3GPP was to produce globally applicable technical specifications for third generation mobile systems based on evolved GSM core networks and the radio access technology UTRA (Universal Terrestrial Radio Access).

ATM Asynchronous Transfer Mode

Broadband transmission technology which provides the backbone of the world's telecommunications network. ATM breaks information flows into small fixed-length cells of 53 bytes. Cells of any type of traffic – voice, multimedia, data or video – can be interspersed with each other. ATM operates at speeds of 25, 155 and 622 Mbps.

Backhaul

Connection between distributed sites (typically access points) and more centralised points of presence – e.g. connecting wireless base stations to the corresponding base station controllers, connecting DSLAMs to the nearest ATM or Ethernet aggregation node or connecting a submarine communications cable system landing point with the main terrestrial telecommunications network.

Backhaul technologies include: microwave transmission and access technologies (e.g. WiMAX), dark fibre, xDSL, PDH and SDH/SONET or Ethernet.

Broadband

A term applied to telecommunications systems capable of simultaneously supporting multiple information formats at relatively high speeds such as voice, high-speed data services and video services on demand. Overall transmission speeds are typically hundreds to thousands of times faster than those of Narrowband systems.

BSA BitStream Access

Bit Stream Access refers to the situation where the incumbent provide transmission services - using its ATM or IP network, to carry the traffic from the DSLAM to a 'higher' level in the network where the operators have a point of presence - to its competitors, making the ADSL access link to the customers' premises available to third parties, enabling the provision of broadband services to its customers.

Circuit-switching

Means of creating telecoms connections by setting up an end-to-end circuit. The circuit remains open for the duration of the communication and a fixed share of network resources is tied up with no one else able to make use of them until the connection is closed. The main advantage of circuit-switching is that it enables performance guarantees to be offered. See also Packet Switching.

CO Central Office

A CO, part of the “telephone network”, is a dedicated building in which the access lines (home or office) terminate in a MDF and, normally, access/switching (PSTN) equipment, and connect to a much larger switching system (dedicated building with a MDF). In large metropolitan areas, COs are more appropriately known as Local (switching) exchanges, because they serve a local area. The term "CO" is from the early days of the telephone system when the telephone company did have only one central office in each area.

CPE Customer Premises Equipment.

Communications equipment, such as modems, set-top boxes, key systems, PABX (Private Automatic Branch Exchanges), answering machines, etc., that resides on the customer's premises (e.g., office building, home office, or factory). They are also called customer provided equipment.

xDSL xDigital Subscriber Line

Collective description for a range of Digital Subscriber Line technologies designed to provide high speed data links over ordinary copper telephone lines. Asymmetric DSL (ADSL), for example, is called asymmetric because the downstream (to the customer) speed is faster than the upstream (to the telco) speed. ADSL speeds are typically 1.5 – 6 Mbps downstream and 64 kbps upstream. Very high data rate DSL (VDSL) is similar to ADSL, but operates at 12 – 51 Mbps downstream and 1.6 – 2.3 Mbps upstream. Rate Adaptive DSL (RADSL) is also similar to ADSL but the transfer rate can be altered allowing it to work over poorer quality lines or over longer distances, albeit at lower speeds. High Bit Rate Digital Subscriber Line (HDSL) uses the same modulation as ISDN on a wider bandwidth and with more sophisticated processing. It operates at speeds of up to 2 Mbps at distances up to 4 km.

Dark Fibre

Optical fibre already deployed (e.g. in ducts), but not in use, i.e. without any electronics/opto-electronics operating at both ends.

DSLAM Digital Subscriber Line Access Multiplexer

The DSLAM is a network device, usually at a CO, that receives signals from multiple customer DSL connections, and puts the signals on a high-speed backbone line using multiplexing techniques (and it also separates incoming phone and data signals and directs them onto the appropriate operator's network). Depending on the product, DSLAM multiplexers connect DSL lines with some combination of ATM, Ethernet, or IP networks.

Duct

Underground conduit holding (fibre, copper or coax) cables belonging to either core or distribution/access networks.

ETSI European Telecomm-unications Standards Institute

A pan-European standards-making body based in France. Many ETSI standards are now being adopted world-wide.

Ethernet

The most widely-installed LAN technology. Standardised as IEEE 802.3, an Ethernet LAN uses Carrier Sense Multiple Access with Collision Detection (CSMA/CD) protocol (originally developed to manage radio based data communications - hence the name Ethernet) running over a coaxial cable or twisted pair wires. The most commonly installed Ethernet systems are called 10BASE-T and provide transmission speeds up to 10 Mbps. Fast Ethernet, or 100BASE-T10, provides transmission speeds of up to 100 Mbps and is typically used for LAN backbone systems, supporting workstations with 10BASE-T cards. Gigabit Ethernet provides an even higher level of backbone support at 1 Gbps.

Feeder line/network

In communications, a feeder line is a peripheral route or branch from a main line or trunk line. In a copper network, the feeder cables extend from the CO/MDF to the street cabinet or similar node in the access network. It is also known as the primary distribution copper network.

FTTx

Fibre to the Cabinet (FTTCab), Fibre to the Premises (FTTP), Fibre to the Home (FTTH), or fibre to the building (FTTB) is a broadband telecommunications system based on fibre-optic cables and associated optical electronics for delivery of multiple advanced services such as of telephone, broadband Internet and television across one link (triple play) all the way to the home or business.

HDTV High Definition TV

HDTV is a digital TV broadcasting format where the broadcast transmits (widescreen pictures) with more detail and quality than found in a standard analog television - provides better resolution than current televisions based on the NTSC or PAL standard or other digital television formats. HDTV is a type of Digital Television (DTV) broadcast, and is considered to be the best quality DTV format available. HDTV requires an HDTV tuner to view and the most detailed HDTV format is 1080i.

In-house wiring

In the context of NGA, in-house wiring relates to the existent/deployed cabling (e.g. copper) between the basement of a building and each flat, normally inside dedicated cable trays.

Interconnection

1. The linking together of interoperable systems. 2. The linkage used to join two or more communications units, such as systems, networks, links, nodes, equipment, circuits, and devices.

Internet

A world-wide network of computer networks in which users at any one computer can, if they have permission, get information from any other computer. The idea was conceived by the Advanced Research Projects Agency (ARPA) of the US government in 1969 and was first known as Arpanet. Since then it has been demilitarised and commercialised and augmented by a series of inventions and innovations, not least of which is the web browser invented by a team led by Tim Berners-Lee in 1991 at CERN, the European Laboratory for Particle Physics. This is the basis for the World Wide Web which has been so successful that it is now often confused in popular conversation with the Internet itself.

IP Telephony / VoIP

Also known as Internet Telephony or Voice over IP (VoIP). Use of Internet Protocol (IP, see TCP/IP) to carry and route two-way voice communications. IP Telephony can support telephone to telephone links through suitable adapters but also voice communications from telephone to IP terminal (such as a PC with sound card) or from IP terminal to IP terminal. The technique promises reduced costs to carriers and therefore prices to end users – but it still suffers problems with quality assurance.

IP

The Internet Protocol (IP) is a data-oriented protocol used for communicating data across a packet-switched network. IP is a network layer protocol in the internet protocol suite and is encapsulated in a data link layer protocol (e.g., Ethernet). As a lower layer protocol, IP provides the service of communicable unique global addressing amongst computers.

ISP Internet Service Provider

Point of access to the Internet for small business and individual users. The ISP provides its customers with dial-up access to its router which relays traffic to web servers on the Internet.

ITU-T International Telecommunication Union—Telecommunication Standardization

The Telecommunications Standardization Sector of the International Telecommunication Union. Note 1- ITU-T is responsible for studying technical, operating, and tariff Questions and issuing Recommendations on them, with the goal of standardizing telecommunications worldwide. Note 2- In principle, the ITU-T combines the standards-setting activities of the predecessor organizations formerly called the International Telegraph and Telephone Consultative Committee (CCITT) and the International Radio Consultative Committee (CCIR).

Local Loop

According to the Access Directive (Art. 2e)), "*'local loop' means the physical circuit connecting the network termination point at the subscriber's premises to the main distribution frame or equivalent facility in the fixed public telephone network.*"

LLU Local Loop Unbundling

LLU (or ULL) refers to the process in which incumbent operators lease, wholly or in part, the local segment of their telecommunications network to competitors. LLU in a copper network can be classified in two main types:

1. Full unbundling (or access to “raw copper”) - the new entrant takes total control of the copper pairs and can provide subscribers with all services including voice and the use of DSL technology. The incumbent still maintains ownership of the unbundled loop and is responsible for maintaining it.
2. Line sharing or shared access –allows the incumbent to maintain control of the copper pair and continue providing some services to a subscriber while allowing an access seeker to lease part of the copper pair spectrum, the non-voice frequency of the loop.

Although the main focus of LLU is the PSTN/copper network, unbundling could be applied to fibre optic networks and a form of unbundling (shared access) could be applied to cable networks.

MDF Main Distribution Frame

A MDF is often found at the CO/local exchange and is used to terminate the copper cables running from the customers’ premises. The frame allows these cables to be cross connected to other equipment such as a concentrator or switch.

Modem MOdulator/DEModulator

Device which converts the digital signals from a computer/network into the analogue tones which are compatible with all telephone networks, and back again. It effectively allows computers to use telephone networks for communication with other computers. The term ISDN modem which is in current usage is strictly speaking incorrect as the signal at both ends of an ISDN modem is in fact digital. The correct term should be ISDN terminal adapter.

MPLS MultiProtocol Label Switching

A set of IETF (Internet Engineering Task Force) specifications describing a label-swapping forwarding algorithm. The algorithm makes forwarding decisions based on the contents of a label inserted by an LSR (label-switching router) in each frame’s link-layer header.

MS Member States (and Country “Codes”)

European Union: Austria (AT), Belgium (BE), Bulgaria (BU), Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), Netherlands (NL), Romania (RO), Poland (PL), Portugal (PT), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE), United Kingdom (UK).

EFTA: Iceland (IS), Norway (NO), Switzerland (CH).

MSAN MultiService Access Node

A MSAN is a device typically installed in a telephone exchange (although sometimes in a street cabinet) which connects customers' telephone lines to the core network and is able to provide telephony, ISDN, and broadband such as DSL all from a single platform.

NGA Next Generation Access

As the term NGN is often used as a catch-all phrase with regard to access networks, a NGA network is generally meant to be a packet switching (IP)-based access network reaching from multi-functional access and aggregation nodes to the end-users. Such a NGA network can be made of fibre, copper utilizing xDSL technologies, coaxial cable, powerline communications, wireless technologies, or hybrid deployments of these technologies, e.g. combining fibre and copper.

NGN Next Generation Network

A packet-based network able to provide 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. *(ITU-T Recommendation Y.2001)*

ODF Optical Distribution Frame

The ODF is a passive device which terminates optical fibre cables. It is used for interconnection and patching between the optical transmission network/equipment and also optical access networks.

OLT Optical Line Termination

OLT is an access concentrator and termination point (for ONUs) on a FTTx (e.g. PON) solution, normally located at the CO. A single fibre runs from the OLT towards the customers (ONUs) and, typically, a single OLT serves 32 ONUs for distances up to dozens of km. It uses separate optical wavelengths for voice/data (and/or video) downstream and upstream.

ONU/ONT Optical Network Unit/Terminal

Within FTTx networks the user nodes are called ONUs or optical network terminals (ONTs). An ONT is a single integrated electronics unit, while an ONU is a shelf with plug-in circuit packs. In practice, the difference is frequently ignored, and either term is used generically to refer to both classes of equipment.

QoS Quality of Service

1. The performance specification of a communications channel or system. Note: QoS may be quantitatively indicated by channel or system performance parameters, such as signal-to-noise ratio (S/N), bit error ratio (BER), message throughput rate, call blocking probability, jitter and delay. *2.* A subjective rating of telephone communications quality in which listeners judge transmissions by qualifiers, such as excellent, good, fair, poor, or unsatisfactory.

In the fields of packet-switched networks and computer networking, the traffic engineering term QoS refers to control mechanisms that can provide different priority to different users or data flows, or guarantee a certain level of performance to a data flow in accordance with requests from the application program. Quality of Service guarantees are important if the network capacity is limited, especially for real-time streaming multimedia applications, for example voice over IP and IP-TV, since these often require fixed bit rate and may be delay sensitive.

Packet Switching

Means of creating connections by breaking up the information to be sent into packets of bytes, sending them along a network with other information streams and reassembling the original information flow at the other end. The main advantage of packet-switching is that it makes very efficient use of fixed capacity. The disadvantage is that the quality of service of an information channel cannot be guaranteed. See also Circuit Switching.

PON Passive Optical Network

A passive optical network (PON) is a system that brings optical fibre cabling and signals all or most of the way to the end user. Depending on where the PON terminates, the system can be described as fibre-to-the-curb (FTTC), fibre-to-the-building (FTTB), or fibre-to-the-home (FTTH). A PON consists of an Optical Line Termination (OLT) at the communication company's central office and a number of Optical Network Units (ONUs) near end users. Typically, up to 32 ONUs can be connected to an OLT. The passive simply describes the fact that optical transmission has no power requirements or active electronic parts once the signal is going through the network.

A PON could also serve as a trunk between a larger system, such as a CATV system, and a neighbourhood, building, or home Ethernet network on coaxial cable.

(x)PON

APON (ATM PON) was the first PON standard. BPON (Broadband PON) appeared in a later phase, largely replacing APON in PON deployments because of its superior characteristics: resilience, WDM support for video overlay, higher bandwidths, dynamic bandwidth allocation and can be run at 622 Mbps or 1.2 Gbps. EPON (Ethernet PON), a 2004 standard by IEEE (Institute of Electrical and Electronics Engineers Inc.), running at 1.25 Gbps symmetric and using Ethernet instead of ATM data encapsulation. Ethernet and PON technologies can a most cost-effective and high-performance access technology, combining the point-to-multipoint technology inherent in the original Ethernet technology. GPON is IP-based and appears to be a standard choice for high-volume FTTP networks, combining attributes of BPON and EPON and supporting gigabit rates enabling “triple play” offers. It recognizes gigabit Ethernet interfaces to enable pure IP transport and does not require active powering points in the access network. GPON is the platform for all FTTP deployments.

PSTN

The public switched telephone network (PSTN) is the network of the world's public circuit-switched telephone networks, in much the same way that the Internet is the network of the world's public IP-based packet-switched networks. Originally a network of fixed-line analog telephone systems, the PSTN is now almost entirely digital, and now includes mobile as well as fixed telephones.

The PSTN is largely governed by technical standards created by the ITU-T, and uses E.163/E.164 addresses (known more commonly as telephone numbers) for addressing.

Router

A device, or in some cases software in a computer, that determines the next network point to which a packet should be forwarded on its way to its destination. Typically, a packet will travel through a number of network points with routers before arriving at its destination.

TCP/IP Transmission Control Protocol/Internet Protocol

Collective name for the set of protocols on which the Internet is based. TCP and IP are the best known of this set, but they are by no means the only ones. TCP guarantees that every byte sent from one port arrives at the other in the same order and without duplication or loss. IP assigns local IP addresses to physical network addresses providing a structure which can be recognised by Routers. Other members of the TCP/IP family include the Telnet protocol which allows a remote terminal to log in to another host, the Domain Name System (DNS) which allows users to refer to hosts by name rather than having to know their numeric IP addresses, the File Transfer Protocol (FTP) which defines a mechanism for storing and retrieving files, and HyperText Transfer Protocol (HTTP) which allows information to be transferred from host computers to computers equipped with web browsers.

SMP Significant Market Power

The Significant Market Power test is set out in various European Directives. It is used by the National Regulatory Authorities to identify those operators who must meet additional obligations under the relevant directive. It is not an economic test as it requires a consideration of the factors set out in the test within a specified market.

SC Street Cabinet

SCs are outdoor cabinets, normally located on the sidewalks above ground, part of the existing copper infrastructure at the distribution/access level, allowing for copper cable connections. For an enhanced use (e.g. FTTCab), the current SCs normally present several constraints, being the major one being the inhospitality of the environment. Such cabinets place severe restrictions on physical size and power consumption, and suffer from inadequate heat dissipation.

SLU Sub-Loop Unbundling

Sub-loop unbundling allows for the possibility to gain access to the incumbent's network on an unbundled basis closer to the customer than at the MDF, which is at a point between the customer's location and the incumbent's site.

SLL Shortened Local Loop

Shortened copper-line between a street cabinet and the end-user.

SDF Sub-Loop Distribution Frame

Cable distributor in a street cabinet, where incoming cables are connected with outgoing cables (secondary distribution copper network connections to the cables from the primary distribution copper network).

TDM Time-Division Multiplexing

TDM is a type of digital or (rarely) analog multiplexing in which two or more signals or bit streams are transferred apparently simultaneously as sub-channels in one communication channel, but physically are taking turns on the channel. The time domain is divided into several recurrent timeslots of fixed length, one for each sub-channel. In its primary form, TDM is used for circuit mode communication with a fixed number of channels and constant bandwidth per channel. In European systems, TDM frames contain 30 digital voice frames.

VDSL(s) Very-high data rate DSL

See xDSL.

WDM Wavelength Multiplexing

In fibre-optic communications, wavelength-division multiplexing (WDM) is a technology which multiplexes multiple optical carrier signals on a single optical fibre by using different wavelengths (colours) of laser light to carry different signals. This allows for a multiplication in capacity, in addition to making it possible to perform bidirectional communications over one strand of fibre. Two options are available: Coarse WWDM (CWDM) or Dense WDM (DWDM), depending on the type of add-drop filters (CWDM uses passive add-drop filters and DWDM uses active ones). Referring to the capacity, DWDM transmission supports up to 160 wavelengths at the current time.