Body of European Regulators for Electronic Communications

BEREC

BoR (10) 08

Next Generation Access – Implementation Issues and Wholesale Products

BEREC Report

March 2010

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Next Generation Access – Implementation Issues and Wholesale Products

Executive summary

This document is a follow up document to the ERG Common Position on Next Generation Access (ERG NGA CP) looking at implementation issues of relevant wholesale products in an NGA environment, and developing where possible some sort of best practice for these wholesale services, including associated aspects such as migration. It describes the status quo as of December 2009.

The Ladder of Investment and FttX scenarios

As concluded in the ERG NGA CP and further developed in the ERG NGA Report the principle of the ladder of investment (Chapter B.1) remains valid in a NGA environment, but is expected to be a more sophisticated ladder, with changes in the relative importance of their rungs and, in general, different dynamics, as a consequence of a shift in the economic bottlenecks.

The ladder concept serves as a starting point as well as analytical framework for this document. Depending on the roll-out scenario intended (FttC, FttB/H) different rungs of the ladder and different wholesale products are relevant. Furthermore, different rungs of the ladder involve different access points along the value chain. Generally, a higher rung of the ladder implies that the access point is located closer to the end-user associated with an increased proportion of own infrastructure used.

The ladder consists of the following access products: resale, bitstream, MDF/ODF unbundling, cabinet unbundling, concentration point unbundling, access to in-house wiring or equivalent, access to the end-user using own infrastructure only. These access products are complemented with different wholesale products allowing the operator to reach the respective access point: competitors may use leased lines (including Ethernet), dark fibre, duct access or own infrastructure only.

Chapter B.2 sets out the main characteristics of the various FttX scenarios: FttH (either as point-to-point or as point-to-multipoint architecture), FttB and FttC.

Chapter C and D analyse the various access/wholesale products in greater details, mentioning (I.) the relevant scenario of an specific access/wholesale product, (II.) providing a general product definition encompassing technical issues (e.g. relevant layer) and (III.) setting out relevant regulatory issues (e.g. possible elements of a reference offer).

Access Products (Chapter C)

Access to in-house wiring or equivalent (Chapter C.1)

Access to in-house wiring is related to unbundling of the copper loop in a FttB scenario, access to coaxial wiring or unbundling/sharing of the fibre loop in a FttH scenario. The fibre wiring architecture inside the building might be single- or multifibre (several fibres per home/end-user).

The obligation to give access to in-house wiring may depend on the distribution of property rights of in-building conduits and cables inside the building. Ownership varies across Member States. Some countries have implemented national laws imposing access/sharing obligations on the party rolling out/owning the in-house wiring. Art 12 (new) FD strengthens the power of NRAs to impose sharing of e.g. in-house-wiring.

Concentration point unbundling (Chapter C.2)

Concentration point unbundling is relevant for specific network architectures within the FttH scenario. A party requesting unbundling at the concentration point may have access to the unbundled fibre (sub) loop to set up a Point to Point (P-t-P) as well as a Point to Multipoint (PON) technology in its own upstream network – independently of the network structure chosen by the operator who gives access to its network (P-t-P or PON).

The concentration point can geographically be located “anywhere” between the ODF (e.g. central office) and the end-user. It is in most cases likely to be located no further from the end-user than the cabinet, but in specific cases it can also be located between the cabinet and the ODF.

In case the operator providing access to its networks uses a PON architecture, only the last segment, consisting of a dedicated P-t-P optical fibre between the end-user premises and the last splitter (in this case located at the concentration point) could be physically unbundled. Upstream of the last PON splitter, physical layer unbundling (user by user) is not possible unless WDM unbundling is feasible at the ODF.

In case of a P-t-P architecture the fibre loop between the end-user and the ODF can be unbundled. Given the economies of scale of NGA networks and feasibility of unbundling at the ODF in this context, it is unlikely that there would be significant demand for unbundling at a concentration point closer to the end-user unless the operator seeking access has already rolled out fibre to the concentration point

So far no SMP access obligation enabling unbundling at the concentration point has been imposed, however symmetric regulation in France and Spain has been recently applied (see Annex for further details).[1]

Unbundling at the cabinet (Chapter C.3)

Technically, unbundling at the cabinet – which is relevant in the FttC scenario – takes place at Layer 1. Generally, an SMP-operator can either choose between adding an additional street cabinet for his active equipment next to the existing one or it can place a new street cabinet above the existing one. Some countries already have taken regulatory decisions with regard to cabinet unbundling (e.g. Germany).

ODF unbundling (Chapter C.4)

a) ODF P-t-P Unbundling

ODF P-t-P unbundling relates to an FttH scenario. To unbundle P-t-P fibre networks, the same methodology as in copper unbundling (LLU) can be used. The alternative operator will terminate its fibre in the ODF location (e.g. central office) and by passive fibre connections from their collocation footprint connects directly to the local access fibre at the ODF.

b) Wavelength Unbundling at the ODF

In a PON scenario, unbundling at the ODF is only possible with wavelength unbundling. In a WDM-PON solution, the end-user is accessed by using a separate wavelength for each, and multiplexing data onto that wavelength, so that each end-user is assigned a particular wavelength, not shared by other users. This type of PON can be unbundled by giving alternative operators access to the appropriate wavelength at the ODF on a user by user basis. WDM unbundling therefore allows operators a form of (virtual) unbundling whilst at the same time potentially allowing cost savings for all, including the opportunity of eliminating many central offices in an NGA PON architecture. WDM technology is currently used mainly in transport networks or large corporate networks and the industry consensus is that it will be some time before it could be considered viable for commercial deployment of unbundling solutions in access networks for the residential market.

Enhanced Bitstream Products (Chapter C.5)

Bitstream products may be applicable for all roll-out scenarios. Bitstream is access at layers 2 (ATM, Ethernet) and/or 3 (IP).[2] The higher in the layers one goes the more functionality is incorporated and the less flexible it becomes.

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1 In Portugal, symmetric regulation is imposed when the concentration point is inside the building (access to in-house wiring).

2 See ERG Common Position on Next Generation Access (ERG (07) 16rev2).

Generally, bitstream offers should be as much as possible modular in order to allow the maximum freedom for alternative operators to define the QoS and the configuration of their own retail services.

Currently SMP-operators are migrating their aggregation networks from ATM to Ethernet technology. A Layer 2 Ethernet bitstream product typically needs the following elements: Flexible allocation of VLANs, control of customers' service speeds and service symmetry, security enabling, ability to support different QoS levels according to current industry standards, flexible interconnection and aggregation at regional & local level, flexible choice of customer premises equipment, support for multicast functionality.

A distinguishing feature between bitstream as an active product and passive products in Market 4 remains, where for unbundling the alternative operator is free to choose the CPEs and its own (active) equipment at the ODF/MDF suiting his parameter requirements. The SMP-operator chooses the providers of the ODF/MDF equipments in the case of bitstream. The choice of the equipments implies that eventually some functions are not available because the SMP-operator does not necessarily implement all the possible features available from vendors. Additionally the SMP-operator chooses the configurations most suited to his own needs limiting the scope for innovation for the alternative operators.

Wholesale products to reach access point (Chapter D)

Duct Access (Chapter D.1)

In principle, in all scenarios, FttH, FttB or FttC, a duct access product could be used by the operators to reach any of the access points, i.e., either to reach the street cabinet, manhole or even the buildings (access network).

Duct access is a wholesale passive access product and can be used in principle by the operators to install all type of cables, copper, fibre or coax. However, the space requirements of these different cables types are rather different and may lead to limitations, as space in ducts is a scarce resource. Thus, installation of fibre cables corresponding to the deployment of NGA should be prioritized in that case.

A reference offer to be published should include inter alia: conditions for granting regulated access, engineering (e.g. depicting available space or defining how to occupy ducts), procedures for ordering and provisioning and SLAs. Moreover, transparency requirements may be met by publishing information on the level of the quality performance as well as by information systems informing about availability of ducts and their occupation.

Dark Fibre (Chapter D.2)

In principle, in all scenarios, FttH, FttB or FttC, a dark fibre access product could be used by the operators to reach any of the access points, i.e., either to reach the street cabinet (core or concentration network), manhole or even the buildings (access network). However, under

a FttH/B scenario, an available duct access product (to deploy own fibre cable) could be preferable to operators, both in terms of costs and efficiency.

Dark fibre is a wholesale passive access product (unlit optical fibre) and can be used by the operators to connect its (equipments in) core networks to the access points.

As with ducts, dark fibre products could exist at the core, concentration or access network levels. However, there is more flexibility in this product, i.e., the installation of new fibre cables is not a costly and prolonged process (although in some cases it may not be feasible due to technical constraints, e.g., no capacity available in ducts).

A priori, access to dark fibre is the closest "substitute" to duct access as a product. However, it sends different investment signals as a remedy. Additionally to the situation of lack of (space in) ducts, a dark fibre offer makes sense when a LLU beneficiary seeks to install equipment in an MDF or street cabinet and needs backhaul.

Compared to duct offers access to dark fibre leads to a reduction in the overall level of investment, potentially freeing up resources for greater coverage of NGAs.

Leased Lines (Chapter D.3)

In principle, and as is the current practice in the LLU with the leased lines, it should be always available an active backhaul product from the SMP-operator, independently of the (type or location of access point) and scenario (FttH, FttB, FttC).

This wholesale product is a dedicated and transparent connection, able to support all kind of traffic and upper layer technologies (e.g., IP/Ethernet based implementations and services) as well as DSLAMs (e.g. VDSL2) or OLTs.

Collocation (Chapter D.4)

At the building

In order to allow new entrants to install fibre optics equipment within or close to the SMP-operator’s facilities collocation services should be provided (see also new Art. 12 FD).

Collocation at the building level may not be related with an access obligation imposed to the SMP-operator, at least in some Member States, where this entity is not the owner of the infrastruture (ducts, cabling, etc.) within the building. Given the great majority of the buildings in many Member States is not recently built, physical (and/or administrative) barriers to the access of customer homes might exist for operators who want to implement (multiple) FttH solutions (as well as FttB for the installation of DSLAMs and access to the building distributor).

At the concentration point

If the concentration point is located outside the building at the manhole, street cabinet, frontage of the building, pole, etc.) collocation will be needed there as fibre is unbundled at this location.

In the case of an imposition of an obligation of access to the fibre loop it is the responsibility of the SMP-operator to foresee a collocation possibility in this infrastructure, notwithstanding the existence of impediments of technical nature duly justified case-by-case. In principle, it should be possible for a certain number of alternative operators to install (operate and repair) an ODF or a set of splitters and interconnect/access to the SMP-operator's optic infrastructure within the concentration point, thus avoiding the duplication of infrastructures and encouraging the services efficiency.

At the cabinet

Accessing the sub-loop at the level of the cabinet could either presuppose the installation of a new cabinet in parallel to the existing, or as an alternative, the possibility of sharing the existing street cabinet, which in any case may have to be updated and expanded.

Given that collocation space is limited it may be necessary to specify rules for assigning collocation space. This could (e.g.) be done on a first come first serve basis in particular if the economies of scale do not allow a profitable exploitation of a street cabinet by more than a few operators.

The definition of such rules, within the updated RUO, should comply with the following basic principles:

(a) The conditions for the physical collocation of the alternative operators' equipment – SDF, DSLAM and backhaul equipment –in the SMP-operator's cabinets (or near by), together with the fact that it may not be possible to determine the immediate extension of facilities to meet all requests, result in the need to specify rules for the use of this scarce resource.

(b) Likewise, the conditions for the provision and use of DC power, together with securing requirements and demand predictability, lead to the need to specify rules for the use of this resource.

On the other hand, interested alternative operators must supply demand forecasts (in the scope of the reference unbundling offer (RUO), namely collocation needs, so as to allow the SMP-operator, in an effective and timely manner, to provide the necessary resources for the performance of the work involved and to overcome any constraints;

Migration: MDF Closure (Chapter E)

In recent years alternative operators have invested considerable amounts of money in collocation, backhaul facilities and own equipment. Assuming that regulation for LLU will remain stable these investment decisions had a long term perspective (amortisation) with according pay-back periods. Should some operators' migration to NGA lead to closing down of MDFs (and adjacent collocation facilities) or to a significant decline of the economic utility for other operators these operators' sunk investment related to the remaining usage period is supposed to be frustrated. This is not only the case for a full MDF closing but remains valid for successive devaluation of investment due to deployment of more innovative access scenarios by competitors and therefore a reduced ability to compete.

Introduction of Transition periods (Chapter E.1)

The European Commission Draft Recommendation on Regulated Access to NGA Networks of 12 June 2009 is based on the assumption of a payback period of five years for unbundling investment and requests an appropriate time period for eventual phasing out of MDFs. However, not all Member States have set a 5-year period, therefore definition of the transition period should be in line with other relevant decisions, e.g. margin squeeze calculation, in a given Member State.

As a matter of principle, an alternative operator having invested in unbundling should have the possibility to realise a reasonable return on investment based on the revenues generated during the remaining economic life of collocation facilities.

Introduction of compensation payments (Chapter E.2)

If it is not possible to fully recover the investment in unbundling facilities on a certain MDF location over the remaining economic life compensation payments may be a viable solution. When determining such compensation payments it is important not to compensate an operator for the total sunk costs incurred during the remaining economic life. This would imply that this operator would even be compensated for his inevitable business risks (e.g. decline in prices or risks resulting from technological innovation) and not only for the risk of having his investments depreciated faster as a result of the SMP-operator's closure of MDF.

Relevance of Standards (Chapter F)

Generally, standardisation at the infrastructure level is not desirable because different technologies are better suited to different geographies depending on factors such as density or pre-existing infrastructure. On the other hand, standardisation at the electronic or active level may support competition and allow for differentiation. Overall, the process of standardisation should be market-driven, which is also in line with the regulatory principle of technology neutrality.

The need for modem interoperability (Chapter F.1)

Interoperability between DSLAM/MSAN/OLTs and CPEs is not guaranteed by ITU standard and it may be more difficult to achieve due to the differentiation possibilities of the VDSL2 and optical technologies (different flavours, deployment scenarios, configuration settings) and due to the more sensitive services like VoIP & IPTV that use these platforms. The Review (Directive 2009/140/EC as of 25 November 2009) has strengthened the competences of NRAs to ensure interoperability of services.

Wholesale access standardisation (Chapter F.2)

Standardised, fit for purpose wholesale bitstream access would enable service providers to reach different types of customers without changing their products or internal processes significantly. With the right characteristics this would help to ensure competitive provision of NGA and would contribute to delivering consumer choice and would facilitate the provision of ubiquitiously available broadband.

Vertically integrated players may not have incentives to deliver a standard which supports downstream competition. Nevertheless, there are existing (Ethernet) standards which enable service providers to set the level of quality of service associated with a end-user's service, rather than leaving that choice to the infrastructure provider.

Will the market deliver wholesale standardisation for next generation networks (Chapter F.3)

On the one hand there are market forces driving standardisation in next generation networks: For example, infrastructure users/service providers benefit from lower equipment deployment and service delivery costs where there is standardised access. Also users will be able to move and share modems and other home equipment if wholesale access is standardised. On the other hand, the prevalence of vertically integrated providers holding significant market power may prevent or delay standardisation as they have an incentive to use proprietary interfaces in order to keep control of their customers.

Best practice for NGA wholesale products as of December 2009

While it is too early to derive detailed best practice principles for NGA wholesale products, given the early stage of implementation of regulatory decision making regarding NGA wholesale products, some more general conclusions can be drawn at this stage.

The BEREC considers that all the best practice principles as identified in ERG (07) 53 in are still valid and should be also applied and accomplished in the NGA environment implying that they are technologically neutral.

While transparency has always been a requirement of general relevance it is of particular importance with regard to NGA. This is also reflected in the new Framework, where Art 12.4 new FD provides NRAs with additional powers to impose specific obligation in that regard.

In addition to the reference offer wholesale customers should be able to:

- obtain relevant information on roll-out of new infrastructure or technologies per geographical area. A reasonable window of announcement is necessary to create a level playing field on the retail market ;

- information on phasing out legacy wholesale services should also be announced a reasonable period in advance to avoid discriminatory situations.

A Introduction

This document is a follow up document to the ERG Common Position on Next Generation Access (ERG NGA CP)[3] looking at implementation issues of relevant wholesale products in an NGA environment, and developing where possible some sort of best practice for these wholesale services, including associated aspects such as migration. It describes the status quo as of December 2009.[4]

As concluded in the ERG NGA CP and further developed in the ERG NGA Report[5] the principle of the ladder of investment remains valid in a NGA environment, but is expected to be a more sophisticated ladder, with changes in the relative importance of their rungs and, in general, different dynamics, as a consequence of a shift in the economic bottlenecks. In any case the principle of promoting competition to the deepest level possible is still appropriate. In the NGA environment this level may change due to the increasing economies of scale or the change of the possible access points: for example, the expected lesser importance of Local Loop Unbundling (LLU) may imply both a stepping back to the bitstream access rung (which means that this rung is likely to become more important) or stepping up to street cabinet or building (possibly with own deployment). The specific dynamics will be determined by the operators' choice.

Structure of the document

The ladder concept as described in more detail in the latest ERG NGA Report serves as a starting point as well as analytical framework for this document. This concept is briefly set out in Section B.1. Depending on the roll-out scenario – Fibre to the Cabinet/Curb (FttC), Fibre to the Building (FttB), Fibre to the Home (FttH) – different rungs of the ladder and different wholesale products are relevant. A short wrap up of different scenarios will be given in section B.2. Section B.3 sets out the structure followed in the analysis of the specific wholesale products. The subsection on each wholesale product in Sections C and D specifies the relevant scenario, gives a product definition (e.g. layer, functionalities) and deals with regulatory issues based on the current EU Regulatory Framework. This implies a particular focus on SMP regulation.

In chapter C the different wholesale access products will be analysed following the rungs of the ladder ("left side of the ladder") according to the structure set out in B.3. Chapter D then addresses the wholesale products to reach the respective access points ("right side of the ladder") in the same manner.

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3 See ERG (07) 16rev2, Chapter 4.6

4 The work program 2010 foresees to update the overview "NGA - Country Case Study Updates" (Annex 1 to ERG (09) 17) in the second half of 2010 after NRAs have taken more relevant decisions and the Commission's Recommendation will have been published, we will take up best practice in the country case studies.

5 See "Report on Next Generation Access – Economics Analysis and Regulatory Principles" ERG (09) 17.

Chapter E addresses various issues concerning the migration period towards NGA networks. Then, chapter F discusses the relevance of standards in an NGA context and in particular whether standardisation will be provided for in the market process.

Finally, the Annex provides practical experiences with various wholesale products in different countries. Moreover, some (of these) countries have enforced national laws allowing for symmetric regulation independent of dominance according to the Art. 7 procedures. Examples where regulation of wholesale products is based on such specific national laws are provided in this Annex.

B The Ladder of Investment and FttX scenarios

B.1 Ladder of Investment

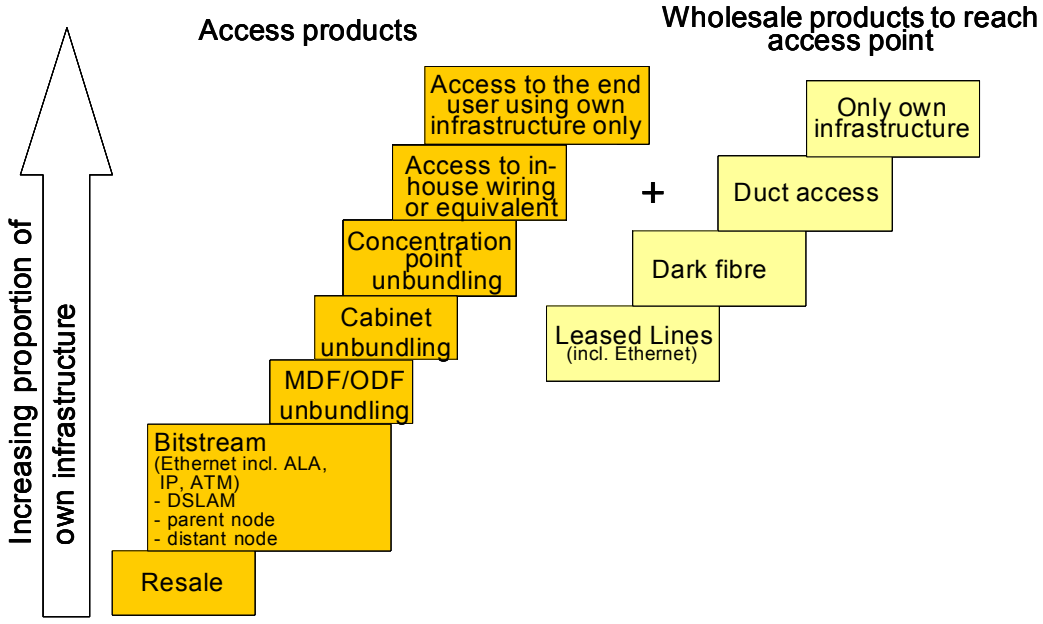

Figure 1: NGA Ladder of investment

The ladder in the left hand side of the diagram in Figure 1 displays the different access products (linked to access points).[6] It applies for both, copper and fibre.

6 In the context of the ladder of investment this diagram is intended to illustrate the most relevant cases. In Here it is assumed that the concentration point is typically located somewhere between the end-user and the cabinet. But in specific cases it can also be located between the cabinet and the ODF.

Where an alternative operator climbs up the ladder, it will generally have to progressively invest in more own infrastructure, but each rung must not necessarily be used. Depending on the roll-out scenario intended (FttC, FttB/H) different rungs of the ladder and different wholesale products are relevant as will be explained in section B.2. Furthermore, different rungs of the ladder involve different access points along the value chain. Generally, a higher rung of the ladder implies that the access point is located closer to the end-user associated with an increased proportion of own infrastructure used. As pointed out in the ERG NGA CP the increased relevance of economies of scale and scope may lead to an increased importance of bitstream products in the NGA context.[7]

In the NGA context, the bitstream rung may involve more access (handover) points than before, ranging from the access node (such as DSLAM, OLT or equivalent) at the beginning of the concentration network to the aggregation level in the middle of the concentration network, up to the parent or distant node in the Ethernet/IP backbone, implying different degrees of own infrastructure used.

The right hand side of the diagram shows the different wholesale products in the access/concentration network an alternative operator may use to reach the access points from its own PoP. Various combinations of access products (left hand side) and backhaul products (right hand side) are possible depending on the scenario and network architecture, implying different degrees of own infrastructure.

Brief description of the different rungs of the ladder (left side of the ladder):

– Resale: The SMP-operator provides all the infrastructure and “products” (i.e, access link plus a backhaul service and also provides the connectivity to the public IP network). At this level, the product that the SMP-operator sells to the alternative operator is technically the same as the one it sells to his own retail customers. The alternative operator does not need to run his own infrastructure, the only thing he has to do is to market (brand), distribute and bill the product.[8] Resale is not dealt with in this paper as it usually is an unregulated product.

– Bitstream: the alternative operator accesses a bidirectional high speed transmission capacity access link to the end-user provided by the SMP-operator, to offer high speed services to customers. This product enables alternative operators to differentiate their services by altering a number of technical parameters and/or the use of their own network. This wholesale product consists of an access link to the customer premises (over copper or fibre) and a transmission service, to a defined set of handover points (the access point) (relevant for FttC, FttB, FttH).[9]

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7 See ERG (07) 16, Ch. 4.6
8 ERG (03) 33 rev1 - page 5
9 ERG (03) 33 rev1 - page 4

- MDF/ODF unbundling: in a collocation space the alternative operator gets access to the copper pair (at the main distribution frame - MDF) or optical fibre (at the optical distribution frame – ODF) that links its end-user to the central office where it he is collocated. This physical link (copper pair or optical fibre) is then connected to his own equipment and network. No active equipment from the SMP-operator is used, thus providing maximum flexibility and independence from the technological choices of the SMP-operator.

- Cabinet unbundling: similar to MDF-unbundling, the alternative operator has access to the copper pair that links the end-user to the street cabinet where it is collocated (access point). This copper pair is then connected to his own equipment. The equipment of the alternative operator can be placed in the street cabinet or in their own near cabinet (relevant for FttC).

- Concentration point unbundling: The concentration point can geographically be located "anywhere" between the ODF (e.g. central office) and the end-user.[10] It is likely to be located no further from the end-user than the cabinet, possibly in locations such as a manhole, a pole or the facade of a building or block, but in specific cases it can also be located between the cabinet and the ODF. The alternative operator accesses the optical fibre coming from the end-user and links this optical fibre to his own equipment (relevant for FttH). The case where the concentration point is inside the building is treated under 'access to in-house wiring' section.

- Access to the in-house wiring: the alternative operator has access to the copper pair or optical fibre that links the end-user to a point of access in the (e.g. basement of the) building (relevant for FttB, FttH).

- Access to the end-user using own infrastructure only: the alternative operator deploys its own access link from the end-user to a certain point; in order to reach this point, it may make use of backhaul products (dark fibre, ducts) or even make use of its own infrastructure). An example would be a (HFC)[11] cable operator.

Right side of the ladder:

– Only own infrastructure: The operator deploy and uses its own access and transport links from the end-user to its network. The alternative operator does not require any use of wholesale product from the SMP-operator.

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10 The concentration point in this paper corresponds to the "distribution point" as defined in the draft NGA recommendation: *"The distribution point is an intermediary node in an NGA network from where one or several fibre cables coming from the MPoP (the feeder segment) are split and distributed to connect to end-users' premises (the terminating or drop segment). A distribution point generally serves several buildings or houses. It can be located either at the base of a building (in case of multi-dwelling units), or in the street. A distribution point hosts a distribution frame mutualising the drop cables, and possibly un-powered equipment such as optical splitters". Whether such a point is called concentration point or distribution point depends on the perspective of either concentrating traffic originating from different end-users or distributing traffic towards end-users."*

11 Hybrid Fibre Coaxial (HFC).

– Duct access: The alternative operator uses the wholesale duct access offer from the SMP-operator (or any available duct access offer) in order to deploy its own fibre cables (access links) from the end-user to its network. This wholesale product can also be used for the own provision of (own fibre) backhaul (e.g. for MDF/ODF unbundling or concentration point unbundling or even bitstream).

– Dark fibre: The alternative operator uses the wholesale unlit fibre (dark fibre) access offer from the SMP-operator in order to reach any access point, either the end-user premisis (access link), a concentration/unbundling point or even the bitstream handover point.

– Leased Lines: The alternative operator uses an active wholesale offer from the SMP-operator, e.g. the leased lines offer and/or an Ethernet product to be used for the provision of backhaul from an access point (MDF/ODF unbundling or concentration point unbundling or bitstream) towards its network.

Various combinations of access products (left hand side) and backhaul products (right hand side) are possible depending on the scenario and network architecture, implying different degrees of own infrastructure. The intensity of regulatory intervention depends on the competition problems found in the market analysis (market 4 and 5), i.e. the number of obligations according to Art. 9 to 13 AD[12] per wholesale product imposed. Generally it will depend on the specific situation in member states and scenarios used which combination of wholesale products are being considered as proportionate and appropriate acc. to Art. 8 AD.

B.2 FttX Scenarios[13]

B.2.1 Fibre to the Home (FttH)

FttH is a fully optical solution based on fibre-optic cables all the way from the ODF / central office to the home or business office, with potential speeds up to several Gb/s per customer. In this scenario, fibre is deployed along the whole access link, from a central office or PoP down to the end-user. The entire copper loop is replaced[14] by optical fibre infrastructure, including the MDF and street cabinets, although some of these network nodes might be of use for the ODF and optical splitters.

12 SMP regulation may include: an access obligations (Art. 12 AD), transparency obligation (Art. 9 AD), non-discrimination obligation (Art. 10 AD), accounting separation obligation (Art. 11 AD) respond price control and cost accounting obligations (Art. 13).

13 The following diagrams are not definitive but can be considered representative.

14 In some case fibre roll-out may also be carried out as overlay leaving the copper in the ground.

FttH networks may exist in different (architectural/topological) flavours, either as a point-to-point architecture or as a point-to-multipoint architecture, usually as passive optical networks – PON.[15]

A key difference to traditional copper-based access networks is the much greater distance allowed by fibre between the end-user and the active equipment. Whereas broadband services based on xDSL can only be provided up to a couple of kilometres, high speed broadband based on fibre access links is possible for distances of 20 km and more.[16]

B.2.1.1 FttH: point-to-point architecture

In a point-to-point (P-t-P) FttH architecture a dedicated fibre (or fibres) is available from the ODF to every single end-user. This topology is similar to a traditional copper-based distribution network, where the MDF is replaced by the ODF (in the same or other location).

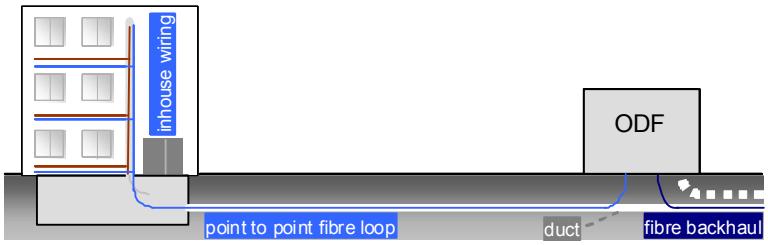

Figure 2: Point-to-point FttH design

Each subscriber is provided with a dedicated “pipe” – no capacity or traffic sharing – accessing the physical media and thus having the full bandwidth available. In the long term, this might be considered the most flexible architecture.

B.2.1.2 FttH: point-to-multipoint architecture

In a Point-to-Multipoint FttH architecture, there is no dedicated fibre for each end-user at the ODF. Instead, a single fibre line at the ODF is shared by several end-users. This fibre line is connected to a passive optical splitter, which splits the incoming light over several (outgoing) fibres, each of which might again connect to other splitter(s).

This architecture is known as PON (passive optical network). Therefore, only the part of the fibre path that is situated between the last optical splitter and the optical termination point in

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15 See also ERG (07) 16, Chapter 2.3.

16 Currently GPON coverage is up to 20 km, with future extension, in the near future, to 60 km. For Point to Point it depends on the optical interface, the coverage can be higher can be more than with GPON

the end-user's home is dedicated, the fibres from that last splitter towards the ODF shares the traffic of all users served by that splitter.

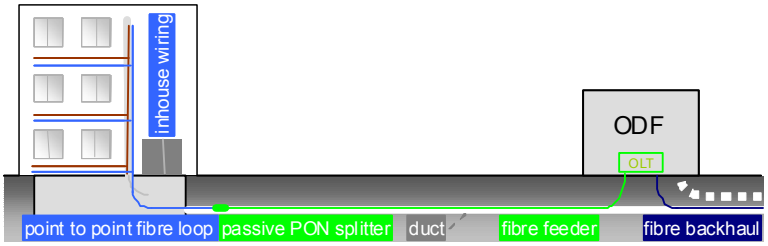

Figure 3: Generic Point-to-Multipoint / PON design

B.2.2 Scenario Fibre to the Building (FttB)

The FttB scenario implies extending optical fibre(s) from the ODF up to the building.

Figure 4: Generic FttB design

In essence, FttB is a hybrid solution, where the final connection between the concentration point and the end-users household is made by some copper-based cabling.[17] From that perspective, the FttB exhibits some similarities with the FttC/VDSL2[18] scenario, e.g. as regards economies of scale. Contrary to P-t-P implementations, the fibre connection from the ODF/central office to the building will be shared by multiple customers. Thus, the fibre link can be seen as a backhaul and an alternative operator (unbundler) will then have to collocate at each individual building to access the copper in-house wiring.

The main difference between FttB and FttH is that in the former the fibre link extends up to an optical networking unit (ONU, usually located in the basement) shared by multiple households and the in-house wiring is still based on copper, thus avoiding the cost of deploying optical fibre cable to each individual household.

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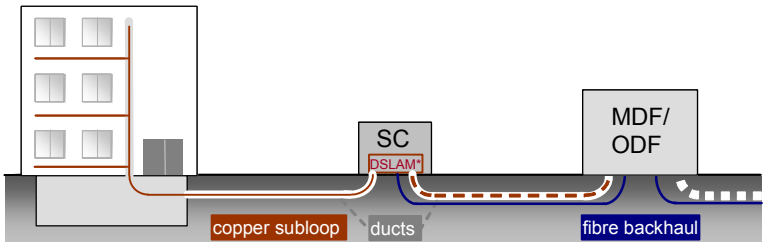
17 This could be an Ethernet solution based on unshielded twisted pair (UTP) cabling or xDSL -based like in a FttC scenario.

18 Despite this, FttB and FttH were analyzed as *one* scenario in ERG (07) 16 (Ch. 2.3) because they are quite similar with regard to their technical and economical bottlenecks arising from the need to deploy optical fibre cable from an ODF to all buildings.

B.2.3 Fibre to the Curb/Cabinet (FttC)[19]

In the FttC scenario, optical fibres are extended (to enclosures or) street cabinets near the end-users. From this location, traditional copper loops provide connection to the end-users. In this scenario, the length of the loops will be shorter than in case of "traditional" LLU. Due to this shorter loops, higher bandwidth than in the case of LLU is possible.[20]



Note*: DSLAM or MSAN.

Figure 5: FttC generic design[21]

In order to link the copper sub-loops to the fibre backhaul, the active equipment (DSLAM/MSAN) have to be installed[22] in (or nearby) the cabinet, where the handover will take place.

Generally FttC is used in combination with VDSL2-rollout. It has to be underlined that the higher speed (compared to ADSL2+) allowed by VDSL2 is possible only within a few hundred meters from the end-user premises. For higher distances, VDSL2 performance tends to that of ADSL2+[23].

B.3 Wholesale product characteristics and regulatory issues

In the following Chapters C and D each access product[24] and each wholesale product to reach the respective access point[25] will be described.

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19 Regulatory challenges and remedies for the FttC scenario are addressed in ERG (07) 16, Ch. 4.3.

20 Another FttC-scenario may involve the use of coax loops to the end-user. This may be the case in the Hybrid Fibre Coaxial (HFC) networks. This is the kind of network most Cable operators transformed their traditional analogue CATV-networks into. HFC networks enable also high speed two-way IP/Ethernet based communication (in conjunction with DOCSIS 3.0). However this doesn't automatically mean that HFC networks will provide an realistic option for FttC-based unbundling. On the contrary, due to technical reasons, coax cable connecting multiple customers cannot be unbundled. Therefore this scenario won't be covered in this document.

21 Pictures were taken from ERG's NGA Report.

22 Some equipment might be moved from a MDF collocation.

23 In other words, the use of copper's higher bandwidth is ineffective beyond a certain distance (where VDSL behaves like ADSL2+). Bandwidth needed for NGN-services will only be available on limited distance (less than 1 km). Instead, ADSL-services are able to offer reasonable speeds (not NGA) up to a 5 km range.

24 I.e. the focus is on the *left* hand side of the NGA ladder of investment (Figure 1).

25 I.e. the focus is on the *right* hand side of the NGA ladder of investment (Figure 1).

The description follows the rungs of the ladder set out above (B.1) and takes account of the relevant roll-out scenario (B.2):

In order to better categorize the various access and wholesale products it is briefly set out to which scenario (FttC, FttB or FttH) they refer to (I.).

Then, a general product definition of the access/wholesale products is provided (II.). This product definition may encompass technical issues such as the location of the access point, the relevant layer or the applied protocol at each layer. Besides such technical issues, it may also contain relevant economic or commercial issues such as a product's functionalities or the flexibility for operators when providing products to their customers.

The third part (III.) in each section then sets out the various regulatory issues each access/wholesale product may involve. For example, what kind of SMP regulation applies? Is there a regulated access price? What could/should be contained in a reference offer? How should transparency obligations look like taking into account the aim to establish competition but also operators' business secrets? Other issues could be contractual issues/SLAs or all the various items that may get relevant during a migration phase (e.g. dismantling conditions for MDFs, parallel running of legacy and NGA networks). Where symmetrical regulation is used reference is made to the relevant examples in the Annex.

The focus of the regulatory aspects is solely on specificities of the wholesale product in question that may be relevant in all or most of the Member States. A full description of the regulations proposed or applied will not be provided. Furthermore, issues of a more country-specific nature will be addressed in the Annex .

Some general points applicable for the access products (Section C) and the wholesale products to reach the access point (Section D) are dealt with in the introduction to Section C.

C Access products

A number of issues are generally needed for wholesale access products like reference offers, migration process which are not specific to NGA developments. They have been dealt with by the ERG in more detail in its „Report on ERG Best Practices on Regulatory Regimes in Wholesale Unbundled Access and Bitstream Access" (ERG (07) 53)[26], where the ERG analysed different regulatory models in place for different items and identified best practice solutions. The main topics were: a) SLA and KPI:, b) migration process and richness of reference offers and c) pricing issues.

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26 See also the corresponding document *"ERG Report on the Public Consultation on the Report on ERG Best Practices on Regulatory Regimes in Wholesale Unbundled Access and Bitstream Access",* ERG (07) 53b, and the *"Common position on Wholesale broadband access"*, ERG (06) 69rev1. All available at: http://erg.ec.europa.eu/documents/docs/index_en.htm.

a) SLA and KPI:

In order to assure a reasonable quality of access products and that service levels are comparable with those provided to the SMP-operator's own business, the ERG stated that it might be necessary to complement a non-discrimination obligation with a requirement to set reasonable time frames through a Service Level Agreement (SLA) at least sufficient to allow effective competition in the downstream markets with the SMP-operator's retail offers. Second, a requirement to publish Key Performance Indicators (KPI) was envisaged which allow identifying where potential discrimination exists. SLA and KPI should encompass the minimal scope for access delivery (validation time, delivery time and delivery precision)[27] and fault clearance. Third, a required for compensation for service provision below the agreed level was suggested. This should incentivise the SMP-operator to comply to the service levels agreed. The compensation scheme should be applied to all SLA indices

b) Migration process and richness of reference offers:

Two main functional issues are essential to allow new entrants to progressively extend their own network closer to the customer: First, appropriate migration processes that allow them to pass from one wholesale access product having a given number of access/interconnection points to another wholesale access product requiring more access/interconnection points. Second, completeness of reference offers that allow them at least to offer the same service as the SMP-operator and richness that render them able to differentiate their services from that of the SMP-operator's retail arm and even to be the first mover by offering new and innovating services. Where non-discrimination and access obligations are not considered to ensure fair competiton, NRAs may need to specify additional ex-ante controls on the wholesale products concerning migration processes as well as reference offers completeness and richness.

As regards migration, two processes were identified as crucial for allow competitors to climb the ladder of investment:

1. First, Migration from resale to wholesale access products permits to kick off the process of climbing the ladder of investment.

2. Second, migration from bitstream to LLU permits to keep on moving to the next rung. Major migration issues were identified: a) availability of a single and a bulk migration processes, b) their effectiveness and fluidity, c) associated pricing conditions.

As far as reference offers' completeness and richness is concerned, wholesale products reference offers must allow competitors to offer new and innovating services and compete on a level playing field by being able to be the first mover.

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27 E.g., a minimal critical timer is set for the validation time, which is the time between receipt of a line order and sending of order acceptance or refusal.

A reference offer may not be imposed if no significant uptake of the service by alternative operators (e.g. subloop unbundling) is to be expected.

c) Pricing issues:

The ERG stated that prices for bitstream access should be consistent with prices for other services to create efficient investment incentives for all operators and to provide incentives for competitors to further climb the ladder of investment. Furthermore, assurance of protection against downstream margin squeeze was considered essential. To provide certainty for operators advance publication of the methodology for assessment of margin squeeze was suggested.

The BEREC considers that all these (best practice) principles mentioned above (a) - c)) are still valid and should be also applied and accomplished in the NGA environment implying that they are technologically neutral.

In this document the focus will be on the specific NGA issues that are new to regulation.

Even though transparency is a general requirement it is of particular importance in an NGA context. In addition to the reference offer wholesale customers should be able to:

- obtain relevant information on roll-out of new infrastructure or technologies per geographical area. A reasonable window of announcement is necessary to create a level playing field on the retail market ;

- information on phasing out legacy wholesale services should also be announced a reasonable period in advance to avoid discriminatory situations.

Art 12.4 FD new provides for additional powers of NRAs to impose specific obligation in that regard.

C.1 Access to in-house wiring or equivalent

I. Scenario

Access to in-house wiring is related to unbundling of the copper loop in a FttB scenario, access to coaxial wiring or unbundling/sharing of the fibre loop in a FttH scenario. The operators reaching the building will have access to the drop cable and in-house wiring, provided by the “building operator” (or by the condominium in some cases and Member States).[28]

28 This is valid for in a non-greenfield scenario, i.e., in existing buildings already cabled (with copper or fibre). For new buildings, sharing rules may apply.

Regarding the former case (FttB), the access point (see C.2 for a definition) is always located inside the building, usually in the basement. This might not be always the case in the FttH scenario. The access point can be located at a concentration point outside the building (see C.2 for a definition).

Since the details are similar in the cases where the access point is located inside the building or outside e.g. at the façade, manhole, on a pole, in a street cabinet or in specific cases even at the ODF[29], see C.2 for a more detailed description of the product.

In any case, the fibre wiring architecture inside the building might be single- or multifibre (several fibres per home/end-user). Multifibre roll out has the following implications: It allows several operators to reach the end-users premises in parallel (see Annex A.2.1 France, A.2.3. Switzerland).

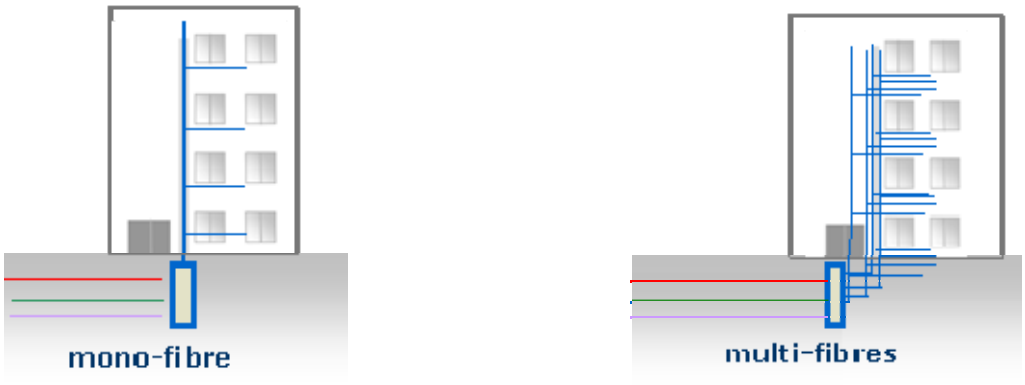

Figure 6: In-house wiring – mono or multi-fibre

II. Regulation

It should be noted that the obligation to give access to in-house wiring may depend on the distribution of property rights of in-building conduits and cables inside the building. Currently property rights arrangements with regard to in-house copper and fibre (and/or coaxial) wiring vary across Member States: In a number of Member States, in-house copper wiring is included in Market 4 and accordingly the obligation to unbundle applies. In other Member States, it is unclear whether it is owned by the telco incumbent/building operator or house owners respectively landlords.[30] There are also Member States where in-house wiring is owned (only) by house owners and therefore not included in Market 4.[31] In some countries the situation for cop-per/coaxial may also apply for fibre, in others specific rules may apply to new fibre roll-out inside the building.

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29 See. C.4 for ODF unbundling.
30 E.g. Belgium.
31 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.

With regard to the obligation to give access to in-house wiring some countries have implemented national laws imposing access/sharing obligations on the party rolling out/owning the in-house wiring (see the Annex for further details).

It should be added that while it should be possible to pass new fibre cables in newly constructed buildings, this capability may be exhausted with the installation of additional and successive cables by different operators. As a result constraints may arise in terms of competition. On the other hand, the installation of several cables in the building does not coincide with criteria of efficiency.

In this context, regulators should promote in-building infrastruture (and cost) sharing, namely for the fibre cabling towards individual apartments[32].

In any case, exclusivity agreements (and/or total occupation of infrastructure) must be avoided, especially in respect of access to buildings, as such agreements would, from the outset, hinder other interested operators from being able to offer their products to these potential (new) customers.

The Review (DIRECTIVE 2009/140/EC as of 25 November 2009) has strengthened the NRA's powers to impose the sharing of in-house wiring as Art. 12 FD para 1 states:

- *"...national regulatory authorities shall, taking full account of the principle of proportionality, be able to impose the sharing of such facilities or property, including buildings, entries to buildings, building wiring, masts, antennae, towers and other supporting constructions, ducts, conduits, manholes, cabinets."*

Furthermore, the new Art. 12 para 3 foresees that:

- *"Member States shall ensure that national authorities, after an appropriate period of public consultation during which all interested parties are given the opportunity to state their views, also have the power to impose obligations in relation to the sharing of wiring inside buildings or up to the first concentration or distribution point where this is located outside the building, on the holders of the rights referred to in paragraph 1 and/or on the owner of such wiring, where this is justified on the grounds that duplication of such infrastructure would be economically inefficient or physically impracticable. Such sharing or coordination arrangements may include rules for apportioning the costs of facility or property sharing adjusted for risk where appropriate"*

So far, there was one case where the obligation to provide access to in-house wiring was based on (current) Art. 5 AD and Art. 12 FD (see Annex, A.2.1 France).

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32 With sharing, inefficient duplication of infrastructure and potential "conflicts" in case of capacity constraints can be avoided. Meanwhile, assuming that customers would not be willing to receive (more) various cables, the first operator to reach a building could monopolise it, without competition in the provision of NGA based services.

C.2 Concentration point unbundling

I. Scenario

A concentration point is an intermediary node in the optical fibre based NGA network, where unbundling/sharing is feasible for a group of end-user connections. Concentration point unbundling is relevant for specific network architectures within the FttH scenario.

Operators can technically give access to different concentration points along their network. Between the concentration point and the end-users, at least one dedicated fibre per household is rolled out.

The architecture can be single- or multi-fibre. A concentration point is typically used for connecting the fibre to the third party's network. In a multifibre context, where fibres are assigned to third parties (e.g. by using indefeasible rights of use). The location where this connection takes place depends on how far the multiple fibres are rolled out and where third parties may want to gain access (energy utilities and/or cable operators may already be present with their networks close to the end-user). Therefore, such a multifibre setting does not involve a wholesale product called unbundling in a narrow sense. For more details on the multi-fibre setting the reader is referred to the practical experience in France and Switzerland (see Annex).

It should be noted that a party requesting unbundling at the concentration point may have access to the unbundled fibre (sub) loop in order to implement P-t-P or PON technology in its own upstream network – independent of the network structure chosen by the operator who gives access to its network (P-t-P or PON). In that sense such an unbundling scheme is there-fore technologically neutral. This is described in the following figure:

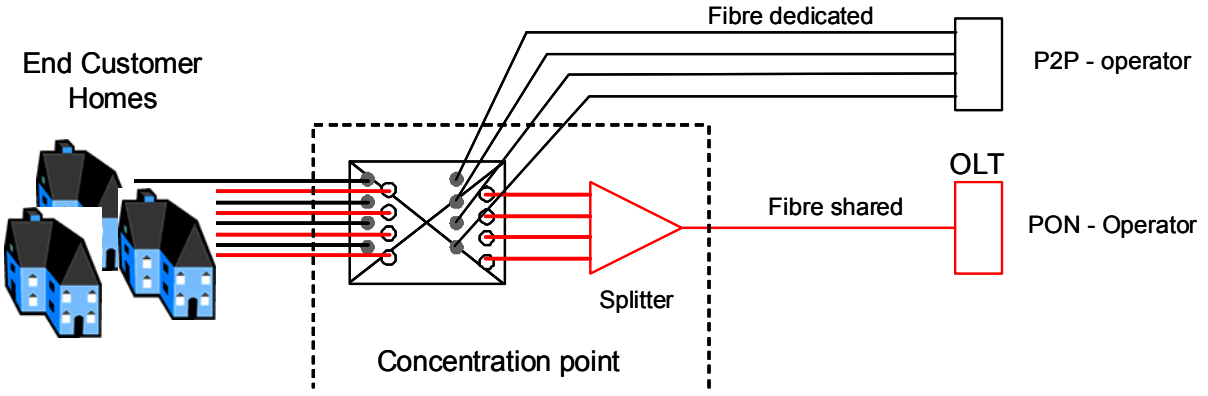

Figure 7: Example of concentration point unbundling

The following sections describe how concentration point unbundling can be set up depending on whether the operator giving access to its network uses a PON or P2P technology.

a) P-t-multipoint architectures (PON)

In case of PON, only the last segment, consisting of a dedicated P-t-P optical fibre between the end-user premises and the last splitter, located itself at the concentration point in this case, could be physically unbundled.

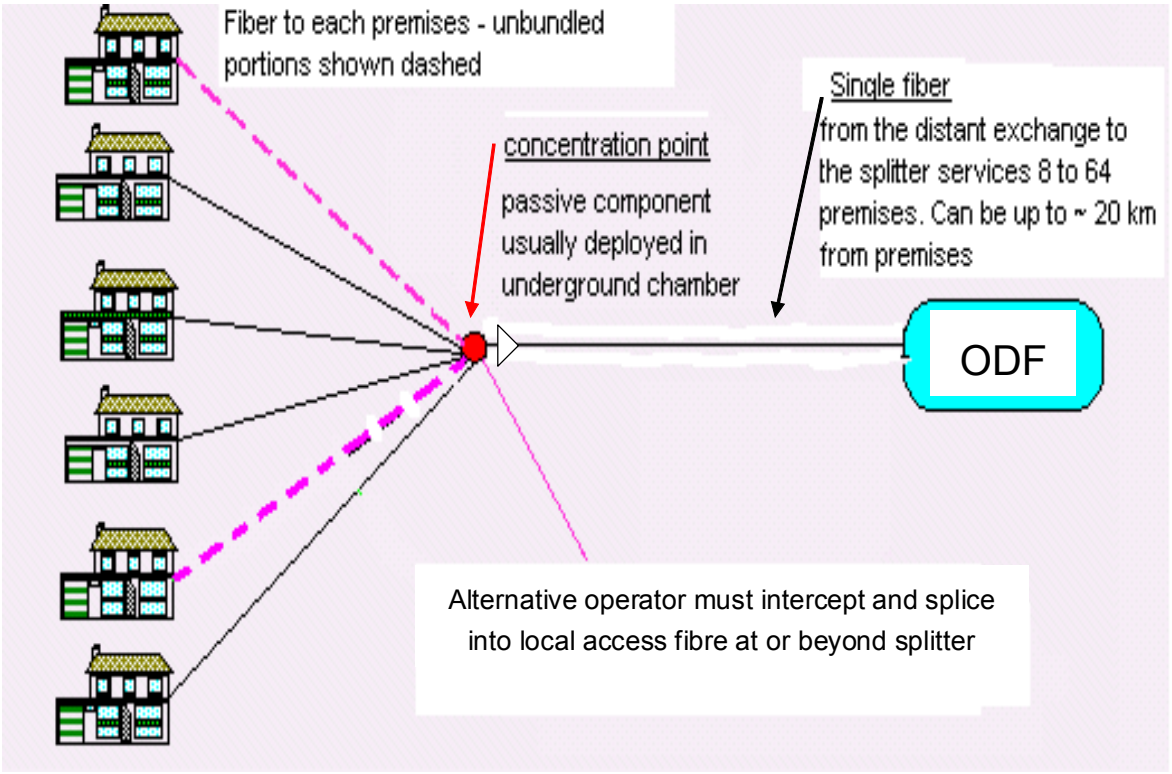

Figure 8: Concentration point unbundling applied to a PON Network

The unbundling of a PON network presents greater challenges for any competitor. To have access to a PON network, the alternative operators will in all probability be required to get far deeper in the network, i.e. much closer to the end-user premises (to the last splitter) and therefore much greater effort will be required to unbundle individual customers.[33]

A consequence of not having a dedicated fibre (or fibres) for each user at the ODF is that traditional full physical unbundling user by user at the central-office like in MDF-unbundling scenario is not possible, unless WDM unbundling at the location of the ODF is feasible (see Section C.4.2).

Unbundling of a PON at the splitter level has some similarities in the economic implications to unbundling copper pairs at the cabinets or at the building; however given the reduced number of reachable customers, economies of scale will play a greater role thereby (cet. par.) decreasing the economic viability of this unbundling option.

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33 If, for instance, the handover point is at the closest manhole or pole to the customer site, then separate interconnect cable runs and splice joints may be required for each customer at discrete points on the respective network, depending on the actual physical layout and accessibility of the SMP-operator's fibre.

In order to extend the fibre backhaul to the handover point ancillary services like duct access or dark fibre should be made available to alternative operators (see Section D).

b) P-t-P architectures

Given the economies of scale of NGA networks and feasibility of unbundling at the ODF in a P-t-P context, it is unlikely that there would be significant demand for unbundling at a concentration point closer to the end-user unless the operator seeking access has already rolled out fibre to the concentration point (e.g SMP-operator, utility, or cable operator owning adequately located ducts). These specific cases may only be relevant in Switzerland or in France.

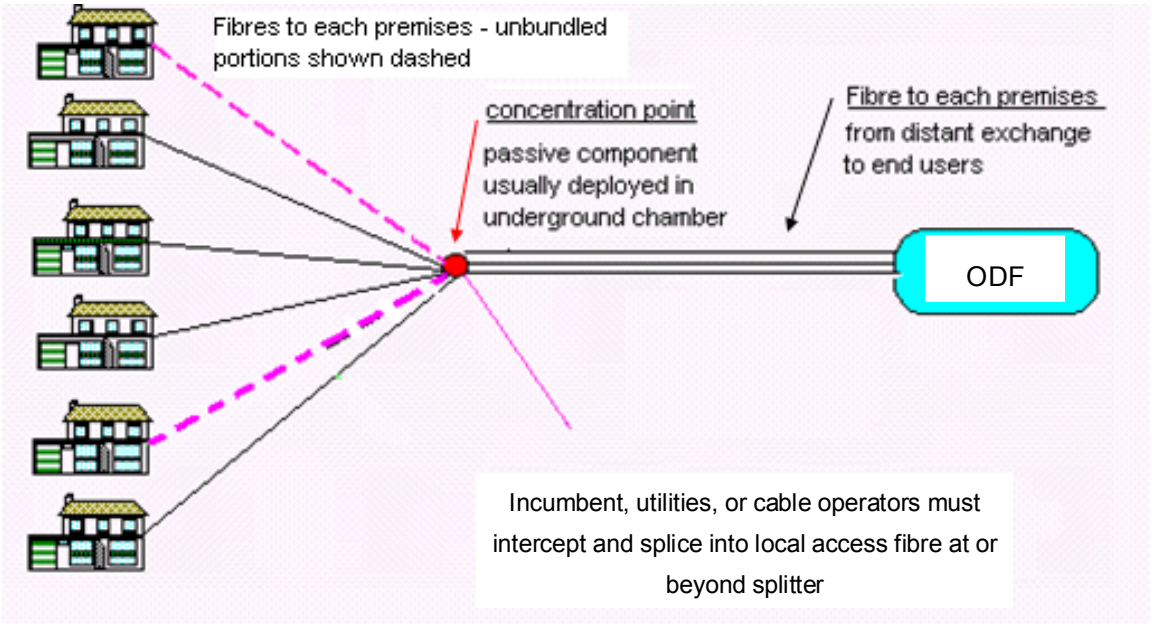

Figure 9: Concentration point unbundling applied to a P-t-P Network

II. Product Definition

A concentration point is an intermediary node in the optical fibre based NGA network, where unbundling/sharing is feasible for a group of end-user connections. It constitutes an interface between drop and feeder sections of the access network where a physical aggregation of fibres takes place. At this physical interface, the optical cables are joined and fibres spliced (fusion splicing or mechanical splicing) or connected. Between the concentration point and the end-user premises, the architecture can be single- or multi-fibre.

Furthermore this point is a physical interface between the network operator providing wholesale access and the network of third operators who links the optical fibre to his own equipment.

The concentration point can geographically be located “anywhere” between the ODF (e.g. central office) and the end-user. It is in most cases likely to be located no further from the

end-user than the cabinet, e.g., at a manhole pole, or street cabinet, but in specific cases it can also be located between the cabinet and the ODF.

The main differences between the unbundling at the concentration point located in a manhole vs. in a cabinet may be the physical characteristics (e.g. space available) and possible additional required functionalities, e.g. power available at the cabinet. Unbundling using active equipment for active backhaul would therefore be possible only in the special case of the cabinet.

In a PON architecture, traditional unbundling user by user is only possible at the last passive splitter, which may be located in a manhole, on a pole, at the facade of a building or at the basement (see Section C.1). No physical layer unbundling user by user is possible upstream of the last PON splitter, unless WDM unbundling is feasible at the ODF.

Layer

Unbundling at the concentration point is access to the optical fibre, i.e., at the physical layer (Layer 1).

Technology

Mainly physical characteristics of the fibre, based on the ITU or IEC standards, are fundamental for a reference offer. Additionally, detailed procedures specifying how to access and handle the fibre are needed.

Functionalities

Unbundling at the concentration point provides the unbundler with a physical fibre (or fibres) from this point (e.g. manhole or cabinet) to the end-user's premises.

Flexibility

Access to the physical fibre at the concentration point allows the unbundler to implement their own PON or a P-t-P network. The unbundler has flexibility regarding transmission technology within the constraints of the type of fibre used and the number of fibres (single or pair) and the type and location of the concentration point (e.g., in a cabinet).

III. Regulation

So far no SMP access obligation enabling unbundling at the concentration point has been imposed in any Member State, however symmetric regulation in France, Portugal and Spain has been recently applied.[34,35]

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34 In France in the context of symmetric regulation it is foreseen to regulate access to only one of the possible access points to the fibre sub-loop. This point is called "the" concentration point in France, whereas technically several concentration points exist, which would allow unbundling/sharing.

Under symmetric regulation it may occur that an SMP-operator seeks access to an alternative operator's fibre network at a concentration point close to the end-user since it is already pre-sent at that point (e.g. at the manhole or cabinet).

The location of the concentration point is a crucial question given the economic implication for the business case particularly for PON unbundling. Generally, the network architecture is defined by the operator but given its implications for the viability of infrastructure competition in some Member States the regulator may have a more far reaching competence. For example, in France the Regulator has the competence to determine the location of the concentration point, depending on operator demand and a number of criteria such as the existing duct infrastructure and area density.[36]

Ancillary products

Collocation services may be a requirement, e.g. for splice enclosures, ODF or installing a PON splitter, depending of the scenario (see D.4 for further details). The unbundler should have access to a wholesale product to extend its backhaul to the concentration point (either by the use of duct access, dark fibre or active backhaul). If such a wholesale product is not available, the unbundler may have to construct new ducts and "break into" the concentration point (manhole, cabinet, façade of the building etc.) in order to bring his feeder cable to this point.

Reference offer content

In addition to what was mentioned as necessary elements of a reference offer in the document ERG (07) 53, the ERG wants to emphasise the need to include in particular the provision of the following elements for access at the concentration point (which may also be inside the building, i.e. valid for the previous scenario):

- Technical handbook, including type and characteristics of fibres (and/or copper in the case of access to in-house wiring), details of terminations in the concentration point and at end-user premises, types of concentration point (manhole or cabinet, pole, etc.) with description, physical characteristics and dimensions, any other physical implementations of splicing or connecting points. Environmental specifications might also be important;

- Operational handbook, including procedures for ordering and provisioning, procedures for service and maintenance, administration of physical infrastructure, identification etc. It might be more of a challenge than with traditional wholesale products regarding access and qualifications;

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35 In Portugal, symmetrical regulation has been applied for the case where the concentration/sharing point is located in the building.

36 In France a national law has given the power to the regulator to decide when the concentration point may be located in the private property, i.e. inside the building. A "very dense area" has been defined and inside this area, the concentration point may be located inside buildings of more than 12 dwelling units or connected to visitable sewers.

- Information resources for existing and planned facilities, including location of concentration points (manhole, cabinet, other..), geographical area and buildings / customers (OTO) covered from each concentration point, length of fibre from concentration point to each customer, roll-out plans and availability of offer (present and covering plans for a clearly defined period).

C.3 Unbundling at the cabinet

I. Scenario FttC

II. Product definition

Layer and technology

Layer 1: Physical layer. Unbundling at the cabinet, access to the copper loop, is done at the physical layer.

A number of practical reasonable options is available for the implementation of DSL technology on the physical infrastructure, mainly VDSL[37] or VDSL2[38] .

Co-existence with services provided from MDF-based DSLAM may – depending on the distance between MDF and cabinet – require e.g. spectrum shaping at the cabinet-based DSLAM in order to prevent signal deterioration due to cross talk.[39]

III. Regulation

Several studies[40] show that the costs and administrative steps necessary for the civil engineering works and the installation of street cabinets are two important factors that slow down the deployment of unbundling at the street cabinet.

An operator can either choose between adding an additional street cabinet for his active equipment next to the existing one, but this is a less flexible solution than placing a new street cabinet above the existing one. For example in the Netherlands there is standard room foreseen for DSLAM equipment of two operators and by using flexible walls it is possible to quickly add an additional module to host more operators. And in Croatia an alternative operator has the ability to install a street cabinet at some point of SMP-operator's access network

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37 According to ITU-T G993.1; possible spectral disturbance when used in co-existence with ADSL-services. Although VDSL-networks do exist most new-built networks are based on VDSL2, mainly because of the higher possible bandwidths.

38 The deployment of ADSL (2+) in the cabinets also increases the speeds compared to the MDF.

39 Spectral interference between services provided from different locations (e.g. MDF and SDF) in general is an issue not only for ADSL but for all xDSL technologies.

40 J.P.Morgan: "The Fibre Battle"; Analysys: "The business case for sub-loop unbundling in the Netherlands"; OVUM: "FTTCab: an investment assessment"; WIK: "Technische und ökonomische Aspekte des VDSL-Ausbaus – Glasfaser als Alternative auf der (vor-)letzten Meile"; Ontwerp van gemeenschappelijk standpunt « Regulatory principles of NGA » ERG (07)16.

althouth the SMP-operator does not have or does not plan to install its street cabinets on the same point.

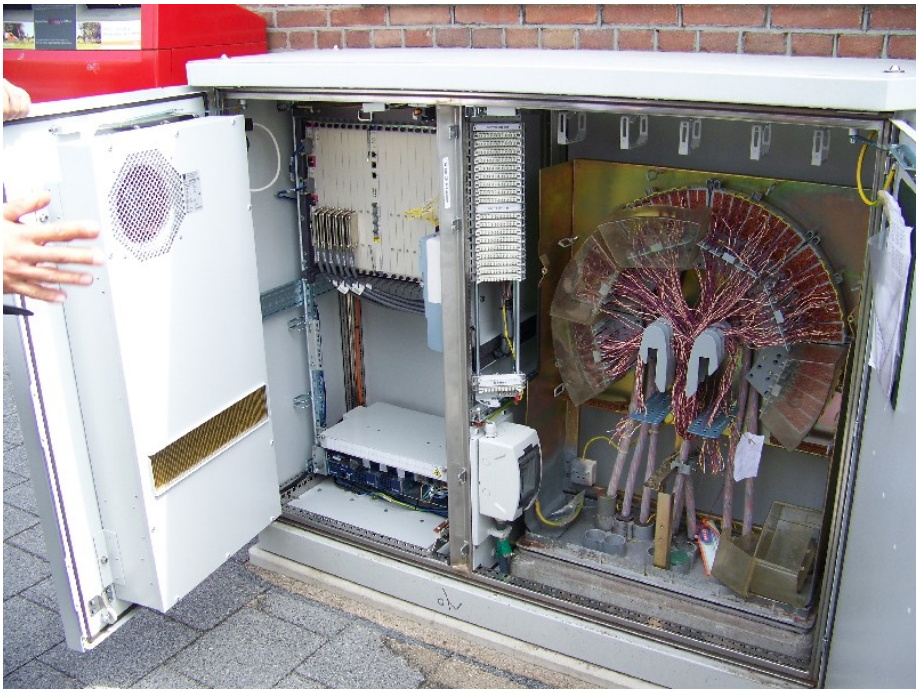

Figure 10: Street cabinet on the existing street cabinet with room for the DSLAM equipment of 2 operators in the Netherlands

By choosing a less flexible street cabinet design the SMP-operator may hamper infrastructure competition.

Reference Offer content

Next to a detailed description of the offering for both access and ancillary facilities (collocation/backhaul) and conditions for granting regulated access, the reference offer should include e.g.:

- Technical handbook, including type and characteristics of the copper sub-loop in a cabinet; technical description of how (i) the introduction of optical fibre takes place; (ii) active elements are provided with electric power; (iii) tie cables must link the blocks with the active elements and (iv) the installation of own equipment in the street cabinet is done;

- Operational handbook, including procedures for ordering and provisioning, procedures for service and maintenance, administration of physical infrastructure, identification, etc.

- Information resources for existing and planned facilities, including geographical data – coverage area of each street cabinet (customers connected to a specific street cabinet); relevant information on roll-out of new infrastructure per geographical area, in particular on roll-out plans for a clearly defined period.

Moreover, ancillary services like duct access[41], dark fibre or active (including Ethernet) backhaul should be made available to alternative operators to connect their fibre network with the active equipment in the street cabinet.

C.4 ODF unbundling

C.4.1 ODF (P-t-P)-unbundling

I. Scenario FttH

To unbundle P-t-P fibre networks, the same methodology as in copper unbundling (LLU) can be used. The alternative operator will terminate its fibre in the ODF location (e.g. central office) and by passive fibre connections from their collocation footprint connects directly to the local access fibre at the ODF. See the following figure:

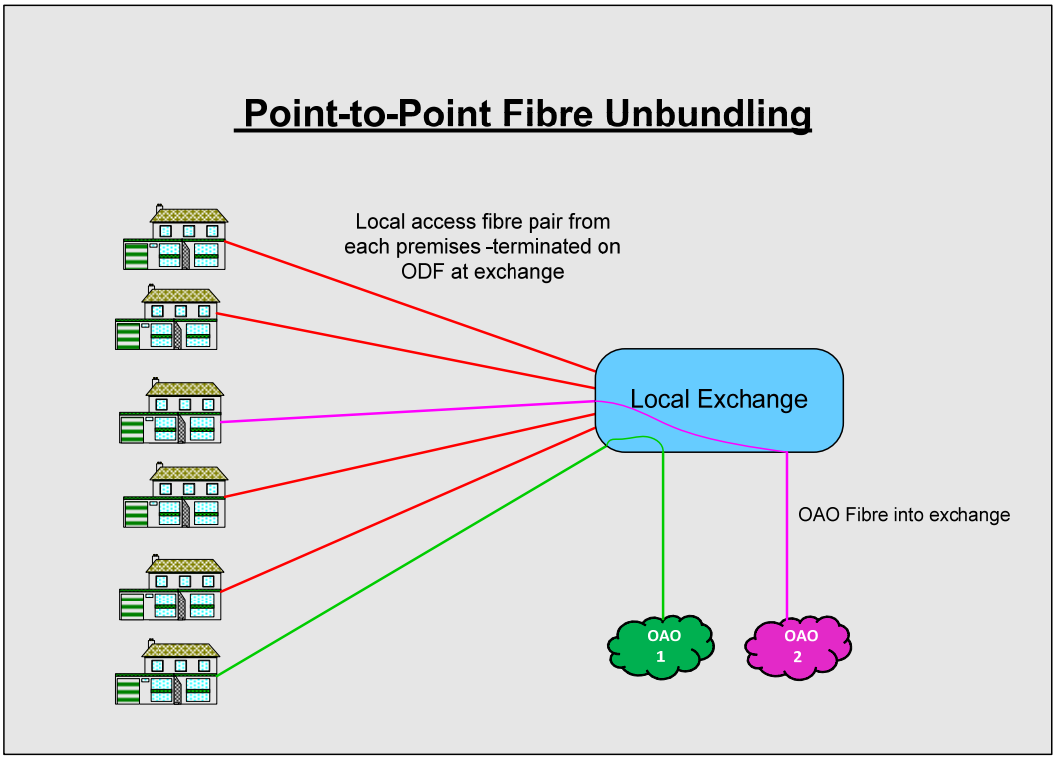

Figure 11: Point-to-point fibre unbundling

Implementation options depend on the number of fibres (and operators) per household:

41 Ducts can also be used by alternative operators to directly access the end-user without using incumbent fibre links (see Section D).

- Single operator
  - o single fibre to each home (for example for offering a full IP-based service package including IPTV);
  - o two separate fibres to each home; in some countries, this architecture is deployed using one for IP-based traffic and the other one for TV-distribution.
- Multiple operator

two or more fibres to each home whereby each can be used to connect different operators (and/or services).

II. Product definition

Technology used at each layer

For unbundled access Layer 1 requirements are relevant: physical properties of the fibre (including type of fibre, e.g. single mode or multimode fibre, attenuation, etc.) according to ITU G.651-656 standards) and length of the fibres, i.e., of the overall fibre path.

III. Regulation

Currently, P-t-P fibre unbundling is mandated in the Netherlands and Slovenia.

For ODF unbundling, the following ancillary products are necessary:

- collocation at the ODF location;
- backhaul from ODF to a higher network level (depending on the competition for backhaul services, to be provided by the SMP-operator) – ancillary services like duct access, dark fibre or leased lines (including Ethernet) should be made available to alternative operators to connect their network to the hand over point.

Reference Offer content

Next to a detailed description of the offering for both access and ancillary facilities (collocation/backhaul) and conditions for granting regulated access, the reference offer should include e.g.:

- Technical handbook, including type and characteristics of the fibre loop from the ODF to the end-user premises and the technical description of the ODF where the physical unbundling is taking place (may include tie cables to link the ODF to the operator's equipment);
- Operational handbook, including procedures for ordering and provisioning, procedures for service and maintenance, administration of physical infrastructure, identification, etc.

- Information resources for existing and planned facilities, including geographical data – coverage area of each ODF (customers connected to a specific ODF); information sharing about the roll-out plans for a clearly defined period.

Moreover, ancillary services like duct access[42], dark fibre or active (including Ethernet) backhaul should be made available to alternative operators to connect their network to the hand over point, located at the ODF location. Furthermore, collocation at the ODF location is necessary.

C.4.2 Wavelength Unbundling at the ODF

I. Scenario: FttH with a PON architecture

II. Product Definition

In a PON scenario, unbundling at the ODF is only possible with wavelength unbundling (for unbundling at the splitter see Section C.2).

In a WDM-PON solution, the end-user is accessed by using a separate wavelength for each, and multiplexing data onto that wavelength, so that each end-user is assigned a particular wavelength, not shared by other users. This type of PON can be unbundled by giving alternative operators access to the appropriate wavelength at the ODF on a user by user basis. WDM unbundling therefore allows operators a form of (virtual) unbundling whilst at the same time potentially allowing cost savings for all, including the opportunity of eliminating many central offices in an NGA PON architecture. WDM technology is currently used mainly in transport networks or large corporate networks and the industry consensus is that it will be some time before it could be considered viable for commercial deployment of unbundling solutions in access networks for the residential market.

A key issue that must be resolved is how to allocate wavelengths to individual end-users. In practise this is realised through the optical transponders that receive and transmit the optical signal at the ODF.[43]

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42 Ducts can also be used by alternative operators to directly access the end-user without using SMP-operator's fibre links (see Section D).

43 These can be of three types:
- transponder using a fixed laser
- transponder using a tuneable laser
- transponder using a colourless wavelength locking laser.

The type of transponder/laser is an important factor in the cost of the equipment at the ODF and, more importantly, at the customer premises, and the complexity of wavelength provision at the ODF and recognition at the customer premises. From a purely functionality perspective, the optimum transponder to use would be the transponder using a colourless wavelength locking laser as it fully automates the subscriber provisioning process.

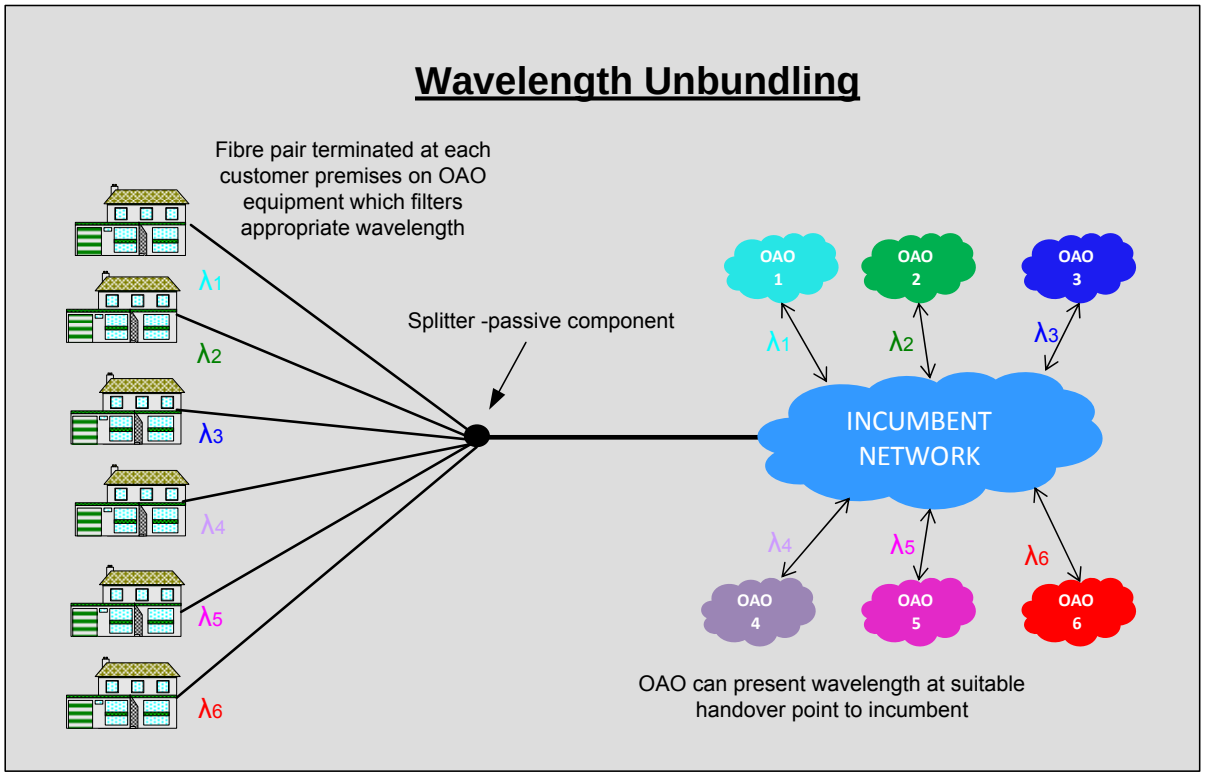


Figure 12: Wavelength unbundling

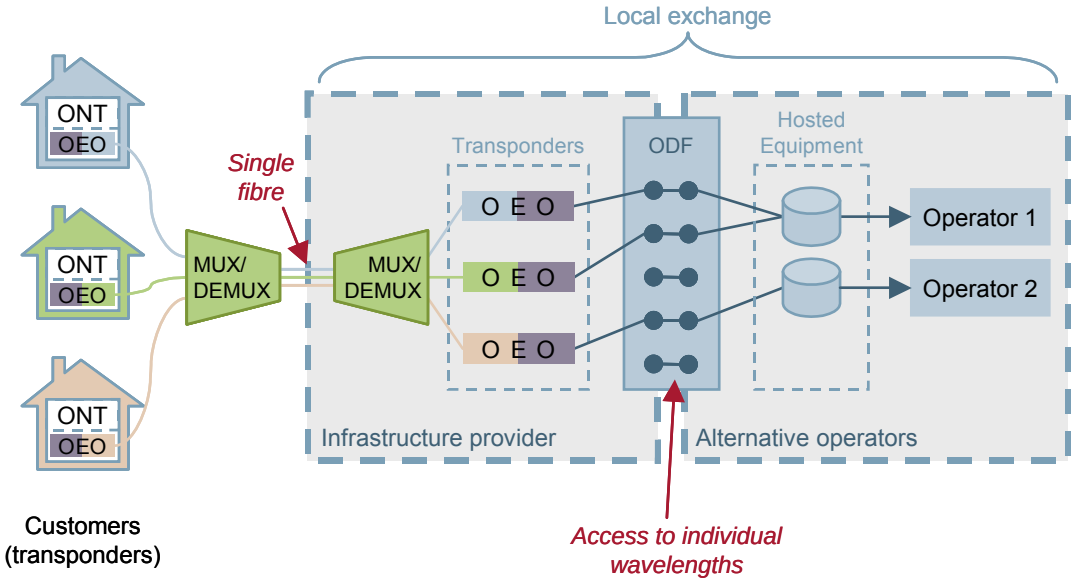
In a PON Scenario unbundling at the ODF is only possible with wavelength unbundling (for unbundling at the splitter see Section C.2)

There are two possible forms of WDM unbundling at the ODF: a) Connection to a wavelength provider through `grey optics` and b) Connection through physical unbundling of transponder.

a) Connection to a wavelength provider through `grey optics`[44]

In this option, the WDM PON system would be owned, operated and managed by the infrastructure provider. An alternative operator wishing to gain access to a particular subscriber could connect to the client side of the associated transponder (using 1310nm grey optics) through an ODF. The limit of responsibility between the infrastructure provider and the alternative operator may be at the ODF as illustrated in following figure:

44 The 1310nm wavelength is known as `grey optics‘ because it is not a WDM wavelength and therefore can be used as a standard interface which is fully interoperable.



Source: Analysys Mason for Ofcom

Figure 13: WDM PON Layer 1 access

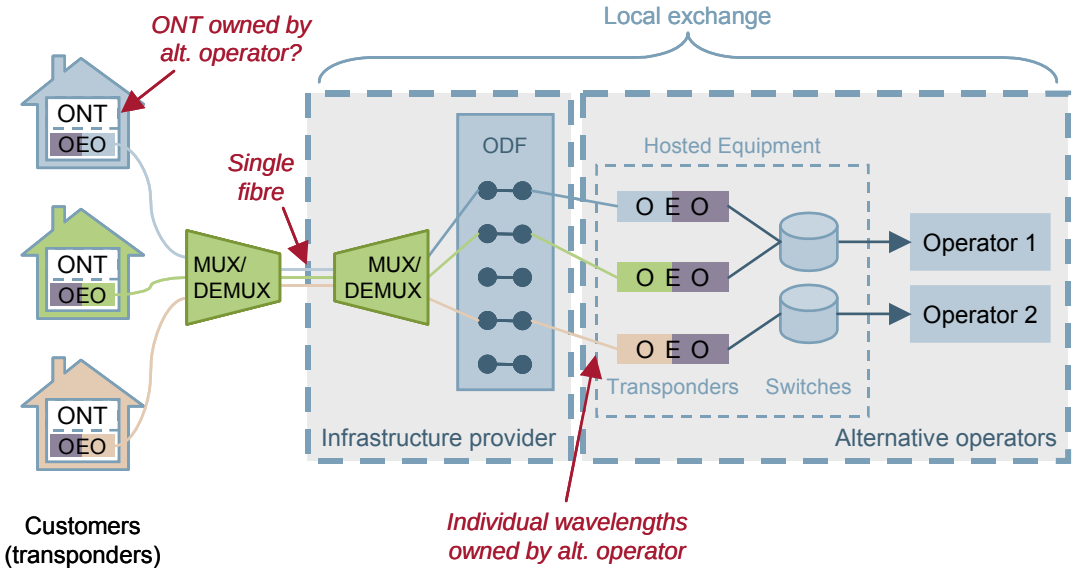
This model has already been used extensively by operators providing wavelength services to other operators for metro or long-haul applications. One of the main advantages of this model is that there are no interoperability issues on the alternative operator's side of the transponder since the interconnection is realised using standard grey optics (1310nm).

Another potential advantage of this solution, which is inherent to WDM systems in general, is that transponders are bit-rate- and protocol-independent on the alternative operator's side – i.e. they can accommodate a wide range of protocols and bit-rates which allows alternative operators to use the protocol that is best suited for providing a high quality service to their customers. The most obvious protocol they could use is Ethernet, but other protocols such as fibre channel or FICON could also be supported by the wavelengths, allowing alternative operators to provide innovative services such as dedicated disaster recovery or storage services. However some proprietary implementation of WDM PON are based on Ethernet and do not support any other protocols. This will be a key area to address for the standardisation of WDM PON.

Finally, in this unbundling option, it would be feasible for alternative operators to own and manage the ONT (Optical Network Termination) if the WDM PON system is based on Ethernet. Standardisation of Ethernet OAM (IEEE 802.1ag, IEEE 802.3ah and ITU Y.1731) means that in theory, ONT will have a standard management interface that will allow any standard management system to monitor its performance from the operator's network opera-tion centre (NOC). However, this would rely on the WDM PON standard to adopt Ethernet as the base technology.

b) Connection through physical unbundling of transponder

In comparison with the model described above, the alternative operator also owns the transponders allowing more innovation on the line side and more independence from the infrastructure provider. This option solves the issue associated with ownership of the ONT. A possible architecture for such a system is shown in following figure:



Source: Analysys Mason for Ofcom

Figure 14: WDM PON Unbundling – Transponder Access

This is an important idea from a competition point of view as it gives the operator the freedom to upgrade its transponder capabilities in line with its own service aspirations and customer needs. However, the key to this option is the standardisation of the WDM PON technology, which should dictate how wavelengths bands could be allocated in a multi-operator environment and how malfunctioning wavelengths could be detected.[45] Sources of faults may be due to different operators using different powers in the lasers from different collocation rooms but at the moment it is still not possible to determine what wavelength (and consequently what operator) is responsible for any malfunction in the WDM system. Also, it should put in place protection mechanisms to prevent wavelengths of a particular operator affecting others.

III. Regulation

For both unbundling options the following ancillary products are necessary.

- collocation at the ODF location;

45 Since the infrastructure provider would no longer have control over the WDM active equipment on the line side, it would be difficult, if not impossible to determine what wavelength (and consequently what operator) is responsible for any malfunction in the WDM system.

- backhaul from ODF to a higher network level (depending on the competition for backhaul services, to be provided by the SMP-operator).

Reference Offer content

Next to a detailed description of the offering for both access and ancillary facilities (collocation/backhaul) and conditions for granting regulated access (as access takes place at the ODF space should be no more of an issue than for LLU currently), the reference offer should include in both options e.g.:

- the appropriate standards to be used for the access points, where these standards currently exist, or access interface specifications if standards are not available;

- guidelines and/or requirements to promote the security of end-user service provision, particularly in the case of transponder access.

C.5 Enhanced bitstream products

I. Scenario

Bitstream products may be applicable for all roll-out scenarios.

II. Product Definition:

Bitstream Access is a wholesale product which consists of an access link to the customer premises (over copper or fibre) and a transmission service (e.g. Ethernet) to a defined set of handover points (the access point). It enables alternative operators to differentiate their services by altering a number of technical parameters and/or the use of their own network.

Access point/level

In the case of a copper based distribution network bitstream access is composed by a xDSL link (ADSL2+, SHDSL, VDSL2, etc.) from the CPE to the DSLAM/MSAN (located at the cabinet or MDF) and a transport link (backhaul) from the DSLAM/MSAN output port to the alternative operator's hand over point (feeder node). In case of a fibre based distribution network there is a fibre link from the CPE to the optical termination equipment (like OLT for GPON) (located at the ODF).

The alternative operator can access the SMP-operator's network at DSLAM/MSAN/OLT level[46] or before the parent node at Layer 2 or at the exit of the parent node and/or distant node level at Layer 3[47].

Technology used

In practice, 'bitstream' is access at layers 2 (ATM, Ethernet) and/or 3 (IP). The higher in the layers one goes the more network functionalites are incorporated and the less flexible it becomes for the alternative operators. For example IP, at the network layer, incorporates network routing, while Ethernet, at the lower datalink layer, has P-t-P addressing.

A pure Layer 2 Ethernet based bitstream, similarly to an ATM bitstream, implies a pure transport link between the user data and the access point; on the other hand, an IP-based bitstream involves the SMP-operator's usage of additional functionalities and equipment such as the Broadband Remote Access Server (BRAS). A Layer 2 access is more transparent and can allow quite a broad range of functionality options for the alternative operator.

The handover points for Layer 3 bitstream products is in the IP core network and will in general not differ from traditional bitstream handover points used in the past. The bitstream handed over at these points may stem from NGA access networks and transported across new Ethernet concentration networks.

Currently SMP-operators are migrating their aggregation networks from ATM to Ethernet technology.[48],[49] There may be different forms of Layer 2 Ethernet based bitstream products one of which is called Active Line Access.

The previous concepts can be graphically represented in the figure below, which depicts possible access points and technologies for an alternative provider.

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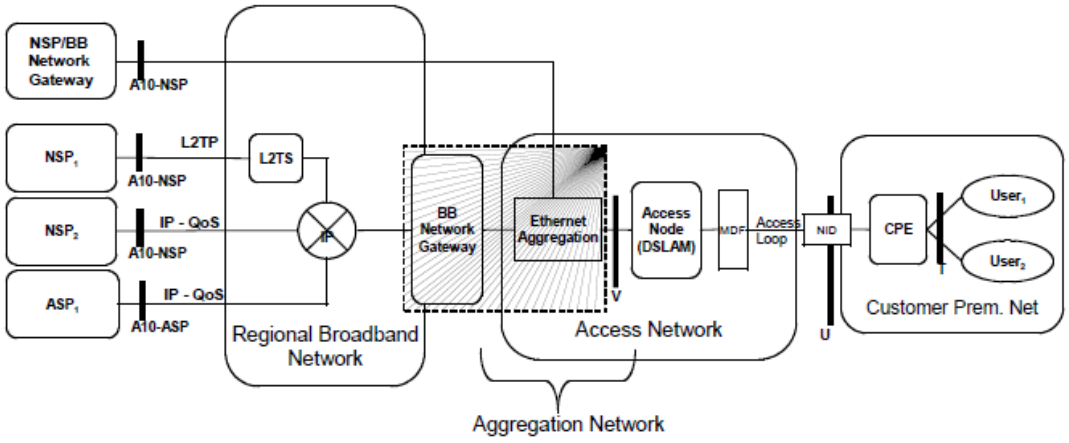
46 DSLAM access allows a lot of freedom in the configuration of the service since the alternative operator gets from the SMP-operator just the DSLAM functionalities: xDSL modems, multiplexing into a single high speed packet stream and a high speed interconnection port.

47 Compared to DSLAM access, parent node access is much more utilized because it allows economy of scale, due to statistical multiplexing of packets which enables the overbooking of the bandwidth handed over at the feeder node.. The high speed handover port can be at 34/155 Mbps, in the ATM case, 1 Gbps, in the Ethernet case.

48 In this case feeder Ethernet nodes located in different areas are interconnected through IP long distance links.

49 One problem of the native Ethernet protocol is that the maximum number of VLANs in a single Ethernet network is limited to about 4000. This means that it is not possible to provide a VLAN for every customer (the number of customers in a single local area is easily grater than 4000). Recently, to solve this problem, incumbents are introducing the stagged VLAN protocol which increases the number of potential different VLANs in a single local area.



Source: Broadband Forum, TR-101

Figure 15: Network architecture for Ethernet-based DSL aggregation.

Relevant functionalities of an Ethernet based Bitstream Access (Layer 2)

Generally, bitstream offers should be as much as possible modular in order to allow the maximum freedom for alternative operators to define QoS and the the configuration of their own retail services. Such disaggregation of the access segment (the physical link from the CPE to the DSLAM/MSAN/OLT) from the transport segment (the transmission link from the DSLAM to the feeder node) allows the alternative operator to define, with enough freedom, the configu-ration of the bitstream service by choosing the best mix of parameters for the retail service to be marketed: xDSL profile, Quality of Services, quantity of bandwidth to be shared between its customers, overbooking factor, etc.

A wholesale bitstream offer with enough diversification options allows the alternative operator to create a more varied retail product offer to anticipate the various needs of customers (end-users and business customers alike). Such an Ethernet bitstream offer is typically considered to need the following elements to be fit for purpose:

– Flexible allocation of VLANs to allow maximum potential for service differentiation. For example, business clients typically prefer their own private network with dedicated VLANs, while for mass market purposes, shared VLANs for all connections may be sufficient.

– Control of customers' service speeds and service symmetry: business traffic is generally symmetric, while mass markets usually demand asymmetry - more download than upload.

– Security enabling: security is enabled by separation of traffic streams and allowing whole-sale-users to implement their own security measures.

- Ability to support different QoS levels [50]: Competing operators need to have the ability to control QoS parameters in order to supply differentiated retail products and also to respond to the requirements of end-users. The ability to distinguish between high priority and low priority traffic is needed, because for example TV & voice services are more sensitive to delays than data services. Control messages need the highest priority because they are vital for keeping the network and services up and running.

- Flexible interconnection and aggregation at regional & local level: interconnection at different levels in the network is needed to give alternative operators the possibility to lower their backhaul costs and invest in their own backhaul infrastructure when they have critical mass or to give them the opportunity to keep using their existing backhaul infrastructure in an NGA environment.

- Flexible choice of customer premises equipment (CPE's) from different vendors: Interoperability between DSLAM/MSAN/OLT and modems from different vendors is needed to prevent a vendor monopoly. Alternative op-erators don't have the same scale advantages as the incumbent to get the same price certainly not when they are forced to buy it from a certain vendor.

- Support for multicast functionality allows alternative operators to compete effectively for IP-TV customers (broadcasting functionality) and to provide triple-play offers because this drives the economic distribution of audio-visual content. In some countries the provision of multicast, within the bitstream reference offer, has been imposed by considering multicast as a Layer 2 network functionality. A critical issue is the quantity of bandwidth that has to be allocated to provide IPTV. In fact, price test of bundled services, which include IPTV, have to take into account the average transport cost to provide triple play. Thus, knowledge of the amount of bandwidth required allows the regulator to correctly evaluate the network costs incurred by the alternative operators.

Active Line Access (ALA) is a particular form of bitstream access where the wholesale product is as basic as possible. Differentiation flexibility is in part created through giving the alternative operator the CPE control instead of having a wholesale a product with as many different features or options as possible. So for example when we talk about security either the bitstream can offer lots of security options, or it can be transparent to whatever security the CP imposes like in ALA access.

There are existing industry (as opposed to regulatory) trends which could lead to an Ethernet bitstream product such as an ALA product getting closer to passive access products: The first is the increasing ubiquity of Ethernet as a 'raw', relatively simple, Layer 2 protocol and the second is the increasing automation of service maintenance and support through next generation operational support systems (NGOSS). These two factors may enable more con-

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50 Ethernet protocol provides 8 QoS classes. Current networks generally still use a subset of these Classes: The lowest QoS (0 & 1) are used for best effort traffic, while the higher QoS for real time services and more important traffic streams (2-5). The highest QoS (6 & 7) are used for control signals.

trol of characteristics such as QoS, complexity and security of service streams than traditional bitstream products.

A distinguishing feature between bitstream as an active product and passive products in market 4 remains, where for unbundling the alternative operator is free to choose the CPEs and its own (active) equipment at the ODF/MDF suiting his parameter requirements. The SMP-operator chooses the providers of the ODF/MDF equipments in the case of bitstream (and the choice of CPEs is limited). The choice of the equipments implies that eventually some functions are not available because the bitstream provider does not necessarily implement all the possible features available from vendors. Additionally the SMP-operator chooses the configurations most suited to his own needs limiting the scope for innovation for the alternative operators.

The key characteristics, and the operational requirements, are summarised in the conceptual representation of ALA functionality overleaf:

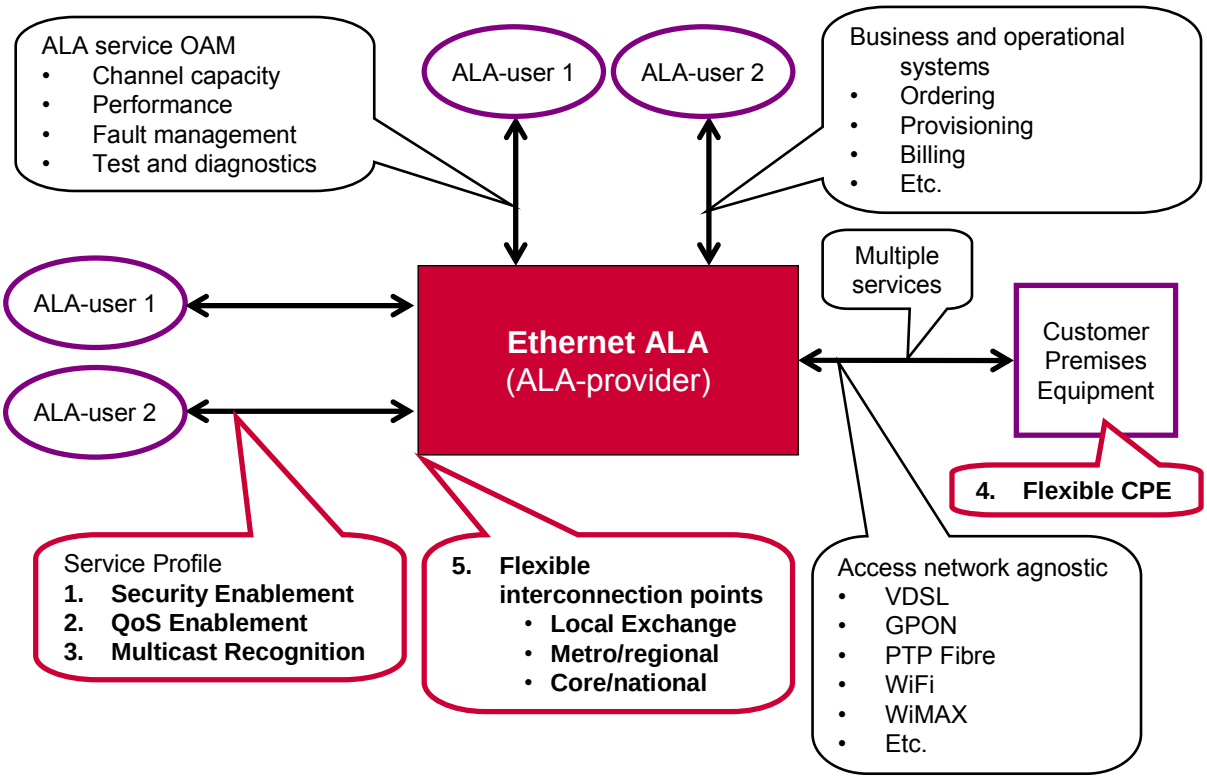

Figure 16: Conceptual summary of ALA functionality

III. Regulation

If the choices made by the SMP-operator do not leave enough room in the wholesale product for the alternative operator to diversify his retail product, the NRA may impose a different configuration at the wholesale level. For example the Belgian regulator has imposed on the SMP-operator to add a symmetrical profile and different VLANs per QoS to its wholesale bitstream VDSL2 offer.

Another consequence of the ownership of active equipments by SMP-operators is that the alternative operator does not manage the active equipment except if the equipments chosen by SMP-operators allows different domains of right of control without any possibility for an operator to access to AltNet management objects of other ones. The additional possibility to invest in the own interface cards (and manage them) for alternative operators depends also of the SMP-operator choice of equipments.

An NRA can also intervene beforehand by specifying standards or functionality. ALA for example is a particular form of bitstream access which aims to ensure differentiation and flexibility through standards. Differentiation may also need to be supported through regulatory intervention at the systems level to ensure appropriate access.

Migration Issues[51]

Migration (e.g. dismantling conditions for MDFs, parallel running of legacy and NGA networks, if applicable allocation of migration cost between market parties, timeframe)

- From WBA over ATM to WBA over Ethernet

- From WBA to ALA

Reference Offer content

The content of a reference offer has been dealt with in more detail by the ERG in its "Report on ERG Best Practices on Regulatory Regimes in Wholesale Unbundled Access and Bitstream Access" (ERG (07) 53)[52]. These principles remain valid in an NGA context.

For wholesale bitstream access, the following ancillary products are necessary:

- collocation at the handover point;

- backhaul from handover point to a higher network level (depending on the competition for backhaul services, to be provided by the SMP-operator).

D Wholesale products to reach access point

In order to reach an access point (left side of the ladder), an alternative operator may need an appropriate wholesale product., either through ducts, dark fibre, leased circuits or other active backhaul products.[53]

51 See also Chapter C. for migration issues.

52 See also the corresponding document "ERG Report on the Public Consultation on the Report on ERG Best Practices on Regulatory Regimes in Wholesale Unbundled Access and Bitstream Access", ERG (07) 53b, and the "Common position on Wholesale broadband access", ERG (06) 69rev1. All available at: http://erg.ec.europa.eu/documents/docs/index_en.htm.

D.1 Duct access

In this section the general principles and conditions are presented that should be followed by the SMP-operator and alternative operators for the use and access to ducts and associated infrastructure of the incumbent, if existent and available.

I. Scenario

In principle, in all scenarios, FttH, FttB or FttC, a duct access product could be used by the operators to reach any of the access points, i.e., either to reach the street cabinet, manhole or even the buildings. Also, (vertical) duct access inside the house might be applied in the FttH scenario.

II. Product Definition

Duct access is a wholesale passive access product and can be used in principle by the operators to install all type of cables: copper, fibre or coax. However, the space requirements for these different cables types are rather different and may lead to limitations, as space in ducts is a scarce resource. Thus, installation of fibre cables corresponding to the deployment of NGA should be prioritized in this case.

Ducts (and associated infrastructure, like poles or manholes) could exist at the core or access network level. However, there is no flexibility in this product, i.e., either ducts exist or not and, in this case, cannot be used by the operators to reach that specific access point. In case the available space in a determined path is limited, rules for allocating the limited space must be established. Also, the build up of new ducts is a costly and prolonged process (or it may not be feasible due to technical or legal constraints).

III. Regulation

Access obligation

The SMP-party shall provide access to its own ducts and associated infrastructure (including poles, manholes etc.) for cable installation purposes

Reference offer

In case an obligation to publish a reference offer was imposed, the SMP-operator, must publish a reference offer for the use and access, from the beneficiary entities, to ducts and associated infrastructure, which must comply with the principles of transparency, non-discrimination and cost orientation. Restrictions, if any, should be described, if any, with respect to network technologies, equipment and operators that are authorized to access the infrastructure of the SMP operator. Any restrictions must comply with the principles of transparency and non-discrimination.

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53 The focus in the Chapter is on the right hand side of the ladder of investment (Figure 1).

In case no obligation to publish a reference offer is imposed, rules for allocating limited available space may need to be imposed separately as generally one of the main regulatory problems is the allocation of limited available space.

Reference offer content

The reference offer should include e.g.:

(a) Engineering rules

Descriptions should clearly depict the available infrastructures, define how to occupy ducts[54], whether there is spare capacity, etc.

Specifications regarding the occupation may be based on network separation concepts: usage of sub-ducts (including micro-ducts) in order to keep separated the fibre cables from different operators. Certain space reservation should be allowed, to be shared among all operators for maintenance purposes[55].

(b) Allocation rules for limited available space

In any case, the SMP-operator should not be allowed to install, in the ducts, sub-ducts or associated infrastructure, cables/equipment not corresponding to the current or foreseeable needs in terms of service provision[56], and, as a result of the undue excessive space occupation, prevent or limit the access to infrastructures by the beneficiaries.

Size of a duct may also become a regulatory issue as it may need to be determined how to allocate the available space in the duct to the requesting parties. For example, in Germany access is provided to a fourth of the ducts reasoning that greater granularity was not justified considering that the economies of scale do not allow an efficient utilization by more operators. Another conceivable option could be to grant access to micro-ducts. In Croatia based on an ordinance an infrastructure operator is obliged to provide the usage of free space in cable ducts at the request of a alternative operator on the basis of regulated prices (depending on the length and cross section of the cable), as well as usage of micro-ducts.[57] In Spain, generally subducts are provided to operators, except in areas close to the buildings where subducts are not available due to limited size

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54 E.g. cables shall be identified in manholes with a code enabling the identification of the respective owner.

55 In Portugal, the space intended to the maintenance and repair works, the SMP-operator should leave, to be used by the beneficiary entities, in each pathway, an area corresponding to 20 % of the internal area of each duct or sub-duct.

56 The SMP-operator may reserve, for a maximum period of e.g. one year, in the ducts and associated infrastructure that it operates, space for its own future use, provided that this reservation has due grounds in the guarantee of the appropriate future development ot the concession services (e.g. US).

57 Free space in a cable duct is defined as any unused space greater than the maximum cross section of the largest cable in a cable duct. Moreover, any cable that has not been used for longer than 6 months is considered free space as well. There is an obligation that direct pulling of fibre optic cable into large diameter ducts is not allowed, but a protective small-diameter duct or micro-duct must be installed first (see Annex).

of the duct; where space is limited, alternative subducting methods, for example based on flexible textile materials, are admitted.[58]

For the allocation rules, it is important to identify, for each infrastructure, the availability of space to be used by the beneficiaries, and which space may be freed both by the SMP-party and by the beneficiaries. Information about spare capacity in ducts and manholes is necessary, and should be provided on demand (see below information system).

Alternative solutions for saturated paths

Alternative routes to avoid saturated paths (set of ducts) are recommended[59]. When such solutions are provided, it should not imply disproportionate costs to the operator.

If, following a request, no space is found and one or more “dead” or clearly obsolete cables (e.g. cables that have not been used for more than one year and not to be used within a reasonable period of time) are identified, such cables should be removed[60] , where it is physically and technically feasible.

In addition, mechanisms to discourage the SMP-operator to provide unreasonable alternative paths, or systematic negatives to remove dead cables, must be defined, such as the provision of dark fibre equivalent to the initially requested path.

(c) Operational Rules

Operational rules cover procedures regarding ordering, provisioning, and operational procedures. The reference offer should provide the sequence of procedures and interactions to be established with the beneficiaries in the provision of information, requests and procedures to request, accept and book maintenance and repair operations.

In this context, joint site surveys are recommended in order to clearly agree on the infrastructures that can be occupied by the operator, and quickly determine an alternative solution (e.g. removal of old cables).

Moreover, the reference offer could encompass the development of an online IT "Information System", enabling the automatic handling of operator requests (and the SMP-operator’s responses), giving autonomy and speed to the procedures for requests for information, scheduling and feasibility of interventions for the installation of fibre optic cables.

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58 See the Annex for details in Spain.

59 Where it is physically or technically unfeasible for the SMP-operator meet the requests for access submitted by beneficiaries, it should propose an alternative route/pathway as close to the initial request as possible.

60 The costs of removing „dead“ or clearly obsolete cables should be borne by their owner, having regard to the principle of proportional and causal costs.

Information resources for existing and planned facilities, including geographical data

The information system should provide the information, requests and replies, related in particular to the:

i) occupation and availability of (space in) the desired ducts, manholes and associated infrastructure (if a online database is not available);

ii) occupation of ducts or associated infrastructure: installation or removal of cables/equipment in ducts and manholes

As regards the provision of information Art. 12 para 4 (DIRECTIVE 2009/140/EC as of 25 November 2009) foresees that:

> *"Member States shall ensure that competent national authorities may require undertakings to provide the necessary information, if requested by the competent authorities,in order for these authorities, in conjunction with national regulatory authorities, to be able to establish a detailed inventory of the nature, availability and geographical location ofthe facilities referred to in paragraph 1 and make it availableto interested parties."*

Geographical data and Information systems

The need for the description and identification of ducts and associated infrastructure require a complex flow of information between the parties, and the need of transparency and availability of information to the beneficiaries requires that the SMP-party should make available, maintain and update an (online) database to provide descriptive information of ducts and associated infrastructure[61].

Graphical and updated information should be provided showing civil works location (ducts, manholes, poles, etc.), up to the private domain, so that operators can arrange occupation requests. This information/database should be accessed in real time, e.g., through an Extranet page[62].

If no information with respect to duct occupation is available, surveys should be conducted to compile information and update records of the infrastructure data, in order to provide information on the occupation of duct, with the identification and characterisation of the cable or cables installed in each duct/sub-duct.

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61 E.g. the number of man-holes, its type, and distances to reference elements, the type of ducts, its length, number of sub-ducts and its occupation, with explicit reference to the type of calibre of the already installed cables and distances to reference elements.

62 With the respective price oriented to costs. One key principle is that only those incremental costs arising as a result of the obligation imposed to develop a database to be accessed by the beneficiaries shall be considered relevant. It is considered that the SMP-operator should have already built its database (and geo systems) for own use (including surveys). Therefore, no regard should be given to costs connected to: (a) additional local surveys for the provision of information on ducts; (b) updating records; or (c) the acquisition of cartographic information.

Service Level Agreements

The SLAs should foresee quality of service indicators and levels and clauses that foresee any breach thereto.

The indicators to be included in the reference offer should cover, in particular: i) Time limit to reply to a request for access and use of ducts and manholes; ii) Time limit to schedule the monitoring of urgent intervention operations to be carried out by the beneficiary entity (repairs); and iv) Time limit to schedule the monitoring of non-urgent intervention operations (time for installation, maintenance, removal and repair operations); time limit to solve specific infrastructure problems (ducts obstruction, cut, etc.)

SLAs may need to be complemented with penalties to be imposed to the SMP-operator when services are not provided in accordance with the referred time limits.

Publication of the performance levels

The SMP-party should submit reports to the NRAs on the quality performance offered for each beneficiary[63]. Information should be provided on the installation and clearance requests, time to reply, etc.[64] Both service-by-service and quarterly averaged values (eventually broken by month) are essential to allow a close follow-up of the service quality provided to alternative operators.

It should be noted that the non-discrimination obligation requires that similar cases must be handled in a similar way. In this sense, the proper implementation of this obligation requires the awareness of the levels of the quality of service provided to internal departments with the same service provision and service recovery procedures defined in the reference offer.

Hence, the SMP-party, in compliance with this principle, should publish the proper indicators on the process of provision/supply of services to its own internal departments (i.e., carried out by its own services or by subcontractors)[65,66]. NRA should examine the proposed data and confirm that they respond to activities that can be considered equivalent to those provided to operators in the framework of the reference offer.

Prices schedules and Billing procedures.

Prices should be provided for all the the different items for access and use of ducts and associated infrastructure (e.g., manholes).

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63 The reports should be submitted in reasonable time intervals (e.g. quarterly, eventually broken down by months).

64 These are important activities for good operational processes. In particular the installation request may play an important role for the whole process of accessing and occupying ducts.

65 The collection of information in connection with the services provided to the SMP-operator's own departments is important. See ERG CPs on that matter.

66 This information may help to analyse possible discriminatory situations and to ensure that the market power of a vertically integrated SMP-operator in wholesale markets will not be leveraged to the associated retail markets.

Pricing of services provided in the reference offer should include, in particular,

- Provision, preferably online,) of information (availability/space) on ducts and associ-ated infrastructure - including the assessment of occupation feasibility (with/without alternative) and communication of a project for the construction of new infrastructures;

- Site surveys / access to points of entry (e.g. manhole);

- Cable installation in ducts and associated infrastructure (if not installed by the bene-ficiaries) – in this case, including the price for monitoring and supervision of work to be performed by the beneficiary entitiy);

- Monthly fee for occupation of space in ducts and sub-ducts and associated infra-structure (e.g. space in manholes) and, if applicable, an one-off fee.

Penalties might be applied (in form of a compensation) provided for in any of the "phas-es"/processes of the reference offer (e.g. for non-compliance with time limits to reply)[67].

Cost Orientation

To date, prices of the passive access (e.g. ducts, unbundling) are regulated according to the principle of cost orientation, an important tool for setting prices in respect of the reference offer in question. It is also noted that the passive infrastructure “markets” are characterised by a lack of competition leading to reduced incentives for the SMP-operator to operate effi-ciently and reduce costs for the provision of ducts.

All countries that have taken decisions on pricing of duct access have considered that is ob-jectively justified and proportionate to impose/maintain the obligation of cost orientation of wholesale prices and accounting of these costs, which decisively contributes to the existence of efficient and sustainable competition in the (downstream) markets for wholesale access, incentivising competition and efficiency along the ladder.

According to the applicable regulatory framework, particularly the principle of non-discrimination, the SMP-operator should apply in the scope of the reference offer the condi-tions applied to their subsidiary companies, except where a lower price results from the anal-ysis of costs and from the application of the principle of cost orientation of prices, in which case this price shall be applied.

Moreover, the beneficiaries should not be charged any amounts for costs which are not, by their very nature, incremental costs allocated to such entities (such as keeping in order and cleaning SMP-operator’s own infrastructures).

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67 It should be established mechanisms which encourage the SMP-operator to monitor and intervene to re-move any obstacles to the progression of processes with respect to the requests of beneficiaries with the same speed and interest as when handling their own requests. That is, the requests of the beneficiaries, in light of the principle of equivalence, should receive equivalent treatment to those of the SMP-operator itself.

Duct Access: Current situation

The following table summarizes the current situation in European countries as regards duct access (for details see Annex).

In most countries where there is a regulated price this price is made up of a one-off fee and a monthly fee, the latter being a function of the size of the duct (Bulgaria, Denmark, Estonia Hungary, Lithuania[68], Norway, Poland, Portugal, Spain, Switzerland Turkey). In some countries the prices are pending regulatory approval (Croatia, France[69], Germany, Italy, Slovenia). A few countries do not have a standard reference offer for access to ducts (Austria, Croatia, Germany, Greece, Ireland, Slovakia). In some countries the duct access obligation is imposed in regulatory authority orders on a case-by-case basis (Germany[70], Belgium). Commercial offers apply in (Finland, France, Latvia, Lithuania, Malta, United Kingdom). A duct access offer does not exist in Belgium, Czech Republic and the Netherlands.

68 For more information on the basis of price regulation in Lithuania see Annex.
69 In France, regulated prices for the FT reference offer are being modified. Former tariffs are still valid.
70 In Germany such an order may be developed into a standard reference offer.

	Reference offer *Yes/no*	***Commer-cial offer***	***Regulated price (* indicates that decision on price is pending)***	***No duct offer, but duct exist***	***Ducts not existing***
Austria	n				
Belgium					x
Bulgaria			x		
Croatia	n		x (*)		
Czech Republic					x
Denmark	y		x		
Estonia			x		
Finland		x			
France	y (FT)	x (local authorities)	x (*)		
Germany	n		x (*)		
Greece	n				
Hungary			x		
Ireland	n				
Italy			x (*)		
Latvia		x			
Lithuania		x	x		
Malta		x			
Netherlands					x
Norway	y		x		
Poland			x		
Portugal			x		
Romania				x	
Slovakia	n				
Slovenia			x (*)		
Spain	y		x		
Switzerland			x		
Turkey			x		
United Kingdom		x			

Table 1: Duct Access (situation as of January 2010)

D.2 Dark fibre

I. Scenario

In principle, in all scenarios, FttH, FttB or FttC, a dark fibre access product could be used by the operators to reach any of the access points, i.e., either to reach the street cabinet (core or concentration network), manhole or even the buildings (access network).

However, under a FttH/B scenario, an available duct access product (to deploy own fibre cable) could be preferable to operators, both in terms of costs and efficiency.

II. Product Definition

Dark fibre is a wholesale passive access product (unlit optical fibre) and can be used by the operators to connect its (equipments in) core networks to the access points.

As with ducts, dark fibre products could exist at the core or access network levels. However, there is more flexibility in this product (than with ducts), i.e., the installation of new fibre cables is not a costly and prolonged process (although in some cases it may not be feasible due to technical constraints, e.g., no capacity available in ducts).

Fibre is a Layer 1 product but supports several Layer 2/transport technologies, as WDM, Ethernet, SDH, etc.

III. Regulation

A priori, the closest "substitute" to duct access – when the access to passive infrastructure (including ducts) is technically or physically impossible, for example, due to lack of (capacity in) ducts, and there are no conditions whereby competing operators may develop their network in a way which is "equivalent" to the incumbent – is access to dark fibre, the rental of unlit fibre (dark fibre) with a route which is equivalent to that guaranteed through access to ducts. In this case, instead of renting duct capacity and installing their own fibre optic cable, the operator leases the physical fibre optic infrastructure.

Additionally to the situation of lack of (space in) ducts, a dark fibre offer makes sense when a LLU beneficiary seeks to install equipment in an MDF or street cabinet and needs backhaul. In the event that the SMP-operator implements FttC solutions and alternative operators decide to (co)install (in or) at the street cabinets, a specific backhaul offer should be made available[71].

Hence, the offer of dark fibre (by the SMP-operator with excess fibre capacity) could, from the outset and in certain situations (e.g. where there are economical or technical barriers which impede the immediate installation of new cables by operators), be complementary to other offers, namely the duct offer. Compared to duct offers access to dark fibre leads to a reduction in the overall level of investment, potentially freeing up resources for greater coverage of NGAs. In this regard, it can be argued that a dark fibre reference offer, especially between the core network nodes of the operator and the access points (ODF or cabinets) could help to overcome some of the difficulties that alternative operators have faced in extending their networks .

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71 In some countries (e.g. Portugal and Belgium), an extension of the current dark fibre connection for backhaul (at short distances) provided by the SMP-operator in the reference ULL offer.

Reference Offer content

Next to a detailed description of the offering for both access and ancillary facilities (eventually, collocation) and conditions for granting regulated access, the reference offer should include e.g.:

- Technical handbook, including type and characteristics of the fibre and the technical description of the ODF where the optical interconnection is taking place;

- Operational handbook, including procedures for ordering and provisioning, procedures for service and maintenance, administration of physical infrastructure, identification, etc.

- Information resources for existing and planned facilities, including geographical data – The definition of specific rules for the provision of dark fibre requires information, by the SMP-operator, on the actual occupation of the ducts as well as the effective use (date of installation and commencement of use) of the installed fibre.[72]

D.3 Leased Lines

I. Scenario

Leased lines are used as an active backhaul product to connect to the access points, independently of the type or location of access point and scenario (FttH, FttB, FttC).

Moreover, in the event that there are no ducts or capacity restrictions in the ducts and restrictions in the use of dark fibre of the SMP-operator, an offer of transmission capacity for the backhaul may be necessary as an alternative.

II. Product Definition

Layer and Technology

Optical fibre is used at Layer 1 (e.g. DWDM). The active backhaul product is a Layer 1/2 product, consisting in an active connection between two network/access points using transport technologies as Ethernet or SDH.

Functionalities

In principle, the active backhaul, similarly to a leased line (in some cases it may happen to be a standard leased line), is a dedicated and transparent connection, able to support/connect

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72 The fact of having to perform a case-by-case examination of the various “sub-sections” (i.e. different ducts and associated infrastructure where the fibre cables are laid, especially between the core/exchange and the buildings to be connected) to assess capacity, both in terms of space (for new fibres) and the capacity of currently installed optical fibre cables, may make this a complex process.

all kind of traffic and upper layer technologies (e.g., IP/Ethernet based implementations and services) as well as DSLAMs (e.g. VDSL2) or OLTs.

III. Regulation

In case leased lines are regulated the conditions (procedures, prices, quality of service) offered for active backhaul, should not be inferior to those included in the SMP-operator's regulated leased lines offer (or regular commercial offer, if no regulated offer exists), independently of the network topology and technology (e.g. SDH, Ethernet).

The *reference offer* should include the possibility to use leased lines as active backhaul product for connecting to an access point. Furthermore it should contain e.g.:

- Service and technical descriptions of the various types of lines (e.g. GE, STM-64, etc.);
- Tariff schedules and Billing procedures;
- Procedures regarding ordering, provisioning and maintenance (including SLA's)

The compulsory SLAs must include conditions on supply and migration, fault notification and repair, and respective penalties for non-compliance.

Regulated access price

Prices should be broken down by component (e.g., installation, monthly fee, etc.) and cost oriented.

However, in certain situations, depending on the competition in the backhaul market, e.g. backhaul from the cabinet (SDF) to a higher network level including collocation in the case that the MDF backhaul market is considered to be competitive and SDF locations are on MDF level, it has to be considered whether it is reasonable to regulate SDF-backhaul). Backhaul services can be realised via duct access, dark fibre access, DWDM access or Ethernet access.

D.4 Collocation

Regulators should guarantee that the alternative operators may access, with its own infrastructure and in an economically efficient and rational manner, the SMP-operator's exchanges, concentration points and/or cabinets.

Hence, collocation services – which constitute ancillary services – that allow new entrants to install fibre optics equipment within or close to the SMP-operator's facilities should be provided.

In addition, NRAs may have to make sure that ducts connecting collocation chambers with new entrant's networks are provided to operators as well.

D.4.1 At the building

I. Scenario

Collocation at the building is related to the FttH/B scenario, where there is, respectively, fibre or copper (sub-loop/client drop) unbundling.

II. Product Definition

For collocation, it should be defined a suitable set of physical conditions within the building, namely, space (e.g., in the basement) for installation of the operator's equipment (DSLAM/ MSAN, transmission, SDF/ODF, splitter), energy (AC) feeding and, if needed, cable trays from the building cable entrance towards the vertical infrastructure.

III. Regulation

Collocation at the building level may not be related with an access obligation imposed to the SMP-operator, at least in some Member States, where this entity is not the owner of the infrastruture (ducts, cabling, etc.) within the building.

Given the great majority of the buildings in many Member States is not recently built (and according to the technical requirements for multi-cable/technologies deployments), physical (and/or administrative) barriers to the access of customer homes might exist for operators who want to implement (multiple) FttH solutions (as well as FttB for the installation of DSLAMs and access to the building distributor)[73].

In the case of FttH deployments, also a (shared) ODF (with capacity to terminate at least, a pair of optical fibres for each independent unit of the building), should be installed if the architecture is fibre. It can be installed at the basement/entrance of the building if it is the concentration point[74].

D.4.2 At the concentration point

I. Scenario

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73 Because there are no internal ducts (or space in existing ones) or permission is not given by the condominium for their installation or for the installation of additional cables and/or equipments (DSLAM/ODF, etc.).

74 Aditionally, it may be considered a pre-installation of a power source for permanent use, linked to the General Electric Panel according to the authorisation of the condominium.

If the concentration point is located outside the building at the manhole, street cabinet, frontage of the building, pole, etc.) collocation will be needed there as fibre is unbundled at this location.

II. Product Definition

For collocation, a suitable set of physical conditions within the concentration point should be defined, namely, space for installation of the operator's equipment (e.g. splitter or ODF).

The location of the concentration point can have consequences on operational constraints. If operations are needed at the concentration point in case of churn for example (which is the case in a single fibre architecture), the accessibility of the concentration point is different whether it is located in a manhole, in a cabinet, or on the frontage of a building.

III. Regulation

In the case of an imposition of an obligation of access to the fibre loop it is the responsibility of the SMP-operator to foresee a collocation possibility in this infrastructure, notwithstanding the existence of impediments of technical nature duly justified case-by-case.

In principle, it should be possible for a certain number of alternative operators to install (operate and repair) an ODF or a set of splitters and interconnect/access to the SMP-opearator optic infrastructure within the concentration point, thus avoiding the duplication of infrastructures and encouraging the services efficiency.

It may be defined a minimum area to be considered for purposes of determination of the price associated with the collocation in the concentration points.

In the case where the concentration point is located in a manhole, and there is already a duct reference offer in place, it may be updated to include this possibility, both in terms of procedures and information and pricing. If there is no duct reference offer in place, it must be defined a subset of rules and procedures (conditions, prices, deadlines and compensation in case of non-compliance, etc.) - see section D.1. If deemed necessary, one (new) multi-operator manhole may be installed and used both for purposes of interconnection or access point. In any case, whenever there is already a multi-operator manhole near the access point, this one should firstly be used for this purpose.

D.4.3 At the cabinet

I. Scenario

This section describes collocation at the cabinet related to the FttC scenario, where there is copper (sub-loop) unbundling.

II. Product Definition

For collocation at the cabinet, it should be defined a suitable set of physical conditions within the existent, namely, space for installation of the operator's equipment (DSLAM, transmission, SDF), energy feeding and, if there is the need to install new cabinet(s), external cabling from the SMP-operator's cabinet.

III. Regulation

For the purpose of access by the alternative operators to the sub-loop, at the level of street cabinets, this could presuppose the installation of a new cabinet in parallel to the existing one with the inherent duplication of costs, or as an alternative (due, e.g., to technical or legal constraints), the possibility of sharing the existing street cabinet, which in any case may have to be updated and expanded. The community might add additional (legal) constraints for new or enlarged cabins implying that the entry of an alternative operator becomes more difficult or even impossible.

The assessment of operational conditions at the level of collocation and availability of DC power supply in the SMP-operator's cabinets, as well as the definition of rules to be implemented in the reference unbundling offer (RUO), in order to minimize identified constraints, are important in a scenario of FttC implementations by the SMP-operator.

The definition of such rules, within the updated RUO, should comply with three basic principles:

(a) The conditions for the physical collocation of the alternative operators' equipment – SDF, DSLAM and backhaul equipment – in the SMP-operator's cabinets (or near by), together with the fact that it may not be possible to determine the immediate extension of facilities to meet all requests, result in the need to specify rules for the use of this scarce resource.[75] As a rationing mechanism one could e.g. apply a first come first serve basis, an assignment of lottery or an assignment in separate tranches.[76]

(b) Likewise, the conditions for the provision and use of DC power, together with securing requirements and demand predictability, lead to the need to specify rules for the use of this resource.

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75 Although these SDF specific equipment comes with a more compact design than MDF equipment, space in or next to street cabinets generally is limited. Therefore it should be analysed on a national basis whether space in existing cabinets (to be adapted for VDSL2) is available to the extent needed by alternative operators and whether cabinet sharing is possible. Should existing cabinets have not enough space available for housing of alternative operators' equipment other possibilities like deploying adjacent cabinets or containers should be evaluated. In some municipalities the placement of (multiple) outdoor cabinets may be seen as a problem with regard to the overall appearance of the locality (German term: Ortsbildpflege). This leads to a first mover advantage for operators deploying new cabinets at an early stage or already possessing cabinets. The more cabinets are deployed in the streets, the harder it will be for late-comers to deploy further cabinets.

76 See Annex, A.3.3 where the rationale and the properties of these conceivable mechanisms are briefly explained.

(c) These rules must be minimally necessary to achieve the target of accommodating the demand from different alternative operators, in an efficient and non-discriminatory manner.[77]

On the other hand, interested alternative operators must supply demand forecasts (in the scope of the RUO, namely collocation needs, so as to allow the SMP-operator, in an effective and timely manner, to provide the necessary resources for the performance of the work in-volved and to overcome any constraints;

Considering the limited space in the cabinet, it could be helpful if the SMP-operator offers collo-cation space per height unit (as part of their SLU reference offer).[78] This means that in contrary to MDF-collocation wholesale parties are not forced to order a full-height footprint (in practice an entire separate part of a cabinet). Instead wholesale customers can co-mingle with other parties and the SMP-operator in the same cabinet and pay an appropriate cost-oriented tariff for only the space actually used.

In the case of all new cabinets to be deployed, the European Commission's appeal for increased cooperation in NGA deployment brought forward in its recent Draft Recommendation on NGA should be taken into account. In that context it seems reasonable for operators to inform each other on planned new build of cabinets offering others the opportunity to co-operate regarding the envisaged deployment. It may be necessary to introduce an according remedy for SMP-operators obliging them to invite competitors to file their interest in collocation at certain cabinet locations before actual roll-out, in order to consider space demand at a given cabinet at an early stage.

In addition to collocation at the cabinet deployed in the context of sub-loop unbundling it may be necessary for alternative operators to retain their existing collocation at the MDF (or a similar point in the NGA, e.g. Metropolitan Point of Presence, MPOP) as this is used e.g. as an aggregation point connecting to a higher network hierarchy. Furthermore it may be considered whether collocation facilities at the MDF are allowed to be used in a wider context as handover point for various access-related wholesale products, e.g. access to ducts, dark fibre, λ-unbundling or leased lines.

E Migration: MDF Closure

In recent years alternative operators have invested considerable amounts of money in collocation, backhaul facilities and own equipment. Assuming that regulation for LLU will remain stable these investment decisions had a long term perspective (amortisation) with according

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77 In Germany, for example, BNetzA required Deutsche Telekom to provide co-location in the street cabinets. It was assumed that there is sufficient space for up to four further DSLAMs.

78 This was the case in the Netherlands, where KPN agreed to do so during the implementation process of SDF-access. That offer became part of their SLU reference offer. See http://www.kpn-wholesale.com/templates/dispatcher.asp?page_id=1857.

pay-back periods. Should some operators' migration to NGA lead to closing down of MDFs (and adjacent collocation facilities) or to a significant decline of the economic utility for other operators these operators' sunk investment related to the remaining usage period is supposed to be frustrated. This is not only the case for a full MDF closing but remains valid for successive devaluation of investment due to deployment of more innovative access scenarios by competitors and therefore a reduced ability to compete.[79]

Migration (from existing access services to NGN Access)

The reachable length of NGA networks might have an implication on the number of PoPs (as less of them are needed) and thus on the migrations scenarios, if PoPs with existing collocation are phased-out.

Several issues have to be considered regarding migration:

- continuation or discontinuation of the existing legacy network: if existing copper-based service[80] (that are served form the MDF) are to be phased out, it is reasonable that current alternative unbundlers will be enabled to migrate their services to the NGA network (FttC, FttH, FttB). A different scenario is the co-existence of an copper (MDF) and FttX-network alongside in the same geographic area. In that case if the incumbent is a SMP-party on unbundled access, it could be considered reasonable that alternative operators should be enabled to act on a level playing field on fibre. Even if they could continue their copper-based business case. Enabling alternative operators to an early migration to fibre is even more important if the coexistence of copper and fibre is limited in time.

- costs for (forced) migration: if operators are being forced to migrate towards NGA, because of the phasing out of an existing wholesale access service (e.g. MDF Access), the question is who will pay for these migration costs?

Other migration issues:

- Stranded assets and costs of migration.

- Alternatives in case of MDF-closure (SDF Access and/or bitstream).

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79 Devaluation of investment can occur due to MDF closing, deploying faster broadband technologies at remote units (e.g. FttC or FttB), deploying all-new transmission media (FttH) or degrading the performance of existing services by means of e.g. cross talk.

80 PSTN services: PSTN-based communication is also possible over sub-loop by both in-cumbent as by alternative operators. As VDSL2 has a defined spectrum reserved for POTS and ISDN transmission at low frequencies it is possible to have traditional voice and data communication on one line in parallel. Alternatively it is possible to use POTS-emulation line cards in the DSLAMs in the cabinet. A further option is to terminate the VDSL2 (data) service at the cabinet (utilising the fibre backhaul to connect to the back-bone network), while using a remaining copper line between cabinet and MDF for provi-sioning PSTN services.

E.1 Introduction of transition periods

The European Commission Draft Recommendation on Regulated Access to NGA Networks is based on the assumption of a payback period of five years for unbundling investment and requests an appropriate time period for eventual phasing out of MDFs. However, not all Member States have set a 5-year period, therefore definition of the transition period should be in line with other relevant decisions, e.g. margin squeeze calculation, in a given Member State.

Taking into account an economically viable life of collocation facilities (e.g. five or ten years) the remaining economic life could possibly to be calculated based on the handover time of a certain collocation facility. For that remaining time an efficient alternative operator utilising a certain collocation facility should not be confronted with deteriorating quality for existing (and new) services due to a competitor migrating to NGA. As a matter of principle, an alternative opera-tor having invested in unbundling should have the possibility to realise a reasonable return on investment based on the revenues generated.

This general principle should also be applied for cases where the alternative operator is not using collocation facilities on SMP-operator's premises but other collocation methods in-stead, e.g. in a outdoor container.

E.2 Introduction of compensation payments

For the case where an alternative operator does not have the possibility to fully recover the investment in unbundling facilities on a certain MDF location over the remaining economic life (see E.1) the according percentage of the investment may be accounted as frustrated. Compensation payments which may be a viable solution in order to protect alternative opera-tors' investments in unbundling are discussed in some Member States (e.g. the Nether-lands).

Regarding the amount of compensation payments it has to be considered that an alternative operator confronted with frustrated investments possibly cannot expect to get the full amount of sunk costs incurred for the remaining economic life period compensated as this would re-duce that operator's business risk to zero. This would imply that the risk would have to be borne by the operator having to make the compensation payment only. As the alternative operator should not be put in an obviously better position, one must take care not to shift inevitable business risks (e.g. risk of economic breakup, cyclical risk, risk of technological innovation or decline in prices on the retail market) from one market player to another. Such inevitable business risks should be born by each operator for its own investment.

Income streams anticipated at the time of investment will possibly be reduced by certain business risks becoming eventually effective at a later time. Technological innovation and the appearance of new products on the market are examples for such risks. Investment in NGA deployments and roll-out of innovative services will probably lead to a decline in prices for

legacy broadband services. These effects have to be differentiated from effects due to collocation facilities not to be used efficiently any longer because of other operators migrating to remote access units. As a basis for compensation payments one could possibly assess an alternative operator's one-off payments for investment at the MDF (sunk cost).

The deployment of remote units (at cabinets or in buildings) by incumbent or alternative operators may lead to a successive devaluation of investment at MDF, as customers connected to the respective cabinets no longer can be serviced without restriction.[81] In such cases frustrated investments in a certain access area could possibly be compensated in an aliquot manner, e.g. taking into account the number of potential customers in areas affected by NGA deployment vs. the number of potential customers in areas not effected.

F Relevance of Standards

One way of helping to overcome the challenge of the patchwork quilt of technologies which are likely to emerge in NGA would be to standardise the next generation access technology. However, standardisation at the infrastructure level may not be desirable because different technologies are better suited to different geographies depending on factors such as density or pre-existing infrastructure. Standardisation is possible at the electronic or active level, and if this is done in such a way as to support competition and allow for differentiation, then consumers could continue to benefit from effective competition even in the absence of physi-cal unbundling.

In general standards are considered beneficial for competitiveness and efficiency in production and distribution. As such, regulators could be tempted to intervene heavily in order to ensure the availability of standardised wholesale access products, by, for example, setting a standard and mandating its use. However there are many complex technical issues to be resolved before standards can be agreed in practice and regulators are not best placed to resolve these issues; indeed, European regulators at least have a bias against imposing technological choices, and in practise technology neutrality is a common regulatory principle.

Independent of the level of competition in a market, there are commercial incentives to standardise and achieve interoperability between market players. Although the commercial standardisation process is complex and lengthy, there are many examples of it working well. The most ubiquitious example is probably the internet, which would not work without the use of standardised protocols. Whilst there was public sector involvement in developing internet protocols, as users, they were not mandated for commercial use. The rationale for any public sector regulatory intervention must be based primarily on the ability of the market to deliver the desired outcomes.

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81 Deployment of FttC can harm VDSL@CO deployment and FttB can harm both FttC and VDSL@CO.

In general communications markets are susceptible to a particular type of market failure driven by network effects. This term refers to the fact that connecting to a network becomes more valuable – and thus more attractive – the more people are already connected to it. Proprietary interfaces tend to discourage network effects by making it more difficult for communications providers to interwork and therefore to achieve these direct and indirect network externalities; as a result the social value of the network is reduced. Network operators may try to use proprietary interfaces to exploit the network effects for themselves, for example by excluding smaller operators from interconnecting with them. This behaviour could give rise to concerns in case of dominance. Customers of that smaller network who are unable to connect to the larger pool of customers on the larger network might be encouraged to move to the larger network operator and, as the effect is self-reinforcing, the market may 'tip' into a monopoly. Although it is possible to have interoperable proprietary standards, open standards facilitate greater interoperability and are generally considered an important part of promoting competition, in addition to the network effects they create.

However, as suggested above, the process of standardisation may be less effective when one provider has a large market share and is not therefore subject to the normal market incentives which promote interoperability. For example, if a provider has 70% of a given market, interoperability will at best give them access to 30% of the market whilst risking their existing 70% market share. A large market share combined with proprietary closed interfaces can be a significant barrier to competition.

F.1 The need for modem interoperability

Interoperability between DSLAM/MSAN/OLT and CPEs is not guaranteed by ITU standard and it may be more difficult to achieve due to the differentiation possibilities of the VDSL2 and optical technologies (different flavours, deployment scenarios, configuration settings) and due to the more sensitive services like VoIP & IPTV that use these platforms.

However, at the moment there are several indications that enough interoperability between chipsets from different modem and DSLAM vendors exists:

- University of New Hampshire (UNH) plugfests[82] for VDSL2 started in 2006 and have reached a level comparable to ADSL2+. Attendance spans across multiple competitive silicon and system vendors, thus, ensuring VDSL2 interoperability in a heterogeneous deployment (ie. different silicon and system vendors at opposite ends of the wire).

82 http://www.iol.unh.edu/services/testing/dsl, http://www.iol.unh.edu/services/testing/dsl/grouptest.

- The Broadband Forum has defined technical recommendations[83] for VDSL2 performance and functional tests which are at a comparable maturity level to their equivalent tests in the ADSL2+ world.

- Several countries already have a heterogeneous deployment (ie. different technology and vendor at the central office versus the CPE) with multi-vendor interoperability: the Netherlands (KPN), Spain (Telefonica), Germany (DTAG), Switzerland (Swisscom), Austria (Telecom Austria), New Zealand.

The modem vendors advise NRA's to run the VDSL2 modems through a proper, formal, thorough, fast validation cycle, and to allow it then for deployment in the field. However in case operational problems occur in spite of a thorough validation process[84], regulators may help to overcome such problems e.g. by initiating discussion processes between operators.

In any case, measures that may be taken by NRAs have to be appropriate and proportionate.

The Review (Directive 2009/140/EC as of 25 November 2009) has strengthened the competences of NRAs to ensure interoperability of services. Art. 2 para 3 suggests the following insertion to amend current Art. 5 para 1:

- *"in justified cases and to the extent that is necessary, the obligations on undertakings that control access to end-users to make their services interoperable"*

Furthermore, Recital 11 states:

- *In order to allow national regulatory authorities to meet the objectives set out in the Framework Directive and the Specific Directives, in particular concerning end-to-end interoperability, the scope of the Framework Directive should be extended to cover certain aspects of radio equipment and telecommunications terminal equipment as defined in Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity and consumer equipment used for digital television, in order to facilitate access for disabled users.*

F.2 Wholesale access standardisation

There is increasing industry standardisation around a suite of Ethernet standards as service providers move away from traditional but expensive Synchronous Digital Hierarchy (SDH)

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83 TR-114: VDSL2 Performance Test Plan,
TR-115: VDSL2 Functional Test Plan.

84 - How to deal with CPE bugs that were only detected during deployment and not during validation
- How to deal with interoperability issues after a firmware upgrade impacting services?
- Who is responsible for incompatibility issues or interoperability bugs?
- Which process and contractual conditions need to be elaborated?

equipment to much cheaper and flexible Ethernet. Standardised, fit for purpose (ie competition-enabling) wholesale bitstream access would enable service providers to reach different types of customers without changing their products or internal processes significantly.

With the right characteristics this would help to ensure competitive provision of NGA and would contribute to delivering consumer choice and would facilitate the provision of ubiquitously available broadband. In this way the right standardised wholesale bitstream access could make a significant contribution to delivering competition and consumer choice and therefore bring very real benefits to consumers.

Even if the market incentives should be properly aligned so as to result in standardisation for wholesale access this may raise competition concerns if this is highly influenced by dominant, vertically integrated players. These players may not have incentives to deliver a standard which supports downstream competition. With new bitstream products, there is the opportunity as much as LLU to deliver significantly improved capability for innovation by making the right technology choices. For example, there are existing (Ethernet) standards which enable service providers to set the level of quality of service associated with a end-user's service, rather than leaving that choice to the infrastructure provider. Vertically integrated SMP-operators may not have the proper incentives to make these kinds of choices.

If the industry standardises by default around the wholesale offering of the SMP-operator – assuming intellectual property issues allow this to happen – then these competitive limitations will be standardised and the opportunity for competition and innovation in broadband markets will be considerably reduced.

F.3 Will the market deliver wholesale standardisation for next generation access networks?

Certainly there are market forces driving standardisation of the wholesale access in NGA:

- Smaller infrastructure providers who wish to attract a wide range of service providers recognise they have to offer standardised interfaces
- Infrastructure users/service providers benefit from lower service equipment deployment and delivery costs where there is standardised access
- As a residential market, per unit costs of equipment, both at the home and in the exchange, are likely to be an important part of the deployment economics and the need to achieve scale economies through standardised equipment is an important factor.
- There are some direct network benefits in having standardised wholesale access for the end-user. For example, it is more likely that the user will be able to move and share modems and other home equipment. Service providers and residential equipment vendors may respond to this.

- Wholesale access to shared infrastructure is only one model of infrastructure sharing. It is worth noting that other models have emerged, particularly in the mobile industry and these may also drive standardisation. For example standardisation of 3G base station management supports Radio Access Network sharing. Standardisation of duct and fibre specifications supports shared duct access. In some cases the standardisation requirements may overlap with those in support of wholesale access, one example would be standardised network and service management interfaces.

However there are countervailing forces which may prevent or delay standardisation:

- The prevalence of vertically integrated providers holding SMP in a particular geography who have little incentive to open up to competitive providers, or to follow standards. Indeed where they have existing wholesale products in the market it may be more attractive to continue to use existing proprietary interfaces than to develop new standardised ones. If they are large enough, others may wish to replicate their proprietary interfaces however they may be prevented from doing so is by IP issues, organisational knowledge or scale.

- Generally, standardization processes may take long. This may also impact on the abilities of smaller operators to participate in these processes. Overall, this contribute to situations where countervailing powers are stronger than market forces implying that interoperability problems are more likely to be used in a anti-competitive manner.

- Systemic barriers to inter and intra industry co-operation in difficult economic circumstances, which may delay further agreement on technical requirements. Infrastructure providers are actively competing for the provision of fibre in new build deployments and, in the absence of an infrastructure provider industry grouping, may have little opportunity to come together to discuss industry requirements.

Because of this, the Commission recommended that NRAs should work with the appropriate standards bodies to promote standardisation.

G Best practice for NGA wholesale products as of December 2009

While it is too early to derive detailed best practice principles for NGA wholesale products, given the early stage of implementation of regulatory decision making regarding NGA wholesale products, some more general conclusions can be drawn at this stage.

The BEREC considers that all the best practice principles as identified in ERG (07) 53 in are still valid and should be also applied and accomplished in the NGA environment implying that they are technologically neutral.

While transparency has always been a requirement of general relevance it is of particular importance with regard to NGA. This is also reflected in the new Framework, where Art 12.4 (new) FD provides NRAs with additional powers to impose specific obligation in that regard.

In addition to the reference offer wholesale customers should be able to:

- obtain relevant information on roll-out of new infrastructure or technologies per geographical area. A reasonable window of announcement is necessary to create a level playing field on the retail market;

- information on phasing out legacy wholesale services should also be announced a reasonable period in advance to avoid discriminatory situations.

Glossary

3D: Applications with 3 dimensional graphics.

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 communica-tions just as well as it supports voice communications

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: Generally a connection between a point (node) belonging to the access network and another point (node) of the core network or transport network. It can also be a 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.

Bitstream: This wholesale product enables alternative operators to differentiate their services by altering a number of technical parameters and/or the use of their own network. This wholesale product consists of an access link to the customer premises (over copper or fibre) and a transmission service, to a defined set of handover points (the access point).

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.

CMTS (Cable Modem Termination System): Equipment which functions as a protocol translator and allows the transport of Internet data over a coaxial cable network. In the CMTS, the digital Internet signal is converted to analogue and sent to the “cable modem” installed at the computer of the subscriber which transfers back into digital. The main CMTS suppliers work with the open DOCSIS standard (“Data Over Cable Service Interface Specifications”).

Circuit-switching: Means of creating PSTN 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.

Central Office: A central office (CO), part of the “telephone network”, is a dedicated building in which the access lines (home or office) terminate in a MDF or ODF and, normally, access/switching 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.

Concentration Network: The concentration network is the part between the access point and the node with the first IP core network router.

CPE (Customer Premises Equipment): Communications equipment (modem, telephone, set-top-box, etc.) installed on the premises of the end-user. They are also called customer pro-vided equipment.

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

DSLAM (Digital Subscriber Line Access Multiplexer): Equipment which allows copper lines to support broadband access. It is network equipment, normally located in the local exchange (but may also be installed in a street cabinet) whose function is to aggregate the traffic of several access lines which have modems that are compatible with xDSL technology and re-lay it through the data network (core). Depending on the product, DSLAM multiplexers connect DSL lines with some combination of ATM, Ethernet, or IP networks.