ERG Opinion on Regulatory Principles of NGA

The ERG Opinion constitutes at the same time the ERG Common Position on NGA.

This document is the ERG Opinion on Regulatory Principles of NGA requested by Commissioner Viviane Reding in her letter dated 30 April 2007, which was welcomed by the I/ERG Chairman Roberto Viola in his answer of 7 May 2007. It is based on the NGA consultation document that was consulted upon from 4 May to 11 June and also takes into account of the comments received in that period. In order to enable the Commission to draw upon the Opinion for the upcoming proposals on the Review of the ECNS regulatory framework, it will be submitted by 1st October. The consultation report will be published later in a "Supplementary Document" which will also contain several additional parts with country case studies and business case studies and other factual information referenced in the Opinion.

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This ERG Opinion on NGA constitutes the Common Position of ERG on Regulatory Principles of NGA.

Executive Summary

The introduction of Next Generation Networks (NGN[1]), leading to a multi-service network for audio (including voice), video (including TV) and data, as well as new plans and investment in next generation access (NGA) sets the communications sector on the verge of a new era. These developments give rise to innovation opportunities at both the service and infrastructure level and may subsequently impact significantly on market structure. Additionally, due to the increased economies of scope of a multi-service network cost savings are to be expected.

Creating competitive markets for electronic communications services within and across member states as well as incentivising efficient infrastructure investment, promoting innovation and thereby maximizing benefits for consumers constitute the main objectives of the framework. Furthermore the balance between service and infrastructure competition (ladder of investment) taking into account the existence of other infrastructure (e.g. cable) needs to be considered in the light of the dynamics caused by NGA roll-out.

In this document we will analyse the impact NGA deployment has on the scope of regulation and the way in which regulatory principles may need to be adapted. More specifically NRAs have to ask whether current instruments in the ECNS are still appropriate to deal with these developments. The introduction of NGN and NGA may give rise to new bottlenecks while old ones may disappear allowing to remove regulation accordingly.

NGA may impact on the definition of relevant markets at the retail and at the wholesale level. To assess whether or not these markets require ex-ante regulation the 3-criteria test must be carried out. The criteria, which must cumulatively be fulfilled are firstly the presence of high and non-transitory entry barriers, secondly a tendency toward effective competition and thirdly adequacy of competition law to address market failures.

With regard to structural entry barriers points such as cost and demand conditions, substantial economies of scale and/or scope and high sunk costs have to be taken into account. For NGA roll-out some of these factors are analysed in Chapter 3. With regard to the second criterion judgement also needs to take account of the extent and coverage of competing networks or infrastructure.

Markets meeting the 3-criteria test are considered to be susceptible to ex-ante regulation. In case SMP has been found in one of these markets ex-ante regulatory obligations imposed must be appropriate and be based on the nature of the problem identified, proportionate and justified in the light of the objectives mentioned above.

For an effective transition it is important that NRAs ensure that there is transparency and debate surrounding any planned deployment of next generation access networks. Regulators need to develop their regulatory approach early on to provide the necessary predictability to all market players.

This regulatory approach is based on the existing ECNS[2] Regulatory Framework, which I/ERG considers fundamentally sound the principles remaining suitable and allowing NRAs to

1 A list of definitions and acronyms is presented in the Glossary.

2 ECNS – Electronic Communication Networks and Services.

deal with the regulatory challenges posed by the roll-out of NGA. Above all, this is ensured with the principle of technological neutrality (Art. 8 FD) and the general approach of economic regulation to address market power and deliver a competitive environment (Art 14-16 FD). It is important to emphasize that it is services and products delivered via the network newly rolled-out that are regulated and not the underlying infrastructure.

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. NRAs will therefore strive to maintain the level and balance of infrastructure competition achieved and pursue the movement up to the economically viable rung which may vary across Member States and within member states depending on regional characteristics. In those instances where replication of access is not considered feasible, promoting service competition is an important goal for the NRA.

As new plans and investments in 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. As long as competitive conditions have not changed the roll-out of NGAs does not provide an opportunity to roll back regulation on existing services. Also, given the pace of recent developments differing across and within Member States, regulators need rapidly to define common regulatory principles and set clear and detailed guidance in order to positively affect the competitive nature of the (access) markets and efficient investment in general.

The ERG opinion on NGA 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 have recently become a key challenge for regulatory authorities and the Commission. Thus, for the purpose of this document cable (and other alternative wireline technologies such as powerline communications) is outside the scope of the paper. This does not imply any statement on whether or not cable (or other technologies) ought to be included in any of the relevant markets discussed. Moreover where such infrastructure exists or is likely to arise, cable networks and/or other alternative infrastructures must be taken into account when dealing with the market definition, the SMP assessment and the remedies decisions.

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. The powers of NRAs to gather the necessary data and information about the rollout strategies of operators in general and incumbents in particular is crucial for 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** (FttCab), 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** (FttH) 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 as follows.

Economics of NGA

Chapter 3 deals with economic implications of the envisaged 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
- quality and topology of existing network architecture, in particular the number of street cabinets per MDF and available capacity of facilities such as ducts.

As a result, the economics of NGA networks are likely to vary across different technologies and different geographies. Conditions are likely to differ greatly among Member States and within different regions of Member States and may lead to significantly different competitive conditions possibly justifying the definition of sub-national markets (unless there is e.g. a common price constraint) in certain cases. Where a national market is defined, regulators may think of differentiating remedies within the national market.

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.

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. Therefore it is likely that Member States will see a mixture of scenarios.

Considering these differences between and within Member States with regard to either the chosen scenarios or the pace of migration it seems unlikely that a one-size-fits-all approach would reflect the specific regulatory needs of the respective countries or even regions.

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 NGA roll-out also critically depends on the ability of operators to generate higher ARPU for the services offered on these lines.

Investment in infrastructure capable of delivering innovative services may be more risky due to a higher degree of demand uncertainty as their uptake by consumers is difficult to assess for both investors and regulators. However, the demand certainty for existing services may offset the investment risk to a certain extent. Investors should employ commercial mechanisms (incremental investment, cost reduction, co-ordinate deployments) to reduce the degree of systematic risk they are and will increasingly exposed to. Promoting competition with a set of remedies[3] and providing predictability by NRAs is the best incentive for efficient investment. In the case of price control obligations regulators may consider new approaches to deal with a possibly higher investment risk such as a risk adjusted rate of return or a differentiated WACC.

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.

Implications for regulation

Chapter 4 targets the regulatory challenges of NGA deployment. Implications for existing regulation and challenges to the Regulatory Framework have been analysed, with regard to Markets 1 and 2 and more 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,[4] 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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3 See also ERG Revised CP on Remedies, ERG (06) 33, Textbox 4 – Variations in remedies with new or upgraded infrastructure, pp. 116.

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

Without a clear and transparent view of the intentions of market players for deployment of next generation access networks, it is not possible for the regulator to provide a clear indication of the regulatory environment that will apply to these investments. This information can be requested from operators by NRAs according to Art. 5 FD respecting confidentiality requirements.

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. 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. The general procedure of the ECNS foresees that the relevant market is analysed first, after which a further analysis for the need of symmetrical regulation according to Art. 12 FD (e.g. facility sharing obligation) may follow.

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[5] that may lead to different result in different Member States reflecting national circumstances and different fibre deployment strategies. Where cable networks play an important role this will be reflected in the market analysis as they may influence the competitive conditions. Where a mix of different technologies and different regional characteristics across national territories leads to significantly different competitive conditions, the definition of sub-national markets may possibly be justified unless there is e.g. a common price constraint.

Thus, there is no one-size-fits-all solution for the regulatory approach to NGA 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 definition of retail markets 1 and 2

Developments towards a single all-IP network to substitute multiple traditional core networks and NGA developments increasing bandwidth of the access line will change current retail access products because these products are based on TDM technology and infrastructure of the underlying access and core networks. Multiple retail services may be supplied across these NGN/NGAs. It is to be expected that narrowband access products will be increasingly replaced by broadband access products as broadband access combined with VoIP is a potential substitute for narrowband access to the public telephone network. In the presence of such broadband retail offers, future decisions by NRAs related to the definition of this market 1 may include broadband access where it passes the substitutability test.

Currently the markets 1 and 2 are defined as 'access to the public telephone network at a fixed location' for residential and non-residential customers, respectively. Since IP-networks are used to provide telephone services they may be considered public telephone networks. Going a step further the term "public telephone network" may be replaced in the long run by the term "public electronic communications network". Such a step would fully reflect the

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

development towards a multi-service network being a core feature of NGNs. The access market would accordingly be defined without any reference to specific services to be supplied across the network.

As a first step the Recommendation on relevant markets should allow NRAs flexibility to include broadband access in the access markets 1 and 2 where justified by a substitutability test given national circumstances.

Implications for definition of Markets 11 and 12

The network developments might have implications for the definition and 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).

Market 11

In the Recommendation, Market 11 is defined as wholesale unbundled access (including shared access) to metallic loops and sub-loops. In the AD, 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). 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. In line with the AD in the NGA context a local loop can thus be defined 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.

With the introduction of NGA, the former definition of local loop in the Recommendation 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, local loop unbundling can take place at the street cabinet;
- FttB - the local loop consists of the copper line from the building entrance (where fibre ends) to the end-user premises, local loop unbundling can take place at or near the building;
- 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 point-to-multipoint solutions (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 of 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 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.

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.

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. ERG proposes to enlarge Market 11 accordingly. ERG assumes this “enlarged” Market 11 would pass the 3-crieteria-test run by the Commission.

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 as native multicast (e.g. of TV channels). Bitstream access at MDF or equivalent aggregation nodes may become more important with fibre being rolled out closer to the end-user.

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 SMP party (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. For all scenarios the access/handover can be at IP or Ethernet level (as a simple transport protocol Ethernet can facilitate more innovative services features such as multicast). 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 with regard to remedies

FttCab Scenario

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 costs 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 NRA's objective of promoting 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 (SLU) being part of Market 11 implies an access obligation to provide it in all Member States.
- Unbundling the shortened local loop ending at the street cabinet implies the need for colocation at 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;
- Furthermore unbundling the shortened local loop ending at the street cabinet implies the need for backhaul service in the middle mile from the cabinet to the operator's node and/or duct sharing:
  - Backhaul services may be difficult for alternative operators to provide for themselves. Backhaul could be considered: (i) as an ancillary service to market 11 to the shortened local loop or SLU; (ii) as a wholesale terminating segment of leased lines (market 13); or (iii) a separate backhaul market could be defined.
  - Duct sharing could be imposed as an ancillary service to Market 11.
- Wholesale bitstream offers incl. SLAs (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 products 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.
- Access to duct sharing[6] as a remedy could be mandated acc. to Art. 12 AD to facilitate local optical loop roll-out by alternative operators. Different approaches to SMP regulation can be distinguished:
  - o Duct sharing could be imposed as a complementary remedy on a widened Market 11 encompassing both copper and fibre loops;
  - o 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.

It could be considered to clarify the basis for imposing an Art. 12 FD obligation for facilities sharing to encourage efficient NGA investment. A modification of Art 12 FD could further strengthen the powers of national regulators allowing them to:

- impose a symmetrical obligation to any electronic communications operator to negotiate sharing of facilities (ducts, in-house wiring, etc.) 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;
- intervene in particular for promoting fair competition, and in this context to impose the setting up of extra facilities.

Procedural Issues during the migration period

The implementation of NGAs has consequences for regulated services in the overlay phase where the current access network functions next to the NGA and in the substitution phase where the NGA has replaced the current access network.

In general the NRA should make an inventory of possible effects of the NGA of the SMP party on the regulated services. The NRA should analyse whether the national existing procedures (e.g. taskforce for spectral interference issues) are sufficient to deal with this consequences. If this is not the case, it may well be the task of the NRA to create new procedures. If the informal role of the NRA does not lead to solutions, the NRA should have the authority to act more formally (e.g. to solve a dispute or to impose a fine). After all the service which is affected, is a regulated service.

Before the current access network is replaced by a NGA, it should be clear whether all the regulated services can continue to be delivered in the NGA. If this is not the case (e.g. phase-out of MDF access), an equivalent alternative should be determined. This equivalent alternative should be developed and implemented. After it is possible to actually buy the equivalent alternative, phase-out of the (old) regulated service should be allowed. The allowance of phase-out is most probably joined by conditions with regard to e.g. a reasonable phase-out period.

The costs of operating two access networks parallel for a long period can be highly inefficient. If cost orientation applies to the regulated services the service takers and the end-

6 See also Annex „ERG Opinion on the Practicalities of Duct and other Facility Sharing“.

users should not pay for this inefficiency. A possible solution could be found by setting a condition that a user should not pay more for the same service when the (network/service) migration occurs.

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. 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.

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 of investment 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 MDF or equivalent aggregation node 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.

Given the impact of scale effects on competitive conditions in different areas of a country, the national market structure may become more heterogeneous as the NGA roll-out may not happen everywhere. Summing up it can be said that in order to maintain the level of competition reached, NRAs may have to adjust the access products to fit to the NGA hierarchy, potentially followed by a lot of movements of operators, the general concept of the ladder will stay in place.

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 (or retail-minus prices) can be seen as 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

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This ERG Opinion on NGA constitutes the Common Position of ERG on Regulatory Principles of NGA .

1 Introduction

The introduction of Next Generation Networks (NGN[7]) leading to a multi-service network for audio (including voice), video (including TV) and data as well as new plans and investment in next generation access (NGA) sets the communications sector on the verge of a new era. These developments give rise to innovation opportunities at both the service and infrastructure level. Additionally, due to the increased economies of scope of a multi-service network cost savings are to be expected.

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 define common regulatory principles and 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[8], 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[9], 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”, NRAs stated that implementation of NGNs is, normally, beginning at the core (transport) level followed by changes in access networks.[10] Differences between Member States (but also within each country) 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, high-speed data, TV and video) over one or very few platforms.

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7 A list of definitions and acronyms is presented in the Glossary.

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

9 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.

10 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 Supplementary Document Part 4.

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.[11] 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[12] 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, given the current and planned extent of the rollout of technologies like wireless and cable in most Member States. Thus, for the purpose of this document cable (or powerline) is outside of the scope. This does not imply any statement on whether or not cable ought to be included in any of the relevant markets discussed.[13]

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[14] have become a key challenge for regulatory authorities and the Commission recently. Thus, for the purpose of this document cable (and other alternative wireline technologies such as powerline communications) is outside of the scope. This does not imply any statement on whether or not cable ought to be included in any of the relevant markets discussed.

The development towards NGN at the core level and NGA at the access level has implications for the analysis of a number of markets of the Recommendation on Relevant Markets susceptible to ex-ante regulation[15].

At the retail level this may concern markets 1 and 2 since with progressing NGN/NGA access lines may increasingly become broadband only (e.g. "Naked DSL") including the provision of voice telephony.

At the wholesale level implication for markets 8-10 have been analysed in the ERG Report on IP Interconnection.[16] An analysis of implications for Wholesale Markets 11 and 12 is a core part of this Opinion on NGA. More specifically the 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.

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11 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 (UNI).

12 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.

13 For further remarks on cable see Section 3.2.1.

14 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 Member States as well.

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

16 See ERG (2007).

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.

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 to 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? How should the migration process from the current to the NGA network be managed? 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 Opinion is to discuss possible options and solutions to those and, as a result, provide a set of common guidelines to operators and NRAs as well as the Commission 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/Fibre to the Building”.

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 Supplementary Document III). 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, with regard to Markets 1 and 2 and more particularly with regard to Markets 11 and 12 of the Recommendation.[17] 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, are suggested as a result of the analysis. Further sections of this chapter will be dedicated to focusing on procedural issues of the migration phase and 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.

17 The impacts on Markets 1 and 2 are also discussed.

2 Overview over Access / Backhaul Scenarios

2.1 Technologies available

Currently, almost all wireline access lines between the central office (CO[18]) 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[19] 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 this local loop. 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;
- 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 (using ADSL2+ and/or VDSL/VDSL2), fibre to the building, or fibre to the home (fibre only).[20]

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

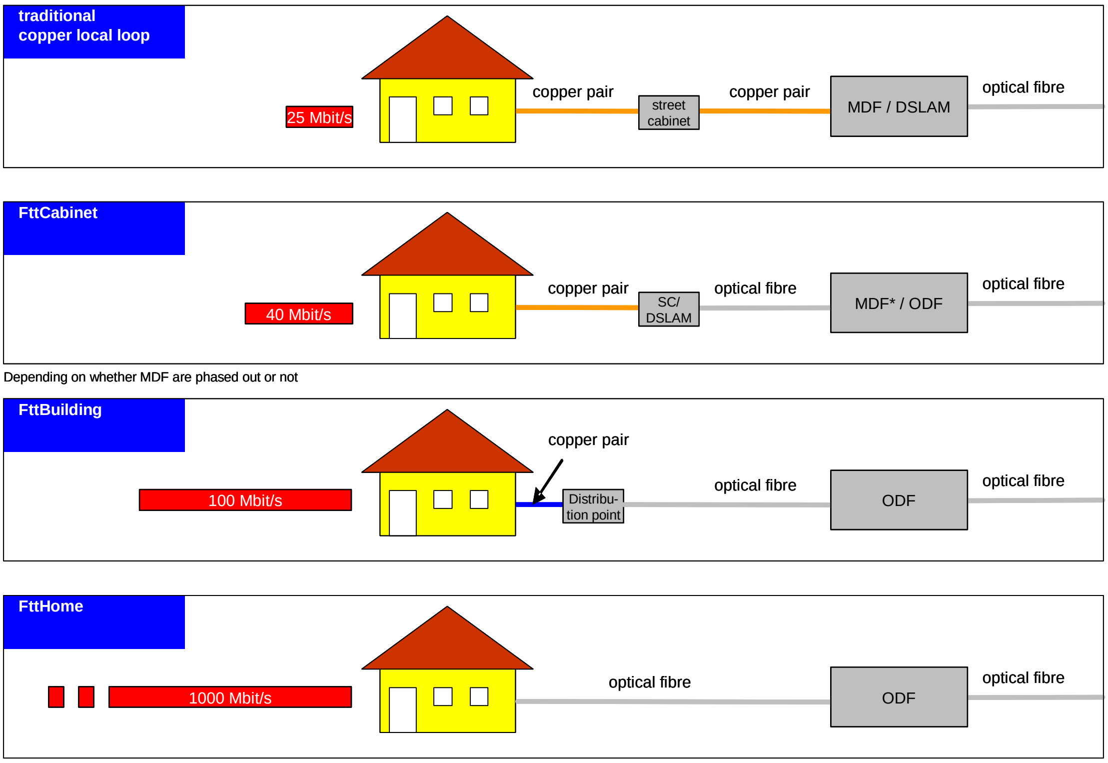


Figure 1: Access architectures using fibre and typical maximum speeds (Source: Arcep).

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 infrastructure (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 to a greater or lesser extent:

- **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 on the remaining copper line;
- **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.

21 Replacing the current copper feeder network.

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, discussed in more detail in Chapter 4.

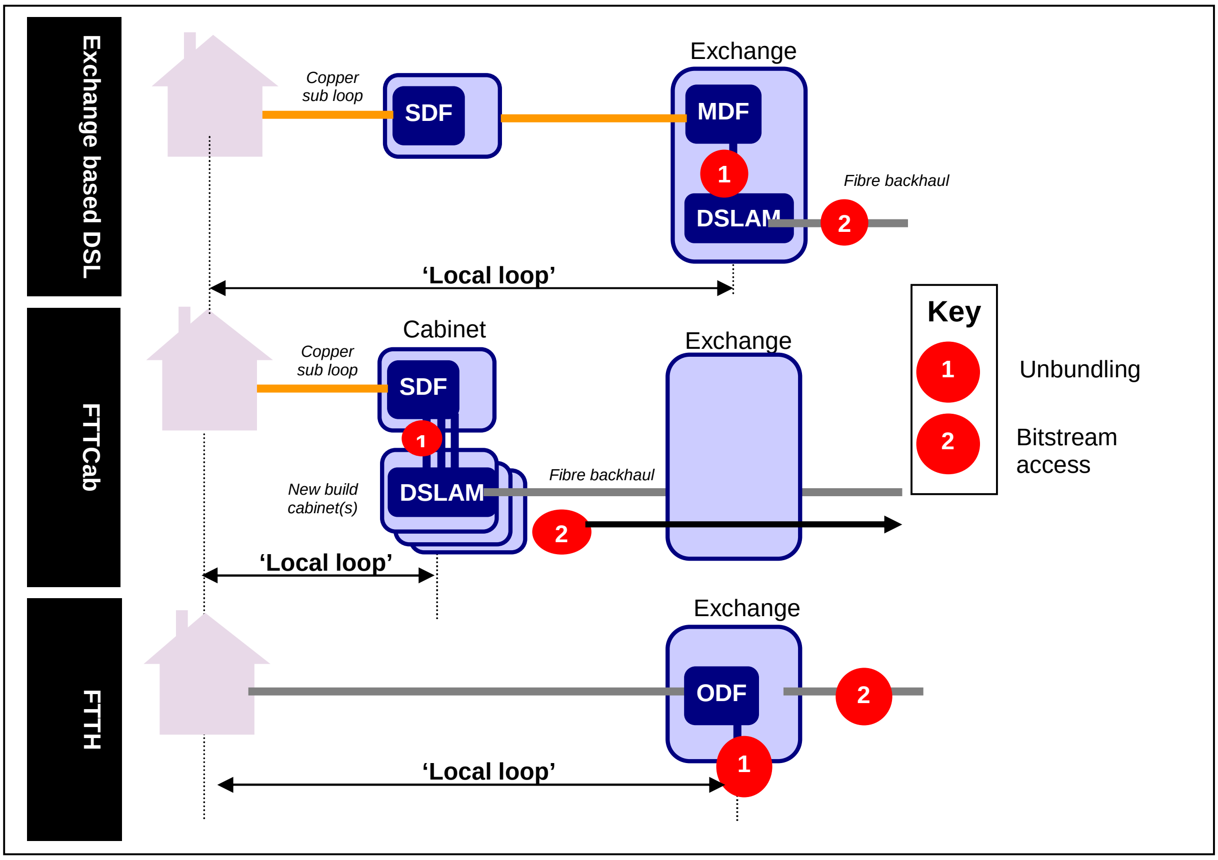


Figure 2: Examples of the 'local loop' under different technology deployments.[22]

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).[23] As opposed to the other scenario considered in this paper, copper remains on the last "mile", between cabinet and end-user.

22 The FTTH scenario in this Figure shows the "point-to-point" solution. FTTH can also take the form of a point-to-multipoint solution (PON), depicted in Fig. 6.

23 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.

Advanced (V)DSL technology[24] 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 boost the reach of their high speed DSL networks to a significantly higher percentage of the population.[25]

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)[26] (see Figure 3). Offers on the market already provide bandwidths up to 50 Mbit/s (downstream) on the basis of VDSL2.

24 E.g. VDSL (ITU-T G.993.1) and VDSL2 (ITU-T G.993.2). The VDSL2 technology is downward compatible with ADSL 2+. However, due to the more intrusive characteristics of VDSL technology, a closer coordination regarding frequency usage may be needed.

25 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 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.

26 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.

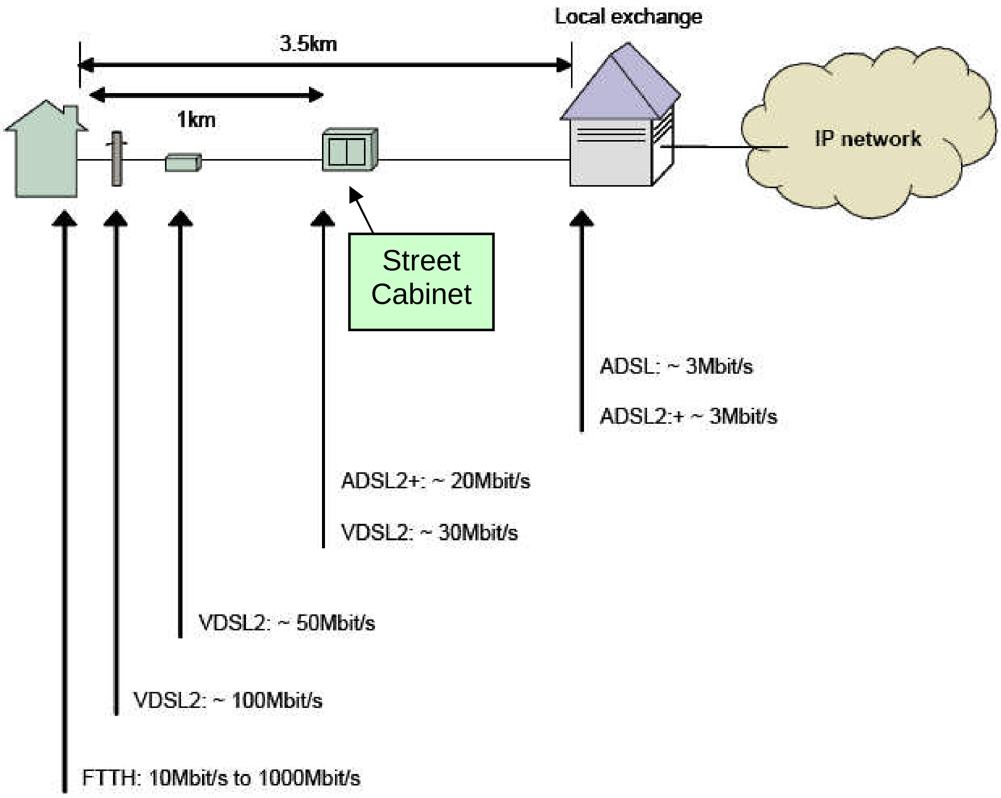
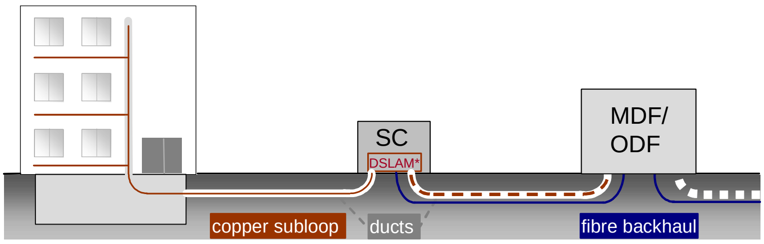


Figure 3: Decreasing loop length, increasing bandwidth (Source: OVUM).

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. Therefore, the DSLAM[27] is shifted from the MDF to the street cabinet 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.

27 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.

At the upper network level, an Ethernet switch[28] (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).[29]

The performance curves of xDSL technologies are valid for a homogenous use of one technology on selected pairs. The deployment of xDSL technologies is more complicated with the usage of different technologies from the same point and the localisation of DSLAMs at several distances from the end-user (MDF, intermediate DF, street cabinets). The radiation of one signal affects the signals in the other pairs of the cable (different spectrum of emitting, different power depending of technology and point of insertion, different modulation code) reducing the download and/or upload speeds. Limitations of the configuration possibilities permit to minimize the consequences of interferences. For possible solutions to these problems see Section 4.5.

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

Fibre to the home (FttH[30]) 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[31] 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 (ODF) and optical splitters. Depending on the type of solution, some electronic equipment might also be needed.

No “one-size-fits-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[32] or point-to-multipoint – “Passive Optical Network” (PON) – networks.

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

29 See JP Morgan (2006), p. 22

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

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

32 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.

- Point-to-point architecture:

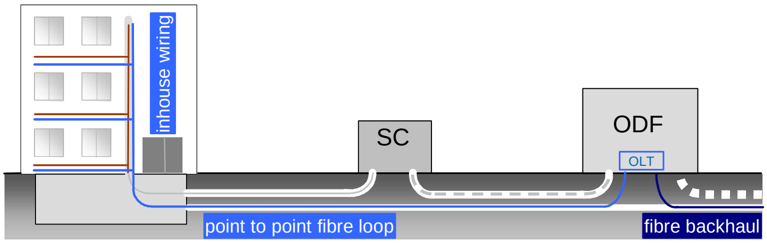

Figure 5: Point-to-point FttH design

Each subscriber is provided with a dedicated "pipe" – no capacity or traffic sharing – accessing the full bidirectional bandwidth available from the OLT[33]/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[34] to distribute fibre to individual homes:

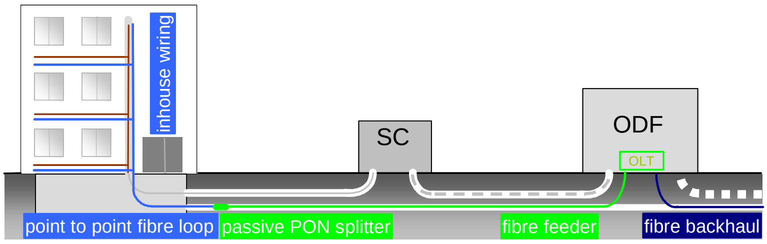

Figure 6: Generic PON design

The basic architecture for communications in the PON is a point-to-multipoint network[35], where the OLT (e.g. at the CO) serves as the control point for the entire PON[36]. 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 up to 64 fibres (each dedicated to a single user) over a maximum distance of up to 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.

33 Optical Line Terminal (OLT) unit. Normally, located in the CO.
34 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.
35 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.
36 The switching and routing is done at the operator's central office.

But there are also several different PON architectures to consider, like APON[37], BPON[38], EPON[39] and GPON[40].

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.

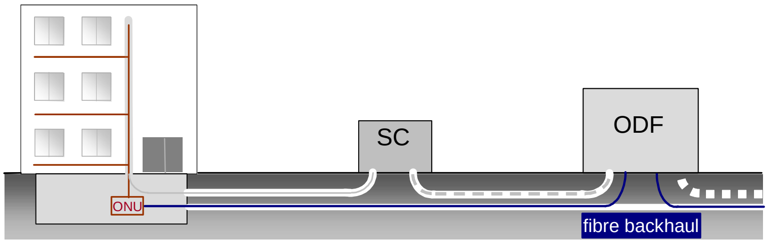

Figure 7: Generic FttB design

In this solution, the access to the subscriber loop at the ONU[41] requires optical connections (generically, a OF backhaul[42]) 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.[43]

2.4 Shared fibre access technologies – Wave Division Multiplexing

There is a further technology, Wave Division Multiplexing (WDM), 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

37 APON (ATM PON) was the first PON standard.
38 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.
39 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.
40 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.
41 DSLAM/MSAN/Ethernet switch, etc.
42 Although in the case of a "PON solution" (for the fibre going towards the building), the principles identified for FTTH/PON are also applicable.
43 See JP Morgan (2006), p. 63 cf. for an overview, see also Annex 2.3, 2.4.

transmission supporting up to 160 wavelengths at the current time.[44] 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 unbundled 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.

44 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.[45] 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 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. 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 (or persistence) 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[46] and BSA[47]) where necessary to allow competitors to gain scale.

Considering the existing differences between Member States with regard to either the chosen scenarios or the pace of migration it seems plausible that a one-size-fits-all approach would not reflect the specific regulatory needs of the respective countries.
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.

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45 Furthermore NRAs shall contribute to the development of the internal market and the welfare of the European citizen.
46 Local Loop Unbundling.
47 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. The existence of cable networks plays an important role in the market analysis as offers from cable operators may influence the competitive conditions and must therefore be considered by NRAs when analysing the relevant market.

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, ranging from 10 in France to about 40 in Germany.[48]

As a result, the economics of NGA networks are likely to vary across different technologies and different geographies. Conditions are likely to differ greatly among Member States and within different regions of Member States and may lead to significantly different competitive conditions possibly justifying the definition of sub-national markets (unless there is e.g. a common price constraint). Where a national market is defined, regulators may think of differentiating remedies within the national market.

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

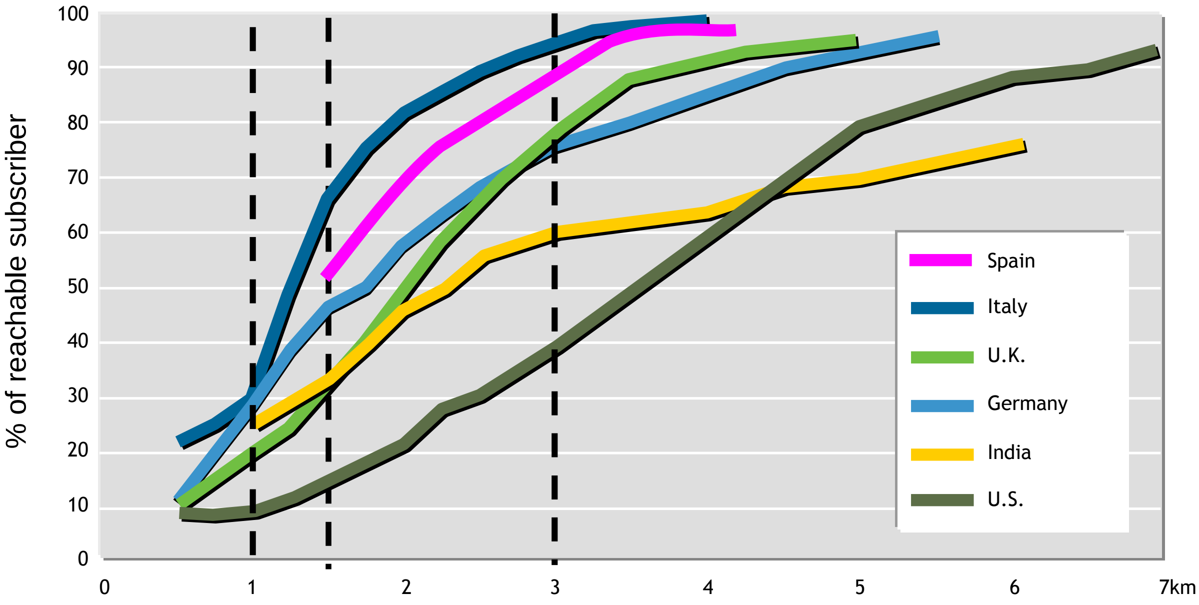

Figure 8: Distribution of Subscriber Loop Length (Source: Alcatel)

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

3.2.2 Business case studies

The results of a number of business case studies (Analysys, Arcep, JP Morgan, Ovum and WIK) are summarized here to give a quantitative flavour to the fundamental economics of NGA fibre deployment. They differ 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). While Analysys supposes that the complete investment of competitors including those for LLU at the MDF need to be recovered by competitors to make the business case viable, the JP Morgan study only takes account of incremental investment to reach the street cabinet when calculating the profitability of roll-out projects.

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 are a crucial cost factor for fibre roll-out. They are even more relevant for the FttC scenario, as fibre is rolled out all the way to the building.

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.

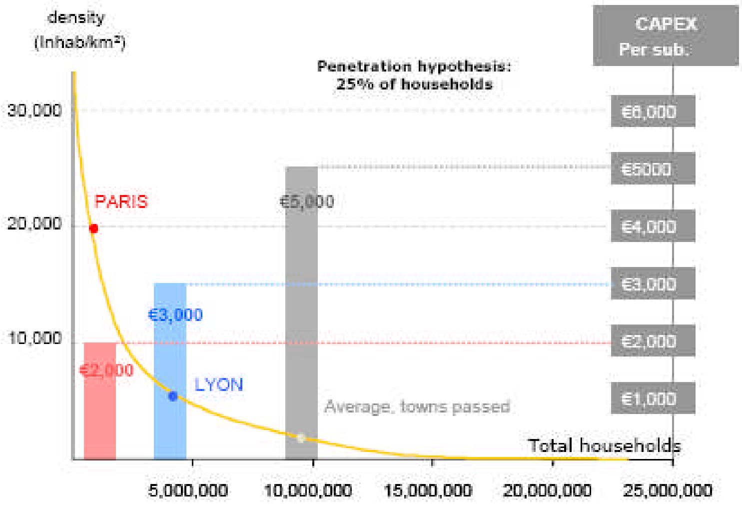

Figure 9: CAPEX (per subscriber) vs. total households/density (Source: Arcep).

These costs constitute between 50% (in Paris) and 80% of the total cost per customer depending on the population and they vary from €55/meter in rural areas to around €120/meter in urban areas.[49]

The level of the – horizontal – roll-out cost depends largely on the usage of existing infrastructure such as trenches or ducts, as this reduces the civil engineering costs.

Other cost components to be considered for the FttCab scenario are the costs of the DSLAM and other electronic equipment (e.g. modems), colocation cost as "fixed" cost and OPEX cost.

For the replicability and viability of the business case, 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. Given that the number of customers reachable is considerably smaller per node than per MDF, the viability of a business is largely affected by the number of street cabinets per MDF.[50] 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.

The following Figure 10 illustrates for the FttCab Scenario how the cost per line depend on the customers served within a typical urban exchange area.[51] Economies of scale are much more significant for sub-loop unbundling than for LLU. For the former they are still significant even with well above 1000 customers per exchange, for the latter they are typically

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

50 In France there are approximately 10 SC per MDF and 40 in Germany. Analysys draws the conclusion that the additional costs per month/subscriber of VDSL compared to ADSL is €2,6 in France and €12 in Germany.

51 See Analysys (2007b). The Figure shows the costs for a typical urban exchange area. 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 – all assumed to be regulated at cost.

exhausted with 500 customers. Thus, a competitor is always likely to be at a relative disadvantage to a larger incumbent.[52] Although the relevant part of the cost curve depends on the country, it is likely to lie more on the left hand side (less customers per area) then on the right end.

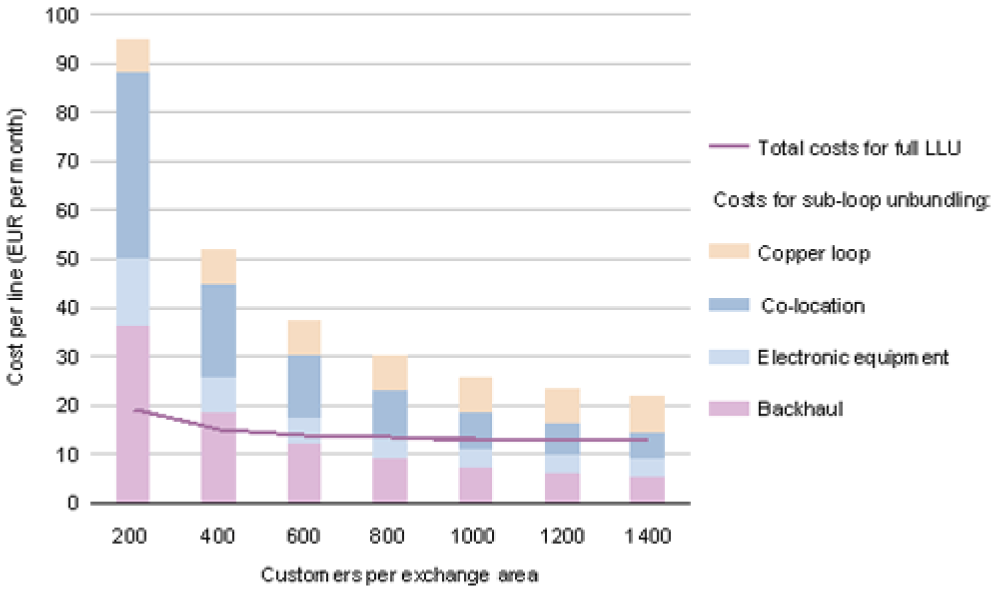

Figure 10: Cost per line vs. customers per exchange area (Source: Analysys).

For the FttH scenario, next to the horizontal costs which are by far the most significant cost component the cost associated with the vertical roll-out (for in-house wiring) are also important.[53]

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 its study WIK concludes that the profitability of the incumbent's VDSL roll-out 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% to 31% of all households passed.[54]

In its case study for the Netherlands Analysys comes to the conclusion that, 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 the use of LLU, except under certain conditions (requiring a significant market share or ARPU increase). Considering the strong local economies of scale effects even cuts of 50% in KPN's wholesale tariffs would not be sufficient to make SLU an economically viable alternative to LLU to reach the mass market.

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52 This holds true even given tight regulation of essential facilities at cost-based rates.

53 They (often) result from difficulties with the physical conditions of buildings (e.g. availability of internal trays) or with the house owners. According to Arcep indoor wiring costs range from €300 to €500 per customer.

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

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.

3.2.2.3 Conclusion of business case studies

Considering that the conditions are likely to differ greatly among Member States and within different regions of Member States the following observations can be derived from the business case studies:

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

"Horizontal" engineering costs are generally seen as the most important cost driver. Access to existing ducts thus allows to significantly lower roll-out costs. Therefore, existing ducts owned by the SMP party are likely to constitute an enduring economic bottleneck.

The profitability of VDSL roll-out depends on several factors, in particular:

- population density
- customers reachable per node
- penetration rate
- market share
- ability to increase ARPU

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. Scale economies may lead to a natural monopoly in certain areas of the electronic communications value chain. Therefore it is likely that Member States will see a mixture of scenarios.

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*".

It should be noted that NGA deployments may entail stranded investment[55] in particular for the competitive operators (but also for incumbent). Although, it will not be possible to completely avoid any stranded investment (as they are often caused by technological progress), NRAs need to carefully examine whether they are caused by strategic decisions - rendering traditional business models no longer viable. See Section 4.1 for a more detailed analysis of this 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 wireline access networks.

55 See Section 4.1

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

There are a number of factors beyond the economics of NGA networks to be considered 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, gas and electricity distribution networks;
  - b) Ducts and infrastructures, owned by municipalities/(public) utilities;
  - c) In-house (building) infrastructure.
- Property rights of:
  - a) Municipalities (installation of additional street cabinets[57]);
  - 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 (new) 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 (or, e.g., sewers) can reduce horizontal roll-out costs, especially 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.[58]

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 (fibre) wiring.

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

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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.
57 And multiple/continuous interventions in the public ground for the installation of new ducts.
58 For possibilities of duct sharing between telco operators e.g. as an ancillary service to the local loop – see Chapter 4 below and Annex: ERG Opinion on the practicalities of duct and other facility sharing.

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;
- *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.[59]

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

59 Cf. ERG (2006), p. 60.

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[60]:

- 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".*

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.*[61] *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".*[62]

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 effective and 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.

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60 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.

61 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.

62 ERG (2006), p. 12.

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, i.e., assuring non-discrimination.

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,[63] to invest in a step-by-step manner in own infrastructure. Service competition based on regulated access at cost-oriented prices (or retail-minus prices) can be seen as 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.[64]

Incentives for efficient investment

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.

The aim of regulators is therefore to encourage efficient and timely investment in NGA networks. Efficient and timely investment involves investment decisions on the most appropriate technology at the right time and in specific locations by operators. These factors result in a wide range of options for the efficient delivery of NGA investments. This large set of potential investments of differing cost, and potentially value to end customers, therefore involves choices across the changing set of options over time that maximises expected private and public value. In most instances, this sort of complex decision is best left to the market, as opposed to regulators, to make while regulators should provide a predictable regulatory environment.

One of the main challenges for regulation is therefore 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

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

appropriate rate of return on its investments. This return should adequately reflect the degree of risk faced at the time the investment is made.

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.

Investment in infrastructure capable of delivering innovative services may be more risky due to a higher degree of demand uncertainty as their uptake by consumers is difficult to assess for both investors and regulators. However, the demand certainty for existing services may offset the investment risk to a certain extent.

Looking at investors in NGA networks first, there are a range of commercial mechanisms investors can employ to reduce the degree of systematic risk they are exposed to. These include:

- incremental investment, limiting exposure to demand side risks until the commercial case has been proven;
- cost reduction – NGA networks deployments may result in cost savings, and therefore not require additional revenues to ensure a return;
- co-ordinated deployments – operators could seek to diversify risk by deploying networks in co-operation with competitors, aggregating their customer bases to increase demand for services delivered via the NGA network.

Promoting competition with a set of remedies[65] and providing predictability by NRAs is the best incentive for efficient investment. Remedies may include access obligation (Art. 12 AD) and price control obligations (Art. 13 AD) where appropriate and proportionate. A general price control mechanism should at least include the principle of fair and reasonable pricing. More specifically in the case of price control obligations approaches to deal with a possibly higher investment risk could include the following:

- **Risk adjusted rate of return** – regulators could seek to incorporate the risk incurred as a result of NGA network deployments by increasing the allowable rate of return on capital employed. This is a relatively simple measure to implement, but difficult in practice to estimate and monitor. Estimating the degree of risk involved in NGA would require a high level of information for the regulator at a time when there were significant information asymmetries. At the same time, the risk incurred will vary over time, with different investment tranches facing different risk profiles. Finally, this approach will not necessarily incentivise efficient investment – operators may be guaranteed a higher return on their capital employed whether this was an efficient investment or not. It could therefore incentivise inefficiently early or large investments in network assets. This is a relatively blunt tool to incentivise investment in NGA.

65 See also ERG Revised CP on Remedies, ERG (06) 33, Textbox 4 – Variations in remedies with new or upgraded infrastructure, pp. 116.

- In order to avoid these downsides and in order not to distort the structure of investments in assets associated with different risks, regulators could think of adopting a **differentiated WACC**, that takes into account the different level of risk, i.e. calculate a divisional cost of capital. The usage of a divisional cost of capital is recommended if the risks faced by the incumbent across various regulated products are materially different. Naturally, the information problem just described exists here too. I/ERG analysed the various methods to calculate a divisional cost of capital and assessed the pros and cons in the "IRG PIBs for WACC calculation" to which reference is made here.[66] However, even though a differentiated WACC allowing investors a return on its investment which properly reflects the levels of risk borne incentivises efficient investment, it aggravates the task to regulate access prices consistently which is crucial for making the ladder of investment work.

66 IRG PIBs for WACC calculation, February 2007, Ch. 5 – The divisional cost of capital, pp. 25.

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[67], 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.

As the I/ERG stated in its Response[68] to the Review consultation documents the existing ECNS[69] Regulatory Framework is fundamentally sound. The principles remain suitable and allow NRAs to deal with the regulatory challenges posed by the roll-out of NGA. Above all, this is ensured with the principle of technological neutrality (Art. 8 FD) and the general approach of economic regulation to address market power and deliver a competitive environment (Art 14-16 FD). It is important to emphasize that it is services and products delivered via the network newly rolled-out that are regulated and not the underlying infrastructure as is sometimes assumed by those who either argue in favour of an automatic exemption ("regulatory holidays") or an automatic open access obligation that was at the core of the old ONP framework.

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. NRAs will continue to follow these principles and the 3-steps process which are not altered by the roll-out of new infrastructure. Thus if an operator is found to have SMP the NRA will impose the appropriate remedies to solve the competition problems. Therefore the general procedure of the ECNS foresees that the relevant market is analysed first, after which a further analysis for the need of symmetrical regulation acc. to Art. 12 FD (e.g. facility sharing obligation) may follow[70].

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 NGA deployment strategies.

It is also worth noting the importance of information and transparency on plans for investment in NGA in formulating the appropriate regulatory principles. Non-transparency in planned deployments raises the risk that competition and some regulatory options could be foreclosed as a result of technology and network decisions made without input from

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

68 See IRG/ERG response to the Review of the EU Regulatory Framework for Electronic Networks and Services of 27th October 2006, p. 29.

69 ECNS – Electronic Communication Networks and Services.

70 The Commission confirmed its view on the need to run a market analysis as soon as possible in 2 recent Art. 7 comment letters regarding measures of Art. 5 AD obligations (case PL/2007/0656, UKE with regard to the internet peering exchange and case RO/2007/0653, ANRCTI with regard to an altnet).

competitors and/or from the regulator. Without a clear and transparent view of the intentions of market players for deployment of NGA networks, it is not possible for the regulator to provide a clear indication of the regulatory environment that will apply to these investments. This information can be requested from operators by NRAs according to Art. 5 FD. Transparency can prompt an informed debate amongst communications providers on the potential characteristics and requirements of planned NGA deployments. Following such a debate the NRA can decide on its regulatory approach to any SMP operator found in the relevant markets and thereby provide certainty and predictability to market players and investors.

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. As mentioned in Section 3.2.1, where cable networks play an important role this will be reflected in the market analysis as they may influence the competitive conditions. Where a mix of different technologies and different regional characteristics across national territories leads to significantly different competitive conditions, the definition of sub-national markets may possibly be justified unless there is e.g. a common price constraint.

Most importantly, a basic principle of today's market regulation – the fundamental principle of technological neutrality according to Art. 8 FD – will continue to hold true also 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. SMP defined as dominance in competition law terms is the trigger for regulation and a finding of SMP necessarily requires the imposition of at least one specific obligation.

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.

Regulators may think of differentiating remedies within a national market to reflect different competitive conditions.

When imposing specific obligations, NRAs must assess their proportionality. Also, remedies must be appropriate and must relate to the nature of the problem.[71] 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.

The appropriateness of functional separation as an additional "remedy" is currently investigated by the ERG.[72]

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71 Cf. for a more extensive description ERG Revised CP on Remedies, ERG (06) 33.
72 See ERG Opinion on Functional Separation, ERG (07) 44-final.

4.1 Implications of NGA deployments on existing regulation including migration procedures

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 adjustments of existing retail markets and 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 including those that allow offering naked DSL.

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 during the migration phase 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 (see Section 4.5 on Procedural issues during the migration phase).

However, NRAs should seek to ensure that there is transparency and debate surrounding any planned deployment of NGA networks.[73] This is important as it allows investors and potential wholesale customers of any proposed NGA network to indicate their requirements and intentions. Such transparency will be beneficial to NGA investors as they explore the degree to which there is demand for wholesale access to their networks – a vital way for these new networks to gain scale and a return on investment. It is also beneficial to competitors, who can make informed decisions on their own investment plans. Finally, it will enable the regulator to adopt the most appropriate regulatory principles.

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. In this analysis, the investment already made by alternative (LLU) operators, should be taken into consideration.

73 See Ch. 4, p. 27.

4.2 Regulatory challenges for Market Definition and Analysis 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 implications, as current upgrades of copper and fibre access networks being carried out in a number of Member States have recently become a key challenge for regulatory authorities.
The developments might have implications for the definition and 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[74]) 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). At the retail level, it is necessary to look at the access markets (Markets 1 and 2).

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. Hence, 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 Markets 1 and 2

Developments towards a single all-IP network to substitute multiple traditional core networks and NGA developments increasing bandwidth of the access line will change current retail access products because these products are based on TDM technology and infrastructure of the underlying access and core networks. Multiple retail services may be supplied across these NGN/NGAs. Broadband access combined with VoIP is a potential substitute for narrowband access to the public telephone network. Therefore it is to be expected that narrowband access products will be increasingly replaced by broadband access products.

Combined with VoIP these broadband access lines have the potential to replace traditional narrowband access products. Therefore for DSL networks, the possibility for end customers to have a DSL connection without an analogue or ISDN line ("naked DSL") will also be a critical determining factor in VoIP's success. The corresponding wholesale "standalone" bitstream product plays an important role. Therefore there is a need to fully review the treatment of naked DSL in the context of future market definitions and market analyses both at the retail and the wholesale level to facilitate alternative operators' market entry. (ERG has a PT Wholesale Broadband Access/Wholesale Local Access which is among other things working on the issue of Standalone Bitstream).

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74 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.

In its 2005 Common Statement on VoIP services[75] ERG stressed that VoIP has the potential to radically change the existing market structure. It was also stated that VoIP services are expected to offer significant benefits to users; mainly benefits related to the creation of new innovative services, price competition and integration of various services.

Broadband access will become more important as incumbents and other operators all over Europe are converting their networks from circuit-switched to packet-switched technology. In the end, the traditional PSTN will be switched off although nobody can predict the exact point in time, which also will differ across Member States.

At the retail level, naked DSL becomes important as soon as the incumbent or any other undertaking with significant market power launches a naked DSL offering including VoIP. It can be expected that this will be quantitatively relevant during the period of validity of the next Recommendation on Relevant Markets, which already is the case in some Member States today. This may have implications for the definition of the retail access markets.

Therefore it will be essential for NRAs to have a reliable foundation and guidance for their decisions. If NRAs have to define relevant markets and consider how to deal with broadband access, the Recommendation on Relevant Markets should be future-proof for the next few years.

The current Commission Recommendation on relevant product and service markets of 11 February 2003 in conjunction with the Explanatory Memorandum does not contain any explicit input about the inclusion of broadband access in the markets for access to the public telephone network at a fixed location (markets 1 and 2). The Explanatory Memorandum only states that "*in the future a wider range of technologies is likely to be used commercially to provide local access and the provision of services including the public telephone services*" (section 4.2.1, page 16). Furthermore there is a footnote (35) stating that "*under certain conditions a broadband connection may be a viable substitute for a narrowband connection, since it offers additional features, whereas a narrowband connection may not be a viable substitute for a broadband connection*" (asymmetric substitutability).

The Commission Staff "Working Document for a Public Consultation on a Draft Commission Recommendation on Relevant Product and Service Markets" of 28 June 2006 at least addressed the relation between narrowband and broadband access. The Commission comes to the conclusion that "*so far most customers when switching to a broadband connection have kept their narrowband connection, indicating that both access products are used as complements rather than substitutes*". According to the Commission, one reason for this is "the absence in some Member States of DSL-only connections (so-called "naked DSL")". The Commission concludes that "for the time being … it is considered that fixed broadband access is not in the same market as fixed narrowband access." (section 4.2.1, page 20).

So it seems that indirectly the Commission's statement in the Recommendation on relevant markets and the draft Recommendation clarifies that the existence of naked DSL could lead to a substitution between narrowband and broadband accesses.

In its draft Recommendation the Commission still considers access to the public telephone network at a fixed location as being susceptible to ex ante regulation. NRAs may come to the situation that the SMP operator offers broadband only bundled with VoIP. Therefore, in the presence of such broadband retail offers, future decisions by NRAs related to the definition of this market 1 may include broadband access where it passes the substitutability test.

75 Currently being developed further by the ERG High Level VoIP Taskforce.

Currently the market is defined as 'access to the public telephone network at a fixed location'. The term public telephone network may be interpreted in a broad sense in fact including access to other services besides narrowband service. Services provided across the public telephone network besides voice telephony included fax service as well as narrowband Internet access. The latter had a significant share of total traffic before the advent of broadband Internet access.

Since IP-networks are used to provide telephone services they may be considered public telephone networks. Going a step further the term "public telephone network" may be replaced by the term "public electronic communications network". Such a step would fully reflect the development towards a multi-service network being a core feature of NGNs. The access market would accordingly be defined without any reference to specific services to be supplied across the network.

In conclusion NGA developments will lead to a replacement of traditional PSTN by IP based infrastructure with broadband access replacing narrowband access. If combined with VoIP naked DSL or All IP broadband access is a potential substitute for narrowband access to the public telephone network. As a first step the Recommendation on relevant markets should allow NRAs flexibility to include broadband access in the access markets 1 and 2 where justified by a substitutability test given national circumstances.

Furthermore markets 1 and 2 in the long run may be called "Access to the public electronic communications network".

4.2.2 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)[76], 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, local loop unbundling can take place at the street cabinet;
- FttB - the local loop consists of the copper line from the building entrance (where fibre ends) to the end-user premises, local loop unbundling can take place at or near the building;
- 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-

76 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 In a point-to-multipoint solution (shared infrastructure topology, such as Passive Optical Networks), 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 (last) 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, which ERG proposes. ERG assumes this “enlarged” Market 11 would pass the 3-criteria-test run by the Commission.

4.2.3 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 streams from the CPE to the switch.

In accordance with the bitstream interconnection options described in its Common Position on Bitstream Access[77], 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);
- Access at the ATM level (ATM or Ethernet backhauling capacity to parent or distant switch) (Option 2);
- Access at the (managed) IP level (Option 3);

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 first aggregation node (DSLAM/MSAN or equivalent, e.g. Ethernet switch) 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).

For all scenarios the access/handover can be at IP or Ethernet level (as a simple transport protocol Ethernet can facilitate more innovative services features such as multicast):

- Ethernet over fibre (connection at OLT/DSLAM or equivalent) plus Ethernet backhauling capacity (connection to an Ethernet transport handover point);
- Access at an Ethernet switch (in a regional aggregation network) plus backhauling capacity;
- Access at the (managed) IP level (handover point in the IP network).

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 its freedom to control the quality parameters compared to the LLU case, where the co-located 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 and mostly in combination with a backhaul service to any concentration node (or behind any system placed at the MDF site, or in the street cabinet/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[78] 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

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

78 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* ."

corresponding retail services (e.g. IPTV) that will be provided on the basis of wholesale broadband access.

4.3 Regulatory challenges and remedies in Scenario I: Fibre to the Cabinet

In all Member States NRAs have found SMP 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.

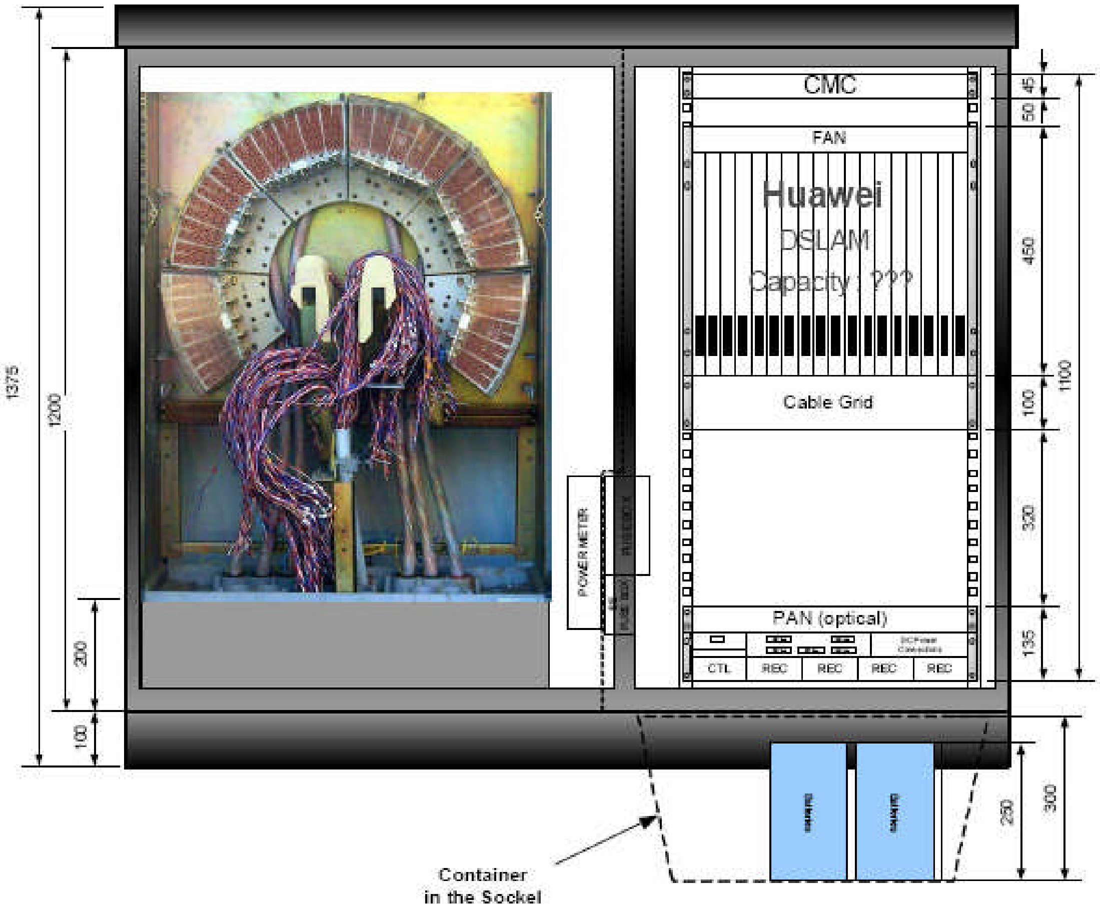
4.3.1.1 Colocation at the street cabinet

Alternative operators who wish to roll-out to the street cabinets – or equivalent location, e.g. in a building serving a neighbourhood – 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, a separate space may be required (within the cabinet, or in the foundation of the cabinet) for the location of one or more batteries;
- 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.



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 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 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 the needs of the interested parties (including itself) into account and make an efficient design (or upgrade) of the street cabinet, increasing efficiency by sharing some facilities, including the splitter.[79]

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. (see Section 4.5 on procedural issues during the migration phase).

Roll-out procedure (simultaneous or sequential)

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.

The challenges of the roll-out procedure are linked with the issue of transparency (see Ch. 4.1). Assuring transparency in NGA investment plans may help to attenuate some of the problems described above, thereby increasing allocative efficiency.

Colocation costs and allocation principles

As already pointed out, the costs for colocation and SLU influence the question whether there is a business case for SLU.[80] 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.

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79 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.

80 Cf. e.g. Analysys Study for OPTA – 2007.

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 SMP operator) or competitors *share* a street cabinet (next to an SMP operator'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 share costs and avoid the inconvenience of 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).[81]

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 parts of its existing copper network e.g. MDFs or copper lines no longer used by itself. These conditions could e.g. comply with the period between the announcement and the actual phasing out.

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 and the operational challenges of its implementation may become more pressing.

“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 SLU 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 it self. Therefore, it may be

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81 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).

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 (e.g. Ethernet-VLAN). SDF-backhaul can be provided in different manners: at physical level (e.g. dark fibre, wavelength/WDM) or at layer 2/3 level (e.g. Ethernet-based, Leased Lines).

In the FttCab case considered here, the competitor uses LLU for the access link and needs backhaul to carry away his traffic. It is not mixed up with traffic from other carriers. Therefore such backhaul products do not constitute bitstream since they do not include the access link and the traffic is not shared between network operators (but between all customers of any one network operator).

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 (dark fibre) could be considered as ancillary service to Market 11;
- SDF-backhaul at layer 2/3 level could be considered 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).[82]

Not all options might be available in all Member States, e.g. duct sharing might be limited due to lack of available spare capacity.[83]

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 WBA as a means to derive competition at a regional level may increase, especially if alternative operators are not able to roll-out their networks towards the street cabinets. 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 - on a non-discriminatory basis - alternative operators maximum control of quality parameters (e.g. multicasting) possible in order to compete on an equal footing with the retail arm of the SMP operator (e.g. IPTV).

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-

82 In its local loop order, published on 27 June 2007, BNetzA required DTAG to grant competitors access to its ducts between street cabinet and MDF. Only if access to the ducts is not possible (when no spare capacity is available) DTAG must grant access to its dark fibre (see: www.bundesnetzagentur.de).

83 For a discussion see Annex „ERG Opinion on Duct sharing".

party implements the changes in its network (either upgrades – e.g. Ethernet replacing ATM – or activation of new features such as multicasting for IPTV or gaming), considering the corresponding set of end-user services that alternative operators may want to offer using WBA (as VLAN Carrier Ethernet product).

In order to maintain as far as possible the benefits of infrastructure competition based on LLU, the design of the WBA product may need to be enhanced to deliver as close as possible level of innovation capability to operators, enabling them to differentiate their service offerings and compete as far as possible on an equivalent basis to the infrastructure owner. One example of this could be a WBA product which gave operators control of QoS to enable high quality IPTV.

However even an enhanced BSA product will give alternative operators less functionality control and is therefore never a full substitute to LLU. It remains a "managed" wholesale access service while unbundling always provides maximum control.

4.4 Regulatory challenges and remedies 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 optical local loops may raise new regulatory challenges. In particular, it may have a significant impact to the existing broadband situation, and thus to the existing broadband regulation.

At first, possible barriers are identified (4.4.1), which can be dealt with either

- by asymmetric regulation such as optical LLU on Market 11 (if appropriately extended to include optical fibre to the ODF of the first aggregation point)[84], WBA on Market 12, duct sharing (4.4.2); or
- by symmetric regulation (4.4.3).

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

84 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[85]). 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[86], 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, applying a principle of sharing existing ducts might require to solve in practice difficulties of implementation, above all (the evaluation of) available spare capacity (and the) network integrity.[87]

4.4.1.2 "Vertical" barrier: in-house wiring

Property rights arrangements with regard to in-house copper or coaxial wiring vary across Member States: In a number of Member States, in-house copper 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.[88] There are also Member States where in-house wiring is owned by house owners and therefore not included in Market 11.[89]

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 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

85 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.

86 Information must be available where the ducts are.

87 See also the Annex „ERG Opinion on Duct sharing".

88 E.g. Belgium.

89 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.

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 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.[90]

4.4.2 SMP regulation: Possible modifications with regard to Market 11 and Market 12 and duct sharing

The roll-out of FttH/B networks may influence existing wholesale products, such as LLU and WBA. Hitherto unused remedies shall also be needed, such as duct sharing.

4.4.2.1 Unbundling of the local optical loop (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 to what has been 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 Section 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 of the 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)

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

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.[91] 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 (ODF) without active equipment: in the case of PON, the traffic sharing on the feeder segment implies that 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 at this point.

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, and an extra distribution frame at the level of the last splitter. 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 and fibres in the feeder segment). 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.

- 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 Wholesale Broadband Access (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 the substitutability test have been carried out for the individual markets, a characteristic of Market 12 products is likely to remain, i.e. the competitor accesses the wholesale service at layer 2 or layer 3 of the protocol stack. In particular:

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

- 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.

4.4.2.3 Other wholesale products to deal with FttH/FttB deployments (Duct sharing)

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, 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.

Access to duct sharing as a remedy could be mandated to facilitate local optical loop roll-out by alternative operators. This requires the NRAs to look more into other possible solutions, in particular for the point-to-multipoint PON scenario, and shared use of in-house-wiring. Considering the main horizontal barrier previously identified, 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 under SMP regulation. 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.

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

- Duct sharing, among other remedies, could be imposed on a widened Market 11, encompassing both the copper and the optical local loop as a complementary remedy.
- Definition of a separate relevant market for ducts used for (public) 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. This option would also allow to impose an obligation of duct sharing in case the SMP party rolls-out FttCab, while alternative operators deploy FttB/H as it does not depend on the choice of the SMP operator.

An additional approach - symmetrical regulation under Art 12 FD - may also be considered (See Section 4.4.3).

4.4.3. Symmetrical regulation (Art. 12 FD)

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 FD of the existing framework to assist facilities sharing, where this is practical and justified.

With regard to lowering the “vertical” structural barrier for all competitors, sharing of in-house wiring might also 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 apply to duct sharing as well as in-house wiring.

It could thus be considered to clarify the basis for imposing an Art. 12 FD obligation, for facilities sharing to encourage efficient NGA investment.[92] . Therefore, Art 12 FD could be modified in order to:

- impose a symmetrical obligation to any electronic communications operator to negotiate sharing of facilities (ducts, in-house wiring, etc.) 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.

4.4.4 Asymmetric vs. symmetric regulation regarding facility sharing

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 and 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 (i) a complementary remedy on a widened Market 11 (including the fibre and copper loop); or (ii) 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.[93] Furthermore, a strengthened Art 12 might also be applicable to impose the sharing of in-house wiring.

4.5 Procedural issues during the migration period

It has become clear in this report that the implementation of NGA’s implies consequences for regulated services. In this section, some procedural issues will be described which can be used to determine how to deal with these consequences. A distinction can be made between consequences in the overlay phase and consequences in the substitution phase. In the overlay phase the current access network functions next to the NGA (4.5.1). In the substitution phase the NGA has replaced the current access network (4.5.2).

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92 See also Annex “ERG Opinion on Duct Sharing”.
93 See Annex: ERG Opinion on the practicalities of duct and other facility sharing.

4.5.1 Procedural issues in the overlay phase

In the FttCab scenario, there is an example of an effect of NGA on regulated services in the overlay phase. As mentioned in Section 2.2, co-existence of services from MDF and from street cabinets request deployment rules to minimize interferences to insure a sufficient level of performances to the various services. VDSL2 is less “pollutant” than VDSL but both require that these rules must be set before their implementation.

A suitable forum to handle these problems might be an expert team/industry group consisting of the SMP operator, alternative operators, manufacturers and NRA. This team should provide a diagnosis of the potential problems when introducing a new technology and/or insertion point, possible configuration’s solutions and choice of the best one (best compromise between disturbance minimization and new features and performances for the end-users). The first two points can generally be adopted by consensus. As regards the choice of a solution it is desirable if the market players involved reach a consensus. If this is prevented due to diverging commercial interests it may ultimately be the NRA that has to take a decision.

Up to now, the relevant deployment rules are integrated in the unbundling reference offer in most Member States. These rules may need to be developed/adjusted to cover technologies such as VDSL/VDSL2. In case it cannot be solved as part of the Reference Offer, a (unilateral) change of the Reference Offer by the NRA may be required, including the imposition of a non-discrimination obligation with regard to the retail arm of the SMP-operator.

In general, the NRA should make an inventory of possible effects of the NGA of the SMP-party to regulated services. The NRA should analyse whether the national existing procedures (e.g. taskforce for spectral interference issues) are sufficient to deal with this consequences. If this is not the case, it may well be the task of the NRA to create new procedures. E.g. the NRA can facilitate talks between the SMP party and the market parties, which services are affected by the NGA services. In order to have fruitful talks it is necessary that the SMP party is as transparent as possible about the NGA services.
If the informal role of the NRA does not lead to solutions, the NRA should have the authority to act more formally (e.g. to solve a dispute or to impose a fine). After all the service which is affected, is a regulated service.

If cost orientation applies to the regulated services, there are two specific issues which have to be taken into account by the NRA and have effect both in the overlay phase as in the substitution phase. The first issue is raised when network elements (e.g. copper lines or MDFs) are not used anymore by the SMP party. It is not specifically clear how costs of these elements should be allocated to regulated services and whether the service takers should pay all the costs of these elements.

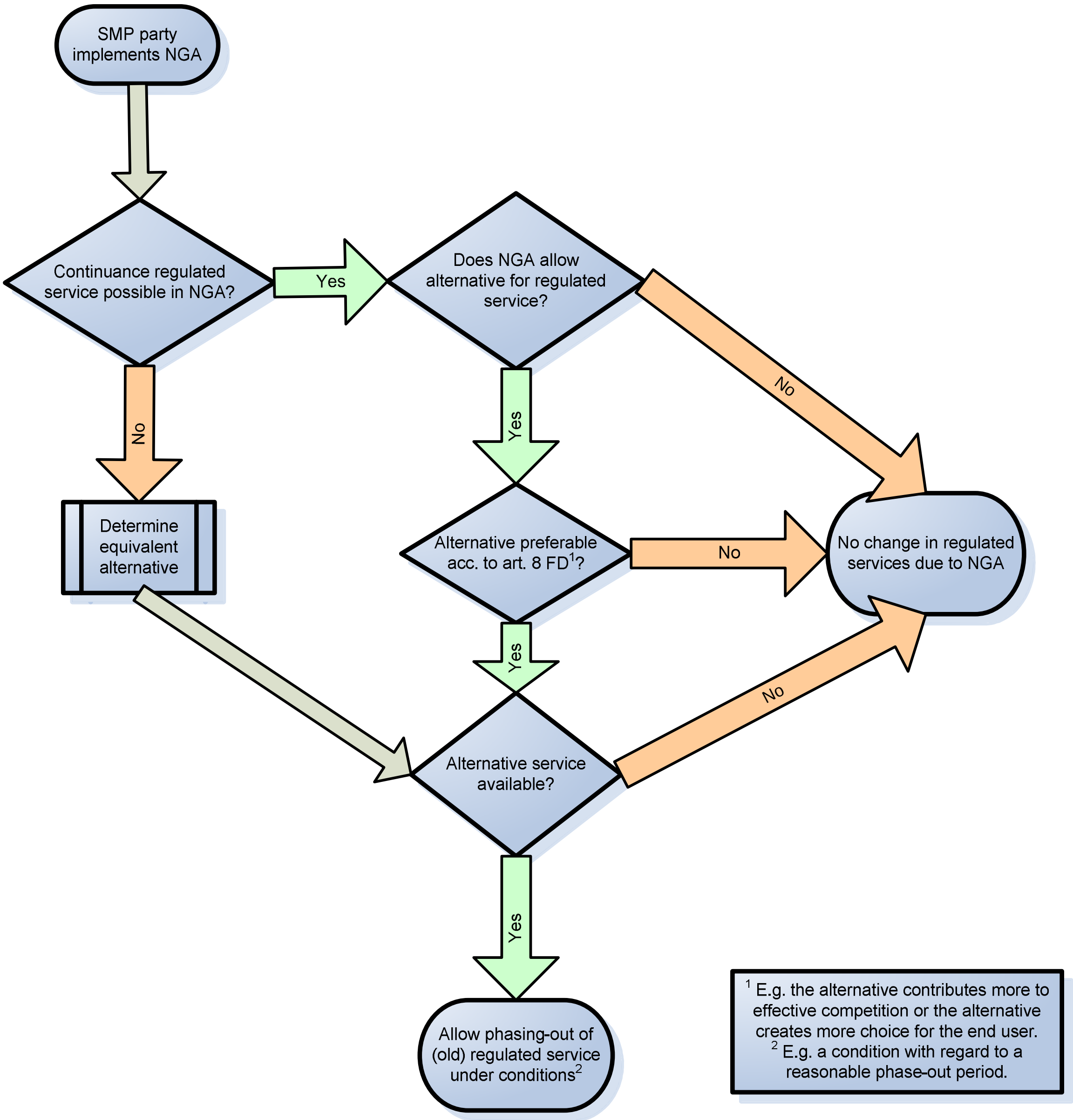
Another issue are the costs of operating two access networks parallel for a long period. This can be highly inefficient. The service takers and the end-users should not pay for this inefficiency. A possible solution could be found by setting the condition that a user should not pay more for the same service when migrating a service.

4.5.2 Procedural issues in the substitution phase

Before the current access network is replaced by a NGA, it should be clear whether all the regulated services can continue to be delivered in the NGA. If this is not the case (e.g. phasing-out of MDF-access), an equivalent alternative should be determined. After all, regulation of this service is found to be needed to address competition problems in a market analysis decision. This equivalent alternative should be developed and implemented. After it is possible to actually buy the equivalent alternative, phase-out of the (old) regulated service should be allowed. The allowance of phase-out is most probably joined by conditions with regard to e.g. a reasonable phase-out period.

If it remains possible to deliver a regulated service in the NGA, the NRA should still evaluate whether in an NGA there is an alternative for the regulated service. If this alternative service contributes more to the policy objectives stated in Article 8 of the Framework Directive and it is proportionate to regulate this alternative, it might be preferable to regulated the alternative service and allow phase-out of the (old) regulated service.
In case there is no alternative or the alternative service is less preferred compared to the regulated service, there is no change in regulation due to the NGA.

The steps written above can be illustrated in the following flow-chart diagram.



Source: Opta

Figure 12: Flowchart on Migration Procedures

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

The ladder of infrastructure investment is a regulatory model[94,95] which was developed among others by Prof. Martin Cave.[96] 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[97] taking them "*progressively closer to the customer and increasingly able to differentiate their service from that of the incumbent*"[98], 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"[99], the initial phase being service competition, which can therefore be seen as a *vehicle* to infrastructure competition[100,101], which is the ultimate aim as 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[102].

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.

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94 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.

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

96 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.

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

98 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.

99 Ibid. p.10.

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

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

102 Allowing ultimately to remove regulation.

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. NRAs will strive to maintain the level and balance of infrastructure competition achieved and pursue the movement up to the economically viable rung (which may vary across Member States and within member states depending on regional characteristics, see Chapter 3). The ladder of investment may become more "sophisticated" and the relative importance of the rungs may change in an NGA environment (see below), albeit not the overall form of the ladder with several rungs requiring more investment in own infrastructure the higher the rung reached.
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).[103]

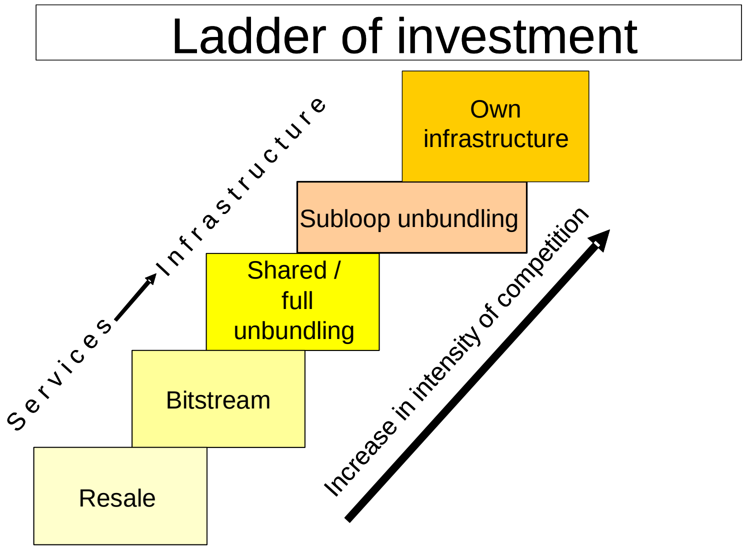

Figure 13: Ladder of investment

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 14):

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

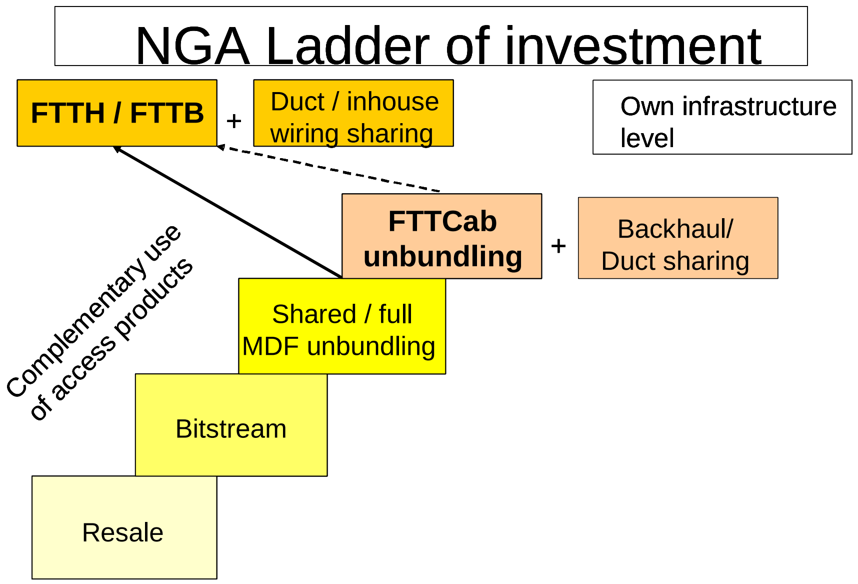

Figure 14: Ladder of investment in the context of NGA

In the FttCab scenario, the alternative operator would unbundle at the street cabinet and a complementary backhaul service/duct sharing is needed. In the FTTH/B scenario, the operators would roll-out fibre up to the building or house (own infrastructure level) and complementary duct/inhouse wiring sharing might be needed. This move could also be made in the FttCab scenario in a second step (dotted arrow).

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 MDF or equivalent aggregation nodes may gain importance. In order to maintain the benefits of infrastructure competition based on LLU achieved so far, the design of the WBA product might need to be enhanced to allow alternative operators maximum control of quality parameters possible. The picture will become more differentiated as some alternative operators will not move to the street cabinet, but make more use of such an enhanced BSA product, while others will invest in own infrastructure and move further down to the customers. However, even those who do invest, will not do so everywhere (as the incumbent), but only in those areas where the economics will allow a business case, i.e. to street cabinets with a minimum number of reachable customers. In order to reach national scale, these operators will draw on BSA products (and other access products) too in areas where they do not roll-out to the customers to complement their offers.

Given the impact of scale effects on competitive conditions in different areas of a country, the national market structure may become more heterogeneous as the NGA roll-out may not happen everywhere.

Summing up it can be said that, in order to maintain the level of competition reached, NRAs may have to adjust the access products to fit to the NGA hierarchy, potentially followed by a lot of movements of operators, but the general concept of the ladder will stay in place.

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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 Bit Stream 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 512 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 telephony, 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, 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

Company providing a point of access to the Internet (and other related services) for business and residential customers. The ISP provides its customers with multiple access methods (e.g. dial-up, ISDN, xDSL, cable modem or E1) to its router which relays traffic to 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 Multi Protocol 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 ISO Country "Codes")

European Union: Austria (AT), Belgium (BE), Bulgaria (BG), 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.

Annex

ERG Opinion on the Practicalities of duct and other facility sharing

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At the ERG17-Plenary meeting in May 2006, ERG was asked to assist the Commission services in deciding whether or not to propose specific obligations for duct and other facility sharing as part of the review. The request for an ERG Opinion stated that duct sharing appears to be most relevant in a Fttx scenario but underlines that there would be little point in seeking to strengthen the legal possibility to mandate it, if physical constraints made it an unrealistic to implement in practice.

Regarding the opportunities for deployment of new optical networks in the local loop, duct and other facility (poles in places where it is relevant, street cabinets, etc.) sharing takes on a new dimension. Ducts actually correspond to the basic civil engineering infrastructure for any wireline transmission network, and represents more than 50% of the total cost of a new local loop for a Greenfield site. Duct sharing could also drastically change the business plans of Fttx deployments, and reduce barriers to entry for alternative operators.

Generally speaking, duct sharing for operators can take different forms:

– granting access to existing ducts of telco operators, especially the incumbent;

– granting access to other existing ducts (local authorities, utilities, etc.);

– sharing new civil works, when there is no more spare capacity in existing ducts.

An obligation “*to provide collocation or other forms of facility sharing, including duct, building or mast sharing*” can be imposed on an SMP operator pursuant to article 12(1)f of the Access Directive. Also Art. 12(2) of the Framework Directive not only gives the opportunity to impose under specific circumstances the sharing of existing facilities between electronic communications operators, but also to facilitate the coordination of new civil works, and this is not limited to electronic communications providers only.

ERG Opinion

First of all, NRAs confirm the importance of duct sharing in the access network in a Fttx scenario. There is a real demand today in business areas. In urban areas, the demand is nascent but should be important too in the future, even though its assessment is difficult at this point in time. An NRA mentioned that operators are sometimes more interested in dark fibre as an alternative rather than duct sharing which has downsides for alternative operators, especially for existing ducts. The two access methods could be seen as complementary.

<u>Practicalities</u>

Considering new ducts, coordination of civil works and sometimes sharing seems to have been successfully implemented in several member states, but rather by local authorities (e.g. Bruxelles) than through national policies.

Considering existing ducts, the arguments brought forward regarding the suitability of sharing are mainly the difficulties of practical implementation, above all: the problem on how to define the available spare capacity; issues of network integrity. However, there is little experience at this stage although some commercial agreements exist (e.g. Malta) and a regulation is being implemented in Portugal.

Legal

The issue of new ducts is mainly related to the role of local authorities, which are generally in charge of rights of way. They can generally coordinate civil works on their territories and more rarely force the sharing (e.g. by imposing an obligation to install a supplementary duct for eventual future operator).

Access to existing ducts seems to be an obligation that could be imposed in the frame of market analysis. However, NRAs wonder what could be the relevant market and if there would be a new market to define, how to establish SMP when there are other ducts (or alternative facilities), belonging to cable operators or utilities for instance.

NRAs also wonder whether suppliers like utilities could be concerned whereas they are outside the scope of the electronic communications framework and do not fall under the current regulatory responsibility of NRAs.

Conclusion

NRAs consider that duct sharing can be very significant in lowering entry barriers for operators to deploy new fibre access infrastructure.

Duct sharing has not so far been implemented widely. There is therefore insufficient experience on which to base a firm conclusion as to its value in general and on what remedy to apply (existing ducts vs. new ducts, telco ducts vs. other ducts). This will need to be studied on a case-by-case basis.

On top of the practical considerations, NRAs note the legal difficulty of regulating to provide access for existing ducts (which relevant market? how to deal with non-telco ducts?). Regarding new ducts, the framework seems not to provide powers to ensure provision is made for duct-sharing at the build phase. Therefore, 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.

ERG considers that NRAs should continue to work with the Commission on this issue and also on access to dark fibre in order to clarify both the practical and the legal aspects.