Supplementary Document to the ERG Opinion on Regulatory Principles of NGA

Part 1 Consultation report

Part 2 Country Case Studies

Part 3 Summaries of Business Case Studies

Part 4 Fact Finding Results

This document ERG (07) 16 rev2b constitutes a supplement to the ERG Opinion on Regulatory Principles of NGA (ERG (07) 16rev2). It contains material that is referred to in the ERG opinion and consists of four parts:

The *Consultation Report* (Part 1) summarizes the main argument of the 37 comments received to the "ERG Consultation Document on Regulatory Principles of NGA" (ERG (07) 16) by topic and outlines how the ERG takes account of the arguments in the ERG opinion.

The following Parts (2-4) of the Supplementary Document constituted Annexes 1-3 of the Consultation Document but have been removed from the ERG Opinion itself. Part 2 contains *Country Case Studies,* which have been updated. Part 3 contains *Summaries of Business Case Studies*. Part 4 summarises the relevant results of the *Fact Finding Exercise* carried out last year.

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Supplementary Document to the ERG Opinion on Regulatory Principles of NGA

Part 1: Consultation Report

In the Consultation Document on Regulatory Principles of NGA (ERG (07)16) interesting parties were invited to comment on the 5 questions, each related to a particular chapter of the document. The Consultation Report is structured along these questions as raised in the Consultation Document:

Q1: Do you agree/disagree with the general approach?
There were slightly more agreeing (mainly competitors / respective associations) than disagreeing comments (mainly incumbents / respective associations)

Q2: Do the scenarios describe the relevant roll-out alternatives for NGA?
The majority of comments considered the 2 scenarios appropriate. Dissenting views mainly missed consideration of alternative technologies.

Q3: Do you agree/disagree with regard to the conclusions on economics and business case studies?
Several respondents commented that the economics of NGA varied substantially between geographic areas. Several altnets stressed that NGA costs and cost savings should be considered together and some felt that NGA increased the scope for the access to be a bottleneck. They also called for investment plans to be disclosed by incumbents prior to deployment. On the other side, incumbents advocated a regulatory approach that did not deter investment and innovation.

Q4: What is your opinion on the regulatory implications and on the evolution of the ladder of investment? Additionally please provide more specific comments regarding the issue of multicast capabilities and their regulatory treatment.
Those who welcomed the general approach also agreed to the regulatory implications drawn by the ERG and stressed the need of having available different rungs of the ladder simultaneously. In particular, they welcomed the inclusion of fibre in Market 11 and some stressed the importance of an enhanced Bitstream product. Broadly, the opposite view was taken by the incumbents, who constitute an extension of existing regulation to the NGA environment. Thus, they reject the inclusion of fibre in Market 11 and express doubt with regard to the appropriateness of the ladder concept in an NGA environment.

Q5: Do you agree/disagree with the conclusions?
Comments to this question overlap in particular with the comments to question 1, but also with the other questions. Therefore the remarks to question 5 are addressed under the other questions.

In total 37 comments were received from the following stakeholders:

1) Alcatel-Lucent
2) Arcor AG & Co. KG
3) Association Française des Opérateurs de Réseaux et de Services de Télécommunications (AFORST)
4) British Telecom
5) Broadband Stakeholder Group (BSG)
6 Bundesverband Breitbandkommunikation (BREKO e.V.)
7) Cable & Wireless

8) Cable Europe *(confidential)*
9) COLT Telecom Group SA
10) COMPTEL
11) Corning Cable Systems
12) Deutsche Telekom AG
13) Ericsson
14) European Competitive Telecommunication Association (ECTA)
15) European Internet Service Providers Association (EuroISPA)
16) European Telecommunications Network Operators' Association (ETNO)
17) European Telecommunications Platform (ETP)
18) Fastweb
19) France Telecom
20) FTTH Council Europe
21) Ingenieure für Kommunikation (IfKom)
22) Internet Service Providers Austria (ISPA)
23) KPN
24) Oni Telecom
25) Platform Telecom Operators & Service Providers
26) PT Comunicações S.A.
27) OTE S.A.
28) QSC AG
29) Riegelmayer, Dr.-Ing. Wolfgang P.
30) Silver Server GmbH
31) Sonaecom SGPS S.A.
32) TDC
33) Tele2 Group
34) Telecom e.V.
35) Telecom Italia
36) Telefónica S.A.
37) WIND Telecomunicazioni S.p.A.

References in the text refer to the ERG Opinion on Regulatory Principles of NGA rather than the Consultation Document.

Question Chapter 1: Do you agree with the general approach?

Consultation Comments

Very broadly there were slightly more comments that supported the approach of the ERG than comments criticizing it. Whereas competitors welcomed the paper, mainly the incumbents hold the opposite view.

Supportive: Arcor, BREKO, C&W, Comptel, ECTA, EuroISPA, Fastweb, Ifkom, ONI, Platform Telecom Operators & Service Providers, QSC, Riegelmayer, Silver Server, Tele2, WIND

These supportive statements range from stating that the ERG took the "right approach" **(Sonaecom)**, to "potential barriers were found out perfectly" **(Silver Server)**, or to "congratulating for tackling the regulatory challenges" **(Comptel)**. Based on a "correct" description of the network and the required equipment the solutions and conclusions proposed by the ERG are considered "adequately fitting the problems" **(Arcor).** Others express agreement to the proposed revisions of the Recommendation on Relevant Markets **(EuroISPA)** or "largely share" **(WIND)**, or are even "unanimously support" **(QSC)** the conclusions. More generally, one comment speaks of a "high quality Consultation Document" **(Tele2)**.

Some comments see "proper ex-ante regulation of access condition to incumbents' NGA network important for maintaining a level-playing field **(ONI, similar e.g. WIND)**.

According to the comment of a stakeholder group the current Regulatory Framework is "fundamentally sound" and the fundamental principles remain valid in an NGA context. However, a need for focus on enforcement and consistency in application throughout the EU is called for **(EuroISPA)**.

It seems remarkable that even an incumbent was rather consenting when answering this question **(TDC)**. It welcomes a technology neutral approach to the analysis of possible bottlenecks in access infrastructure, therefore considering the inclusion of fibre as proposed by the ERG appropriate (see ad 4.2.1 below).

Critical: BT, Colt, DTAG, ETNO, ETP, FT, OTE, KPN, PT, TI, Telefónica

The critics argue that the ERG "fails to ask whether regulation is necessary" **(DTAG, similar BT)** or miss further discussion on when remedies are appropriate **(Telefónica)**. They consider the document to be based on the assumption that current unbundling obligations of incumbent operators need to be mirrored in the NGN situation" **(KPN, similar other incumbents and ETNO)**. One comment evaluates the approach as sending the "wrong message" that all obligations will be applied making the document a "general overview of all the possible regulatory measures that NRAs are working on in different Member States" **(Telefónica)**.

More specifically, a comment refers to the difficulties of implementing some of the proposed remedies and considers a cost/benefit analysis for new measures appropriate **(Telefónica)**.

The critics stress that NGA networks are new and differ largely from legacy networks which "cannot be regulated as legacy networks **(TI)**. Thus, the starting point for the regulatory analysis should be a "hands-off" approach to avoid such mechanical transition of measures to NGNs **(Telefónica)**. Such new investments require a regulatory focus on equal conditions for investment by reducing entry barriers and a technologically neutral view of market development.

According to one comment, only the passive infrastructure is not replicable. Therefore, the regulatory focus should be on passive (e.g. ducts, poles) rather than active infrastructure **(Alcatel-Lucent)**.

Pointing out the new or emerging nature of NGA networks, the critics also argue that regulation will deter investment and innovation **(DTAG, OTE, Telefónica)**.

One comments claims that the ERG needs to "better understand the drivers and barriers to NGA investment" **(KPN)**.

In a broader context, one comment criticizes the Consultation Document for "not taking into the evolution of the communications market as a whole". The ERG approach implies a higher level of regulation for new technological development. This is seen as contradictory to the Review process and its objectives **(PT)**.

ERG Considerations

In this document ERG analysed the impact NGA deployment has on the scope of regulation and the way in which regulatory principles may need to be adapted. More specifically it was asked whether current instruments in the ECNS are still appropriate to deal with these developments as the introduction of NGN and NGA may give rise to new bottlenecks while old ones may disappear.

Identifying the drivers and barriers to NGA investment is considered important by the ERG (see Chapter 3). Based on this analysis it can be shown that NGA networks are more likely to reinforce rather that fundamentally change the economics.

The ERG considers the regulatory approach based on the existing ECNS[1] Regulatory Framework to be fundamentally sound as the principles remain suitable and allow NRAs to deal with the regulatory challenges posed by the roll-out of NGA. Above all, this is ensured with the principle of technological neutrality (Art. 8 FD) and the general approach of economic regulation to address market power and deliver a competitive environment (Art 14-16 FD).

The call for a cost benefit analysis of remedies including the appropriateness and proportionality is a fundamental concept implicit in the Regulatory Framework and, in particular, in the Recommendation on Relevant Market susceptible to ex-ante regulation. As a first step, the fulfilment of the 3-criteria test is seen as a prerequisite for the imposition of ex-ante measures. As a second step, in the markets identified to fulfil the 3-criteria test remedies have to be imposed on SMP operators taking into account appropriateness and proportionality.

Specific issues addressed:

Maturity of NGA developments

Consultation Comments

Several comments stress that at present NGA deployment is at an early stage and that currently there is little prospect for mass roll-out of NGA **(BT, DTAG, ETNO, KPN, OTE)**. Thus, it would be premature to apply regulation to these new markets. Such premature regulation would deter large scale deployment of NGA networks in Europe (see also ad 4.2.2, comments rejecting the inclusion of fibre in Market 11).

1 ECNS – Electronic Communication Networks and Services.

ERG Considerations

The ERG is aware that NGA deployment is at an early stage in many Member States. Therefore, the ERG considers this phase of gaining momentum the right moment for prospectively analysing the developments ongoing. Regulation needs to reflect these developments. This requires a careful analysis of whether NGA networks fundamentally change the economics.

The pro-active approach is required as it increases regulatory clarity and predictability (see below). Tackling the NGA issues at an early stage may also help to improve transparency on planned NGA deployments which was requested in many comments (see also ad 4.1 Transparency).

Need for stable/predictable regulatory conditions

Consultation Comments

Many comments consider stable and predictable regulatory conditions very important. Nevertheless they have a different focus when calling for this predictability.

For some comments, in particular from the incumbents' side, such regulatory clarity and predictability is a prerequisite for investment in NGA networks **(DTAG, ETNO, KPN, PT)**. Regulatory uncertainty surround FttH deployments is seen as a reason for the fact that the discussion in Europe is limited to VDSL **(FTTH Council Europe)**.

A well-balanced regulatory framework could alleviate the risky nature of NGA investments, but too strong or early regulatory intervention should be avoided **(Alcatel-Lucent)**. The ERG should provide a "roadmap" **(KPN)** with a clear set of principles for remedies. Some even more clearly call for a "guideline with clear priority for investments and innovations" **(DTAG, similar FTTH Council Europe)**. Sun-set clauses are also advocated **(PT)**.

Slightly different from these views in another comment the challenges for the Framework is seen in finding the balance between "appropriate regulation to maintain competitiveness" and "encouraging investment" **(Corning)**. Another comment considers timely and effective application of regulatory rules as paramount. It could be observed that in those countries where this is the case investment increases and broadband take-up and innovation are greater **(EuroISPA)**.

Pointing out that is critical that potential builders and buyers of NGA have a clear understanding of the legal situation, one comment sees an opportunity for the ERG to assist the sector by "adopting best practice procedures and guidelines for incumbent NGA builders to smooth interaction with competitors / buyer stakeholders" **(C&W, similar ECTA)**.

"Matter of fact situations" should be avoided by involving all operators at the planning stage **(Sonaecom)**. Another comment requests "clear guidelines on required lead-times on changes in dominant operators' wholesale access portfolio" **(Tele2)**.

A alternative network operator points out that clear regulation provides certainty to market players **(QSC)**. In Japan, an early signal to the incumbent that fibre access lines will be regulated did not deter but rather may have encouraged investments.

ERG Considerations

The ERG agrees that stable and predictable regulatory conditions are an important asset for all market players, competitors as well as incumbents. Regulatory certainty may improve the

conditions for investment and innovation and is, therefore, conducive to increase the competitive dynamics of the market.

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

For remarks on investment incentives and investment risk see below (see ad 3.4).

Relevance of alternative technologies (e.g. cable)

Consultation Comments

Several comments call for alternatives technologies (such as cable, wireless or powerline) to be considered by the ERG **(BT, ETP, DTAG, ETNO, ETP, FT, KPN, PT, TDC, TI, Telefónica)**. They stress that these alternatives could alter competitive scenarios and influence NGA deployment. And one comment draws attention to local fibre initiatives **(KPN)**.

The existence of such alternative infrastructures – leading to a high degree of competition in densely populated areas (see also ad 4 below) – needs to be considered when analysing the replicability of fibre deployments and conducting the 3-criteria test **(ETP, FTTH Council Europe)**.

As pointed out in one comment, the regulatory approach to NGA cannot be developed without taking account for the evolutions of other platforms **(ETNO)**. According to this view, cable already plays an important role in many Member States. Some consider wireless to have an increasing potential in the future **(ETNO, ETP)**. On the other hand, one comment considers wireless at present not a sufficiently ubiquitous platform **(ECTA)**. And another refers to the scarce degree of cable diffusion in its domestic market **(Fastweb)**.

Two comments emphasize the positive relation between a deregulatory approach towards new access networks and the incentives for incumbents to invest in NGA **(BSG, DTAG)**. They mention the examples of the US, Canada or Hong Kong. But, as pointed out by one, such a deregulatory approach would be more difficult to take where there is limited competition from another fixed access platform **(BSG)**.

ERG Considerations

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

Question Chapter 2: Do the scenarios describe the relevant roll-out alternatives for NGA?

Consultation Comments

The Consultation Document distinguishes between two main scenarios - Fibre to the Cabinet and Fibre to the Home / Fibre to the Building – as these broadly appear to be the most relevant cases in several Member states. The majority of comments considered the distinction between these two scenarios appropriate **(Arcor, BSG, FTTH Council Europe, ONI, QSC, Silver Server, Sonaecom, TDC, Tele2)**. A more critical view was taken in particular by the incumbents and cable stakeholders **(BT, Cable & Wireless, Corning, KPN, PT, TI, Telefónica)**. Their main point of criticism was that alternatives technologies (e.g. cable) are missing. Another incumbent **(FT)** considers FttB to belong to the FttCab-Scenario **(similar ETNO)**.

Besides these rather general points some specific issues referring either to the FttCab-Scenario (Chapter 2.2) or the FttH/B-Scenario (Chapter 2.3) were raised in the comments.

Scenario I: Fibre to the Cabinet

One comment considered FttCab a simplification **(ECTA, similar Tele2)**, as incumbent's passive metallic cable distribution systems being closer to the MDF are not always located in street cabinets but of placed in (e.g.) operators' own small buildings or building's cellars. Thus, ERG should apply a more open approach when addressing the issue of access to cable distribution systems, not limiting access to street cabinets only.

The key characteristic of Scenario I is not the fact that fibre is brought lower in the network hierarchy. Instead, key characteristics are the new risks of spectral interference with ADSL2+ deployed higher in the network architecture, and that there is a risk that dominant operators could undermine or breach the unbundling mandate **(Tele2)**.

Another stakeholder emphasized that there will be no clear FttCab scenario "for a very long time" because the roll-out will only be economical in some areas **(ETP)**.

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

In one comment it is criticized that point-to-point fibre NGA is not considered **(C&W)**. Another comment stressed that point to point FttH and point to multipoint FttH roll-outs are highly distinctive **(PT)**.

A competitor points out that currently "probably more point-to-point Ethernet is being rolled out than GPON **(Tele2)**. This is attributed "to the fact that incumbent operators are lagging behind competitors and behind the publicly funded and the utility fibre networks. Thus, footnote 39 is seen as overstating the importance of GPON. Moreover, the ERG is invited to further investigate wavelength access, in particular whether splitters could be utilized, enabling wavelength unbundling at higher levels in the network hierarchy.

An incumbent considers the scenarios "reasonably comprehensive for fibre" **(BT)** and another comment considers FttB/H to be the sustainable long-run solution **(FTTH Council Europe)**.

ERG Considerations

The argument raised that cable distribution systems are not only located in street cabinets is reflected in the Opinion when stating that local loop unbundling can take place at *or near* the building (Chapter 4.2.3).

Point-to-point design is explicitly mentioned in Chapter 2.3 describing the FTTH/FTTB scenario (figure 5) as well as its implications for market definition in Chapter 4.2.3. The ERG acknowledges the distinctive nature of point to point FttH and point to multipoint FttH roll-outs (see footnote 22 to Fig. 2). Furthermore, an illustration of such a design is presented in Figure 6 of Chapter 2.3.

In its categorization of the NGA roll-out options, the ERG did not treat FttB as a *sub*-case of FttH. Moreover, the reason for assigning FttB to the second scenario was that both – FttH and FttB – exhibit the same amount of horizontal fibre extension to the building. This degree of fibre extension is considered the main distinctive feature between the two scenarios. The ERG recognises that, from a technical point of view, FttB has to be considered a hybrid solution (see Chapter 2.1 and Figure 1).

Question Chapter 3: Do you agree/disagree with regard to the conclusions on economics and business case studies?

ad 3.2 Implications of NGA on the economics of electronic communications networks

Consultation Comments

There was a wide range of comments relating to the implications of economics of NGA. Several respondents commented that the economics of NGA varied substantially between geographic areas. One comment identified 3 types of areas identified (market led = urban, risk driven = suburbs and policy driven = rural areas) and that economics and regulation varies between them **(Alcatel)**. Two others commented that that business cases for NGA may vary substantially between areas **(BSG, BT)**.

The economics of infrastructure competition were also raised by some players, and demonstrated another wide range of responses:

- SLU is not economically viable **(BT)**;
- Competition at the cabinet is difficult and so WBA service requirements should be imposed on incumbent **(KPN)**;
- Ability to co-locate at incumbent cabinet, rather than having to locate nearby improves viability of sub-loop unbundling remedies. **(ARCOR)**.

An incumbent believes there is scope for altnets to deploy alternative infrastructure in urban areas **(TI, similar AFORST)**.

Several respondents commented about the relative cost structures faced by incumbents and entrants in relation to NGA:

- Several altnets stressed that NGA costs and cost savings should be considered together. NGA may enable incumbents to make savings but could lead to higher costs for altnets.
    - A stakeholder association stressed that the cost data and ARPU assumptions being made related to an incumbent rather than an altnet **(ECTA)** ;
    - A competitor also commented that it is important to distinguish between costs and ARPU of incumbents and of altnets **(Tele2)**;
    - Another competitor noted that economies of scale enjoyed by incumbents make it harder for altnets to recover infrastructure costs **(Fastweb)** ;
    - A manufacturer acknowledged that fibre deployments may be justified on basis of OPEX savings **(Ericsson)**.

In relation to the access network being a bottleneck, there was a feeling from altnets that NGA increased the scope for the access to be a bottleneck:

- A competitor suggested that NGA may increase the scope of this **(C&W)**. Interestingly, a comment suggested that, in the short term, one should not assume that NGA will be a bottleneck asset if copper is maintained **(BSG)**.
- A stakeholder association agrees that existing legacy advantages and scale economies are likely exacerbated thereby reinforcing bottlenecks **(ECTA)**.

Other comments

One of the incumbents criticised the economic approach taken in the document: "The economic concept of the ERG is guided by a static theory of markets disregarding the dynamic perspective of the EU Framework. Simply referring to technological neutrality is wrong as it does not mean that a new technology with broader functionality should be regulated the same as a former one" **(DT)**. One of the stakeholder associations stressed the difference between investment profiles for passive resp. active infrastructure and retail services **(FTTH Council)**.

ERG Considerations

It is likely that Member States will witness a number of deployment scenarios, depending on their specific characteristics. These may draw from a range of technology options and deployments both between and within countries. Therefore, the ERG believes that it is appropriate to outline a range of potential remedies for NGA networks, and for NRAs to explore the most appropriate option.

ad 3.4 Relation between Infrastructure and Service Competition

As this issue is closely linked with the ladder of investment it is addressed there (see below ad. 4.6).

ad 3.4 Incentives for Efficient Investment

Consultation Comments

Several operators addressed the importance of efficient investment in their responses, for example:

- Important that incumbent business cases not based on vertical integration benefits **(Sonaecom)**;
- Another competitor supported the view that not all investments are efficient **(QSC)**.

Several responses also suggested that incumbents should be forced to disclose NGA investment plans prior to deployment:

- To avoid late-comer disadvantages, access for competitors must be available *before* the incumbents provides retail offers. **(ISPA, Platform Telecom Operators and Service Providers)**.
- A competitor also suggested that there should be some degree of first mover advantage for altnets to take account of pre-emptive strategies by the incumbent **(Fastweb)**.

Public investment in trenches, ducts, etc., is advocated to reduce civil engineering costs and to facilitate private investment in FTTH/B **(FTTH Council)**.

ERG Considerations

It is important to note that regulators should be concerned with incentives for efficient investment in order to maximise benefits for consumers. The aim of regulators is therefore to

encourage efficient and timely investment in NGA networks. Efficient and timely investment involves investment decisions on the most appropriate technology at the right time and in specific locations by operators. However, this results in a range of complex options for investment that the market is best placed to assess. Regulation should therefore seek to leave investment decisions to the market, and to minimise any distortions to efficient investment that could result from regulatory intervention. At the same time, regulators should seek to provide a predictable regulatory environment and address barriers to efficient investment, including market power.

ad 3.4 Treatment of Investment Risk

Consultation Comments

Several responses dealt with what they saw the risks of NGA to be:

- An incumbent argued that the uncertainties surrounding costs, revenues, time and revenues meant that there was little point in trying to define FttH regulation now **(FT)**
- Another emphasised that given large costs and long payback periods, regulatory certainty and impact of regulation on investment were key issues **(Telefónica)**

One of the stakeholder associations commented that it believed that market definitions should be flexible enough to allow for operators to have a degree of freedom to experiment and identify new revenue streams **(BSG)**.

In contrast, a different stakeholder association believes that cost savings provide an incentive for incumbents to invest in NGA **(BREKO)**.

There was a general consensus on the need for a degree of regulatory certainty to facilitate investment in NGA from a number of respondents **(BSG, ETP)**.

An incumbent stressed that the concept of the ladder of investment needed to be defined in order to reduce uncertainty, whilst another reiterated the view that regulatory uncertainty, makes a risky investment even riskier **(PT, OTE)**.

Several incumbents expressed specific ideas as to how returns should reflect risk:

- One incumbent references OFCOM's NGA consultation and suggests that ERG should do an in-depth investigation on cost models as *Cost plus with an activity-specific cost of capital* and *Returns adjusted for a symmetric "fair bet"* **(TDC)**.
- Another suggests that a real options approach could be adopted **(TI)**.

Several altnets also suggested how the risk in their NGA investments might be rewarded:

- One of them suggests a "Broadband Premium" allowing altnets to receive termination rates reflecting the actual cost of their NGA roll-out costs and reflecting difference in cost and risk between altnets and incumbents **(EuroISPA)**.
- Another suggested that altnets might be allowed to use voice termination rates to fund NGA, but also suggested a broadband premium mechanism **(Fastweb)**.

ERG Considerations

Investment in NGA infrastructure may be more risky in comparison to current access networks due to a higher degree of demand uncertainty: uptake by consumers of the services enabled by these new networks is difficult to assess for both investors and regulators. To some degree, this uncertainty can be offset by a range of factors, including:

- delivery of today's, demand certain services;
- investment timing; and
- commercial approaches to mitigating investment risk.

However, the ERG thinks it is appropriate that the investment risk incurred at the point of investment should be taken into account in setting the terms of any regulated access. This is to minimise the risk that regulation distorts efficient investment incentives.

Question Chapter 4: What is your opinion on the regulatory implications and on the evolution of the ladder of investment?

Differences in Competitive Condition and Implications for Regulation

Consultation Comments

Several comments claimed that different geographic markets exhibit different competitive conditions. These differences should be taken account of when applying remedies. This position was taken by several incumbent as well as some other stakeholders **(Alcatel-Lucent, Corning Cable Systems, ETNO, ETP, FT, KPN, TI, Telefónica)**. Thereby they explicitly or implicitly called for a departure from the notion of national markets. ERG is criticized not to draw the right conclusions from recognizing differences among Member States. The right approach would be to refrain from regulation where platform competition exists.

Some of these comments make a distinction between market-driven (densely populated areas, where competition is considered well functioning), policy-driven (rural areas, where there is no case for facilities based competition) and risk-driven (or grey areas, sub-urban regions). Similarly, one incumbent **(KPN)**, referring to the situation in its home market, distinguished between areas with major offices and/or apartment blocks where infrastructure competition could take place and areas with individual houses where the first NGA investor may gain an effective local monopoly. This comment raises the question of how to regulate the various local monopolies. Also, it sees a danger that NRAs might focus regulation on the fixed incumbent who then did not invest.

Some other comments stressed that different situations in different Member states would require a specific analysis and specific remedies **(BREKO, BSG, WIND)**. One of these comments also mentioned possible differences within Member States. These comments have in common that they do not infer a call for deregulation from the differences observed.

A cable stakeholder favoured such a geographical segmentation **(Corning)**.

ERG Considerations

The economics of NGA networks are likely to vary across different technologies and different geographies, as shown in Chapter 3. Conditions are likely to differ greatly among Member States and within different regions of Member States and may lead to significantly different competitive conditions possibly justifying the definition of sub-national markets (unless there is e.g. a common price constraint) in certain cases. Where a national market is defined, regulators may think of differentiating remedies within the national market.

Transparency

Consultation Comments

Many comments stress the importance of transparency on the NGA deployment plans of incumbent **(Arcor, BREKO, ECTA, ISPA, Oni Telecom, Platform Telecom Operators & Service Providers, Sonaecom, Tele2, WIND)**. One incumbent **(BT)** even considers the need for transparent plans and open consultation by incumbents with competitors a key element omitted in the consultation document. Another comment refers that“quasi non-existence” of such transparency is causing uncertainty and ultimately deterring investment by competitors. It is required to set clear lead-times on changes in dominant operator’s wholesale portfolio to balance the interests of incumbents and competitors.

Transparency is also considered necessary as without these information NRAs cannot impose appropriate remedies and regulation must be in place before the incumbent starts to provide services to customers. Thus, NRAs need to proactively disclose this information.

More specifically, transparency is considered a requirement for infrastructure sharing **(Arcor, Sonaecom, WIND)**. This refers to collocation space in the SDF as well as to existence of ducts, their availability and their level of occupancy. Non-transparency would lead to incentives for mismanagement of the resources.

One stakeholder **(ECTA)** urges the ERG to reaffirm its information gathering powers under the EU regulatory framework. Also, the ERG's Opinion should contain an Annex indicating the actions taken by NRAs to obtain information and to intervene where appropriate as well as measurable best-practice guidelines **(similar C&W)**.

In one comment **(ETNO)**, the prospect of timely market reviews and a transparent mechanism for the withdrawal of legacy products could increase the incentive for network operator's wholesale customers to transition to NGN platforms.

ERG Answers

ERG considers transparency crucial as without a clear and transparent view of the intentions of market players for deployment of NGA networks it is not possible for the regulator to provide a clear indication of the regulatory environment that will apply to these investments. This information can be requested from operators by NRAs according to Art. 5 FD respecting confidentiality requirements.

ad 4.2 Regulatory Challenges for Market Definition and Analysis in the existing Framework

ad 4.2.1 NGA and Markets 1 and 2

Note: This Chapter was not part of the Consultation Document. At the ERG's Plenary in Oslo, it was decided to address this issue in the NGA document.

ad 4.2.2 *(4.2.1 in the Consultation Document)* NGA and Market 11

Consultation Comments

Regarding the possible inclusion of fibre in Market 11 the view in the comments diverge. It is mainly the incumbents that oppose such an inclusion **(Alcatel-Lucent, BT, DTAG, France Telecom, OTE, TI, Telefónica and ETNO)**.

The opponents argue that an inclusion of fibre in Market 11 would constitute a "sweeping extension" extension of regulation, which is not justified in view of the 3-criteria test and the guidance for defining markets under the NRF **(ETNO)**. Thus, expanding Market 11 without conducting this 3-criteria test would not follow the logic of the Recommendation **(Telefónica)**. NRAs have to prove the need for sector specific regulation via an adequate delineation of markets followed by the 3-criteria test. Rather, possible issues of market dominance can be dealt with by general competition law **(DTAG)**.

The original intention of Market 11 was to open traditional fixed telecom networks for other operators to provide retail services to end users. Contrasting to this the situation is not the

same for fibre networks as they compete with other infrastructures **(Telefónica, similar DTAG)**. The Consultation Document has not taken account of the emerging nature of these new networks but rather carries over regulation of legacy network without proving the need for regulation.

Another argument raised against an inclusion of fibre in Market 11 is that end-user fibre lines still lack visibility and that the topology of fibre access networks could differ significantly from legacy PSTN access networks **(Alactel-Lucent)**.

It is argued that there is no evidence that fibre access networks constitute enduring economic bottlenecks. Therefore, in order to avoid an inappropriate extension of regulation, an analysis should be conducted in the first place, to find out if and where there are such bottlenecks **(DTAG)**.

Another view on this aspect is taken by another incumbent **(TDC)**, arguing that fibre may enable to deliver services that cannot be delivered by other infrastructure (including VDSL). In that case, fibre will constitute a bottleneck regardless if delivered by the incumbent or other operators since the deployment of a second network is unlikely thus potentially foreclosing the market.

Although one incumbent **(BT)** generally supports a technologically neutral approach to market definition, implying that fibre should be included in assessing SMP or bottlenecks in Market 11, it believes that "technology, operational, and proportionality considerations" applied to realistic PON and DWDM systems will generally preclude fibre or wavelength unbundling.

Another incumbent (**France Telecom**) holds a differentiated view. According to this, FttH should remain out of the scope of Market 11, whereas FttC and FttB are covered by this market. In case of VDSL deployment at the cabinet, or building sub-loop unbundling (with associated resources) and Bitstream access offers must be defined and priced so that the viability of LLU operators is not negatively affected.

More generally, some comments **(Corning, ETP)** point out that NGA challenge market definitions, and in particular the definition of the local loop, more fundamentally. This is due to the fact that aggregation may occur at different points from today. These comments suggest defining the local loop as the dedicated line up to the first aggregation point.

On the other hand, there are many comments explicitly supporting the inclusion of fibre in Market 11 (**Arcor, AFORST, BREKO, ECTA, EuroISPA, IfKom, ISPA, QSC, Silver Server, Tele2, Telecom e.V., WIND**). They call for a technology neutral definition of the Market 11, including also fibre or hybrid solutions. Thus, the Recommendation should be adjusted to include fibre. Such technology neutral approach to Market 11 "should already be possible under the existing Framework", according to one comment **(ECTA)**.

According to one comment, any modification of Market 11 should in no way mean that unbundling of metallic local loop is no longer an obligation. Therefore, NRAs should adopt decisions under the current Framework to avoid that VDSL roll-outs of incumbents put an end to LLU and Bitstream.

In one comment it is considered "extremely useful" that a definition of ancillary service is provided in Market 11 (and Market 12) **(WIND)**. Thus, the definition of Market 11 needs to be completed with a detailed description of wholesale services (such as sub-loop unbundling, collocation services, backhauling, and duct access) to be provided by the incumbent to comply with the general obligations. The ERG is encouraged to verify whether the traditional Markets 11 (and 12) are viable in the NGA scenario and to carry out the necessary adaptations, both from the technical and regulatory perspectives **(EuroISPA)**. An unbundled optical fibre is deemed necessary not only for the development of the market but also for "regulatory

and investor certainty" **(QSC)**. The importance of such certainty is explained by referring to the example of Japan. There, an early signal to the incumbent that fibre will be unbundled did not deter investments but rather encouraged them. Otherwise the strong increase in fibre access to be observed in Japan *after* the unbundling decision cannot be explained.

However, there is also an incumbent (**TDC**) that considers the inclusion of fibre appropriate. According to this comment the role of fibre is not clear for this moment. In case of FttCab fibre is seen as part of a progressive development of an incumbent's access network. This may also be the case for FttH. It is concluded that "in this respect (both FttH and FttCab) obviously are part of Market 11".

One comment generally calls for markets not to be defined too narrow (BSG).

ERG Considerations

The ERG comes to the conclusion that the inclusion of fibre loop into Market 11 is compatible with the AD, but would require a change of the Recommendation to include fibre into the relevant Market. Thus, it is proposed to enlarge Market 11 accordingly. The ERG assumes that such an "enlarged" Market 11 would pass the 3-criteria test run by the Commission.

The ERG derives its proposed conclusion from a thorough analysis of the underlying economics of NGA networks. Based on different business studies (see Chapter 3), it is shown that NGA investments are likely to reinforce scale and scope economies, thereby reducing replicability and potentially leading to enduring economic bottlenecks. Given these results, the proposed inclusion of fibre loops in Market 11 is considered to be backed by economic evidence.

The ERG agrees that NGA developments pose a certain challenge for market definitions, as aggregation points may differ from today. This is considered in the definition of the local loop (See Section 4.2.2).

ad 4.2.3 *(4.2.2 in the Consultation Document)* NGA and Market 12

Consultation Comments

Several comments agree to the conclusion that the definition of Market 12 continues to be appropriate **(AFORST, BT, Corning, ECTA, EuroISPA, FTTH Council Europe, ISPA, TDC)**. This definition even allows for an easier extension of coming access technologies **(WIND)**. Market 12 should cover all forms of Bitstream, irrespective of the underlying network or network protocol and the scenario (FttCab or FttH/B) **(ECTA)**. This comment misses some clarity with regard to the very last point.

Although Market 12 is correctly defined in the list of markets in the Recommendation, one comment argues that today's Bitstream offers are not suitable to enable the requesting party to define its own products or its own QoS **(Tele2)**.

A number of operators stress in particular the importance of being capable to control quality parameters and the ability to provide IPTV **(ECTA, ONI, Tele2, WIND)** *(see also below for the issue of multicast)*. They generally constitute an increasing importance of Wholesale Broadband Access.

An incumbent evaluates the ERG's conclusion that there is no need for amending the definition of Market 12 as "simplistic" **(TI)**. Rather, market developments need to be analysed. Market 12 regulation is only, if at all, conceivable in case of "existing services" that could also be

provided over new infrastructures. In case of “substitute services” to existing ones NRAs should evaluate sufficiency of the imposed obligations only on legacy network elements. And in case of “new services” provided over new infrastructures NRAs should refrain from imposing wholesale obligations (irrespective whether Market 12 or any other Market).

The “layer-based” delineation between Market 11 and 12 is criticized by one comment **(ETNO)** as being “driven by technical considerations and not being technologically neutral”. This would imply substitutability of LLU at the MDF and unbundling of copper at the building in an FttB scenario. On the other hand, unbundling of optical fibre at the ODF (falling into Market 11 according to the ERG notion) and Bitstream at almost the same point would not be substitutable, although both provide comparable quality for end-user services.

One comment of an incumbent disagrees with the statement that Bitstream reduces the freedom to control QoS parameter compared to unbundling **(KPN)**. According to this view, wholesale broadband access services provided over Ethernet allow flexibility in quality and functionality that matches MDF access. Bitstream even offers advantages over unbundled access in strengthening competition at the service level (software-based Bitstream service enabling the end user to more easily change the service provider) and maximising the reach of service provider.

Contrasting to this, another comment clarifies that Bitstream is no substitute for unbundling **(Telecom e.V.)**. Another considers it important to avoid that incumbents use Bitstream to limit infrastructure based competition by forcing entrants to become mere resellers **(Fastweb)**.

ERG Considerations

The ERG considers that the Regulatory Framework promotes sustainable competition by regulating access to the network of the company with significant market power; it does not differentiate between legacy network elements and other infrastructure. This distinction would also be in conflict with the postulate of technology neutrality in the Framework.

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

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

ad 4.3 Regulatory Challenges and Remedies in Scenario I: FttC

ad 4.3.1 Possible barriers

Consultation Comments

It is pointed out in one comment that, in the (near) future, Line Card Access at the street cabinet level may turn out to be a possible solution for lowering barriers of entry **(QSC)**.

ERG Considerations

The ERG expects that the suggested solution of Line Card Access will be the subject of discussions between market players, since it may fulfill the requirements of all operators who want to be present at the street cabinet.

ad 4.3.1.1 Co-location at the street cabinet

Consultation Comments

A competitor stresses that co-location within the SDF is essential, because of cost sharing effects with the SMP and participation in existing economies of scale **(Arcor)**.

A stakeholder association believes that the incumbent should be obliged to reserve a certain percentage of space in street cabinets for the co-location of alternative operators **(ISPA)**. Similar, a competitor defines as a requirement that the SMP party reserves a certain capacity of co-location capability for new entrants in the street cabinet, e.g. 20% **(Silver Server)**.

Several comments advocate co-location in - instead of next to - the street cabinet as the latter is too expensive (**e.g. Arcor, BREKO, ISPA, Silver Server, Sonaecom, Telecom e.V.**). Furthermore, the question is raised whether municipalities allow the deployment of further cabinets **(Telecom e.V.)**.

An incumbent addressing the issue of co-location at the street cabinet proposes the following **(TI)**. In order to increase the level of infrastructure competition, each OLO should built its own cabinet near the SMP's street cabinet. In the case co-location is possible, the relative conditions should be defined by commercial agreements. There should be a symmetrical obligation to negotiate co-location conditions only in the case of failure of the commercial agreement. In addition, a respondent **(TI)** believes that reserving space, according to a one size-fits-all solution, in all street cabinets for collocation would be inefficient since not all Cabinets will be considered commercially interesting by OLOs.

A competitor holds the view that subloop unbundling must be supplied in all the technically possible forms allowed by the incumbent's network **(WIND)**.

ERG Considerations

The ERG recognizes this point, though this type of co-location may not always turn out to be feasible. ERG considers the allocation principles that are applied to the cost of co-location to be an important driver for the SMP party to make the most desirable choices with regard to the space available in the street cabinet.

The ERG recognizes the need for adequate space in the street cabinet in order for others to co-locate. However, an obligation to reserve ex-ante a specific capacity may turn out be too static, not taking into account the requirements of all operators concerned nor possible technological developments with regard to, e.g. line card access.

ad 4.3.1.2 Backhaul

Consultation Comments

An association thinks that it is necessary to oblige the incumbent to offer sufficient backhaul capacity for alternative operators **(ISPA)**.

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

Consultation Comments

A competitor considers the adequate regulatory framework to consist of subloop unbundling, co-location within the street cabinet, access to ducts, access to dark fibre and WDM **(Arcor)**.

Another comment appears to agree that the definitions of Markets 11 and 12 continue to be appropriate to NGA deployment (assuming the provision of backhaul services is considered) **(Corning)**. Adding to that, a geographically focused tiered set of remedies which link both Markets 11 and 12 is advocated.

A competitors expresses the firm belief that the definition of a single wholesale access market, grouping the actual 11, 12 and 13, would better represent the multiple technical/economical solutions that will be deployed in the next 3 – 5 years **(WIND)**.

An incumbent is of the opinion that the currently discussed proposal to delete the word "metallic" in the definition of market 11 and the claim that market 12 already includes fibre technology would in fact add new wholesale markets to the list of the (regulated) relevant markets **(DTAG)**. The ERG declares the incumbents' new fibre components and its ducts as an "ancillary service" of the sub-loop access. In so doing, it extends access obligations to new fibre networks through the back-door. The ERG's approach is even less comprehensible in the case that fibre is deployed as an overlay, as the already established ULL access portfolio is not affected. DTAG rejects an extension of the Recommendation in order to include fibre networks.

Another comment is of the opinion that the focus of NGA regulation should be on passive (ducts, poles) rather than on active infrastructure **(Alcatel-Lucent)**. Regulation for sharing dark fibre between operators can be considered in order to maximize investment in lower density, non-competitive areas.

Ad 4.3.2.1 Unbundling of the Local Loop (Market 11)

Consultation Comments

Whereas the inclusion of fibre loops into Market 11 is supported, according to a stakeholder association limiting the local loop up to the street cabinet is not appropriate **(BREKO)**. It advocates defining ULL as the line between the NTP and the MDF avoiding different end points of the loop depending on the specific situation.

One incumbent supports a technologically neutral definition of Market 11 **(BT)**, but:

- does not consider Layer 1 unbundling proposals for fibre, for backhaul from the cabinet, for duct sharing, or for Layer 1 access to metallic sub-loops, required or proportionate;
- duct sharing should not be an ancillary service to Market 11 as it would result in significant additional costs, that could delay the case for NGA deployment;
- it is not believed that there is any requirement for quality of service differentials in for mass consumer market that need NGA Layer 1 unbundling or even a significant range of diverse bitstream access products;
- it is noted that there may be advantages to the consumer from a common (e.g. Ethernet) presentation to customers for each of end user connection.

A stakeholder association fully agrees that Market 11 needs to be defined in a technology-neutral manner **(ECTA)**. It is trusted that interpreting Market 11 in a technologically-neutral manner should already be possible under the existing Framework.

ad 4.3.2.2 Backhaul / Duct Sharing

Consultation Comments

With regard to Market 11 and backhaul, a company preliminary assesses that the current regulatory framework and Market 11 definition already provide for sub-loop regulated access products which in a FttCab scenario might allow NGA network replicability to an operator who is willing to commit to a critical level of investments in order to obtain an economic efficient scale. This, combined with a backhaul offer on commercial terms, would set a level playing field with cable operators who have also had to invest to reach a critical mass in order to compete with incumbents. It would also be coherent with the essential facilities criterion, set out at the outset, in the sense that copper sub-loops might be identified with legacy monopoly assets.

One of the stakeholder associations supports action to mandate access to dominant operators' ducts where practicable and where it would help to lower barriers to entry **(ECTA)**. However, this should be a remedy to address dominance on Market 11; it should not be a symmetric obligation disconnected from dominance.

Two comments argue that – in the case of the deployment by the incumbent of VDSL – backhaul between the MDF and the street cabinet could be provided as an associated resource of Market 11 under non-discriminatory conditions to competitors having already subscribed LLU at the MDF, to contribute to a viable business case for SLU **(FT, Orange)**.

An association supports The ERG's proposals to improve the regulatory framework in order to allow duct sharing are support by a stakeholder association **(Platform Telecom Operators & Service Providers)**.

One of the incumbent argues that ducts should not be included in Market 11 as ancillary services; on the contrary commercial agreements are favoured **(TI)**. Only in the case that the parties should not reach an agreement the NRAs may intervene by establishing symmetrical obligations.

ERG Considerations

With regard to the first points mentioned above, it should be remarked that the need to impose an obligation to provide backhaul services has to be assessed taking into account the competitive situation with regard to SDF-backhaul and thus the availability of alternative backhaul offers. Without such alternative offers, a regulated backhaul offer may be needed in order to obtain a level playing field.

The ERG fails to see a valid reasoning why the backhaul offer should be limited to competitors that have already subscribed to LLU at the MDF. The development of effective and enduring infrastructure competition requires that VDSL is also an option for new competitors; for this, a regulated backhaul offer may proof to be necessary.

ad 4.3.2.3 Wholesale Broadband Access (Market 12)

Consultation Comments

One of the incumbent agrees, and would welcome further clarification from ERG, that Market 12 comprises all kinds of wholesale broadband access products **(BT)**. According to this view, multicast technologies and standards are still evolving so it is premature to open a debate on regulatory treatments.

A competitor is of the opinion that a regulated bitstream offer should include the capability to opt for multicast. Otherwise the provision of IPTV services will be restricted to NGA builders or those with sufficient market share to connect at the local exchange **(C&W)**.

A stakeholder association fully agrees that Market 12, as defined, covers or should cover all forms of Bitstream access, irrespective of the underlying network/network protocol. Its position regarding multicast is that, where WBA is mandated, the SMP operator must make available, on a non-discriminatory basis, all technical capabilities embedded in its NGA. Multicast capability is simply one such technical capability **(ECTA)**.

Regarding multicasting capabilities, a competitor believes these should be treated by NRAs with due attention since they are fundamental for new kinds of mass market services like video and TV distribution **(ONI)**.

As far as Market 12 is concerned an incumbent believes that only existing retail services should lead to the imposition of the already existing obligations on the legacy networks **(TI)**. New retail services should not lead to the imposition of wholesale obligations on the new infrastructures. It considers multicast as a service closely related to the distribution platform of IPTV content and not to the provision of broadband services, thus it should be analysed in market 18.

Regarding the provision of multicast capabilities, another incumbent states that this should be analysed in the wider context of competition in the delivery of TV services **(Telefónica)**.

ERG Considerations

ERG has added the following text to it's opinion (section 4.3.2.3): "In order to maintain as far as possible the benefits of infrastructure competition based on LLU, the design of the WBA product may need to be enhanced to deliver as close as possible level of innovation capability to operators, enabling them to differentiate their service offerings and compete as far as possible on an equivalent basis to the infrastructure owner. One example of this could be a WBA product which gave operators control of QoS to enable high quality IPTV."

***Specific Issue*: Multicast**

Consultation Comments

This issue was not addressed in greater depth in the comments.

Whereas an incumbent argued that it is "premature to open a regulatory debate" on this topic, because multicast technologies and standards are "still evolving" **(BT),** other comments stressed the need for an enhanced Bitstream product which must include the capability to opt for multicast **(C&W)**. Or, as expressed by a stakeholder association "Bitstream must not be designed to prevent e.g. VoIP/IPTV" **(ECTA)**. This comment also points out that "some members already provide multicast-enabled Bitstream".

An incumbent suggests analysing multicasting in Market 18 **(TI)**. This view is opposed by a competitor arguing that the regulatory treatment of multicast has to be considered only in the environment of WBA" **(QSC)**. In case WBA access is not possible close to the MDF or street cabinet, either the incumbent multicast equipment must be receptive to multiple agents and/or some direct access to the incumbent multicast equipment (via Ethernet connection) has to be provided. Otherwise, competitive providers and their (wholesale) customers will be disadvantaged through significantly higher traffic costs for the concentrator part of the incumbent network.

ad 4.4 Regulatory Challenges and Remedies in Scenario II: FttH/B

Consultation Comments

Regarding the two main bottlenecks identified in the FttH scenario - cost of civil works and in-house wiring - a majority of comments agrees with the position of ERG as regards the sharing of existing infrastructures. In particular, access to existing ducts, especially those of the incumbent, is considered a very important option. Also, sharing of the in-house wiring and "pre-cabling of dark fibre in undeserved areas" greatly reduces costs **(FttH Council Europe)**.

Not surprisingly, alternative operators and their representatives (**AFORST, ECTA, Fastweb,** etc.) strongly support the proposal of the ERG to mandate the sharing of the incumbent's ducts, so that "OLOs (could) roll out their own fibres" without duplicating the ducts, considered as essential facilities, whereas the incumbents **(BT, FT, KPN, PT, TI, Telefónica etc.)**, even if they recognize the civil works bottleneck, point out the practical difficulties of such sharing and suggest that the ERG should take into account alternative facilities.

Unbundled access to the optical local loop of the incumbent is also mentioned, on the one hand by some competitors, either as a complement to access to ducts "when ducts are saturated" (**AFORST**), or in one single approach encompassing both the optical local loop and the ducts, and on the other hand by the incumbents who strongly reject any regulation of the fibre local loop (as seen above).

ERG Considerations

The ERG notes that its analysis of the main bottlenecks for FttH alternative deployments (costs of civil works / in-house wiring) and the main solutions (access to the ducts of the incumbent / sharing of the in-house wiring) are validated.

ad 4.4.2 Possible Modifications: Market 11, Market 12, Duct Sharing

Consultation Comments

Regarding the appropriate regulation in the FttH scenario, the comments differ strongly between incumbents and alternative operators.

Apart from the inclusion of fibre in Market 11 so as to permit the unbundling of the newly rolled out fibre local loop of the incumbent (see above ad 4.2.2), the possibility of regulating access to the ducts of the incumbent through Market 11 or through a separate market raises a lot of comments. The incumbents interpret an inclusion of fibre in Market 11 as an intention to regulate their investments in the optical local loop. This would send a wrong signal to the sector. Some respondents consider that access to ducts has to be addressed in a "separate new market" **(e.g. TI)**, while others do not consider this option realistic **(e.g. ECTA)**.

Competitors in general consider that regulation has to grant access to a wide set of wholesale offers – access to ducts, unbundling of the fibre local loop, bitstream – enabling them to choose which offer to take.

ERG Considerations

The ERG notes that the two options proposed to regulate access to the ducts of the incumbent through market analysis (through Market 11 including fibre / through a separate market) have both their pros and cons. It is acknowledged that defining a duct market may not be an easy task, as ducts may not be strictly considered electronic communication.

However, the ERG proposes to maintain the two options identified in its consultation document.

ad 4.4.3/4.4.4 Role of symmetrical regulation and its relation to SMP regulation

Consultation Comments

With regard to facility sharing several comments advocate a symmetrical approach to regulation **(BT, DTAG, ETNO, Fastweb, KPN, OTE, TI)**. These comments refer to the availability of infrastructures from other telecommunications operators, electricity companies, municipalities or public utilities. Referring to FttH roll-outs in Paris, Vienna and Milan also other infrastructures like water pipes, sewers, or underground railway systems are exploitable. One comment calls for open access to passive infrastructures in the public domain. According to this view “all ducts and poles should be sharable” **(Alcatel-Lucent)**.

One comment states that NRAs can assess on a case-by-case basis the availability of infrastructures in different regional geographies **(FT)**. According to another comments public policy initiatives in non-competitive areas should aim at removing barriers to the development of facilities based competition. Thus, newly created duct networks could then be offered by public authorities on a non-discriminatory basis **(Corning)**.

Nevertheless, in the first instance, it needs to be analysed whether ducts constitute a bottleneck in a specific region. If there is such a bottleneck, then not only incumbent’s ducts should be looked at **(DTAG)**.

According to one comment, the need to consider all existing ducts is already mandated by Art. 12 (2) a) AD requiring that NRAs when evaluating possible access obligations shall take into account the technical and economic viability of using or installing competing facilities **(ETNO)**. Thus, limiting the analysis to ducts used for electronic communication purposes is not in line with EU law and would lead to disproportionate obligations.

Moreover, ducts are not electronic communications services and as such cannot constitute a separate electronic communications market **(ETNO)**. For this reason the ERG-proposal of defining a market for ducts “used for electronic communications puposes” is ill-perceived. Another comment considers a classification of ducts as “ancillary service” as unfounded and incompatible with the Framework **(DTAG)**.

Although symmetrical approach is preferable, any such new obligation in the Framework need to be justified, proportionate and broadly consulted upon by the Commission **(ETNO)**.

The option of using alternative infrastructures, as proposed by those advocating a symmetrical approach, is not uncontested. One comment considers these alternatives for connecting the backhaul network to the SDF as “regulatory unfeasible alternative” due to the high trans-

action **(Arcor)**. Similarly, another one refers to practical issues related to duct sharing such as different ownership, control by utilities or network operators, limited capacity and the possibility of suboptimal tying to an existing physical structure **(TDC)**.

Finally, some comments calls for publicly funded FttX initiatives to be addressed **(ECTA, Tele2)**.

ERG Considerations

The ERG considers access to duct sharing as a remedy that could be mandated to facilitate local optical loop roll-out by alternative operators. In the Opinion it is outlined how the issue of duct sharing can be addressed within SMP regulation under the current framework.

Considering the possible economic relevance for reducing entry barriers, the ERG considers it important to strengthen the powers of NRAs to assist facilities sharing by modifying Art. 12 FD. The issue of facilities sharing is not only related to sharing of ducts but also of in-house wiring. The latter was identified by the ERG as one of the main barriers in a FttB/H scenario.

The ERG proposes a modification of Art. 12 FD in order to impose a symmetrical obligation to any electronic communications operator to negotiate sharing of facilities under reasonable requests.

ERG considers that the sharing of ducts of “non-telcos” does not constitute a viable alternative to telco ducts since it poses specific practical problems (e.g. due to different network structures) and may involve high transaction costs.

ad 4.5 Procedural Issues during the Migration Period

Consultation Comments

A stakeholder association remarks that the migration towards VDSL and FttH is critical, also since alternative operators have invested in LLU **(EuroISPA)**.

An incumbent states that the issue of NGNs has a recurrent problem for SMP operators that are providing wholesale services: if they want to evolve and optimize the network, the operators that use wholesale services are “locked in“ to certain points and technologies of the network **(Telefónica)**. This should not be an impediment for the evolution and optimization. An adequate notice and appropriate transition path should be provided to the customers of current services, allowing them to take up new technologies in a non-disruptive and smooth way, without undermining or delaying the necessary flexibility for the provider.

As proposed by one of the competitors, it is proposed that the closure of MDFs should be prohibited by NRAs, unless and until proper justification has been provided by incumbent operators, and subjected to a test equivalent to article 4.3 of EC Regulation 2887/2000: “The national regulatory authority may, where justified, intervene on its own initiative in order to ensure non-discrimination, fair competition, economic efficiency and maximum benefit for users”. If closure of MDFs is deemed justified after this test is conducted, then it is absolutely essential for the NRA to establish a firm set of rules for eventual closure **(Tele2)**.

ERG Considerations

ERG has added a separate section (section 4.5) to the Opinion dealing with migration issues.

ad 4.5.1 Procedural Issues in the Overlay Phase

Consultation Comments

According to a stakeholder association, it should be possible for the regulator to signal to the market the likely time horizons for the termination of legacy network elements, without fettering its discretion, so that operators have a consistent approach that provides a reasonable level of regulatory certainty **(BSG)**.

Specific Issue: Interference problems

Consultation Comments

Five alternative operators or association of altnet **(BREKO, Colt, ECTA, Tele2, QSC)** consider the interference between VDSL at street cabinet and ADSL at MDF as a major competition issue, especially when a large migration of incumbent end-users to VSDL reduces the impact on incumbent's customers.

Three of them **(ECTA, Colt, Tele2)** observe that only a few NRAs tackle this problem. Thus, the ERG document should address this problem. Two of them **(ECTA, Tele2)** request that all NRAs take actions to solve this issue and to verify that all NRAs have the power to do it.

One alternative operator **(Wind)** answers indirectly to this question by requesting to include into the information to be provided by incumbent the xDSL technologies' list implemented on each cable.

Another comment **(ETP)** points out to another interference problem: the spectral saturation of cable that limiting the number of xDSL users even if a single DSL technology is used.

ad 4.5.2 Procedural Issues in the Substitution Phase

Consultation Comments

A competitor is of the opinion that because of operational (implementation of the necessary measures) and economical (depreciation period) reasons a migration period of seven years per MDF is adequate **(Arcor)**.

A competitors' stakeholder association points out that any phasing out of MDF access should be subject to (i) pre-announcement of modification of the reference offer(s), subject to NRA approval, (ii) agreement by alternative operators which have co-located on the site; (iii) the definition of a timeframe which enables alternative operators to amortize their investment, (iv) a financial compensation for any accelerated schedule, and (v) the availability of fully fledged alternatives to local loop unbundling from the MDF which do not strand alternative operators' assets, and are technically and economically equivalent or superior, and economically viable for alternative operators, in order to sustain competitive provision to the benefit of end-users **(ECTA)**.

ERG Considerations

Other than the position expressed by a competitor that the regulatory precondition for the decommissioning of MDFs is that at least two carriers (including the SMP) are delivering xDSL services from the SDF in question, ERG is of the opinion that an equivalent alternative

to MDF-access should be ready to order before the phasing-out of MDFs is allowed (Section 4.5.2).

ad 4.6 Ladder of investment in an NGA environment

Consultation Comments

Concerning the ladder of investment the different views are expressed.

Some comments are sceptical on the practical relevance of this concept. Originally viewed as giving alternative operators an incentive to move to the next rung of the ladder and to finally roll out their own infrastructure, Iliad (France) is said to be the only example where this actually happened, whereas in most cases alternative operators express little incentive to climb up the ladder **(BSG)**. A competitor **(Tele2)** presents its own development in most Member States as a "perfect demonstration of climbing up".

Citing ERG's finding that NGA network may lead to enduring bottlenecks, then, as pointed out in a comment, the "value of the ladder concept is less obvious" as moving up the ladder will be unlikely in case of a natural monopoly **(TDC)**. According to another company's view "any operator can climb the ladder if infrastructure (ducts) is made available **(Alcatel-Lucent)**.

Two comment considers the ladder to be a "theoretical concept" **(PT, Telefónica)**. Providing multiple access products by regulation leads to "very limited investment in own infrastructure" and contradicts the goal of reaching interplatform competition where possible **(Telefónica)**.

Two comments see a contradiction between the idea of competition at the deepest level (seen as original notion of the ladder, implying that lower rungs to be removed) and the aim of avoiding over-regulation and the notion that all rungs must be available ("sequence of regulated access products") **(DTAG, KPN)**.

Similarly, a comment evaluates the ladder concept as "inadequate in an NGA context" risking systematic overregulation **(ETNO)**. On the one hand the ERG proposes the idea of enabling competitors to "climb-up" the ladder whereas elsewhere the ERG observes that in an NGA context operators may even "step down" (from LLU to Bitstream). Thus, the mechanical interpretation of the ladder would "compromise ERG's to establish a fact based approach to regulation in an NGN environment".

The applicability of the ladder concept is contested in case of access and backhaul technologies using fibre due to "different technological and economic aspects of fibre deployment" **(BT)**.

There are also comments explicitly or implicitly calling for a prioritisation of the rungs of the ladder and a regulatory focus on infrastructure competition **(FTTH Council Europe, Corning)** (see also ad 3.4 on the Relation between Infrastructure and Service Competition). Different from this view, a stakeholder comment considers "that the traditional platform competition doctrine could be partially revised **(EuroISPA)**.

One comment refers to the early stage of NGA roll-out. Therefore, "it remains to be seen in how far the ladders of investment and respective business models will have to be changed because of sub-loop and sub-fibre unbundling **(ETP)**.

On the other hand there is also support for the ladder concept **(Colt, ECTA, ISPA, Silver Server, TI, Tele2, WIND)**. According to one effective and consistent regulation should allow competitors to access at all levels of the ladder **(ISPA)**. This is necessary to select on a case

by case basis the most suitable access product. An inconsistent price system would distort incentives for climbing up the ladder **(Arcor)**. One comment explicitly supports the proposed modifications of the ladder in order to ensure continuity of investment and competition in an NGA environment **(ECTA)**. But this does not imply that substantial further investment up the ladder will be efficient or viable in all areas. Rather, the 'ladder' should be seen as providing a complementary suite of products that will enable investment as far is feasible (FttX roll-outs in some regions, LLU or WBA in other). The complementary notion of the ladder - in particular for regions without own network deployment - is also emphasized in another comment calling for maintenance of a full range of access offers **(Colt)**. Even an incumbent agrees with the ladder as presented by the ERG, pointing out that "in given areas new entrants can climb up by FttCab investments or moving directly towards, FttB/H **(TI)**.

Others also stress the increasing importance of Bitstream **(ONI, QSC)** as difficulties for competing at an infrastructure level increase making it necessary to reposition on the ladder **(ONI)**. The other comments see insufficient chances for entrants to step on the next rung of the ladder as a reason for increasing importance of Bitstream. Line Card Access should be closer looked at as a realistic step on the ladder **(QSC)**.

Another comment, supporting the idea of the ladder, sees the risk that the ladder "might degrade to a one step ladder, by applying Bitstream access as NGA for new entrants only" **(Silver Server)**.

ERG Considerations

From the ERG's perspective, providing multiple access points on different rungs of the ladder is not contradictory to the aim of infrastructure competition and the principle of promoting competition at the deepest level.

This principle is still applicable and appropriate in an NGA context. Infrastructure based competition should be followed where it is practical and economically feasible.

In order to take account of the comments and to clarify the ERG's understanding as regards the ladder concept, the following points were added to Chapter 4.6 of the Opinion (4.5 in the Consultation Document):

Thus, NRAs will strive to maintain the level and balance of infrastructure competition achieved and pursue the movement up to the economically viable rung which may vary across Member states and within Member States depending on regional characteristics.

The ladder of investment may become more "sophisticated" and the relative importance of the rungs may change in an NGA environment, albeit not the overall form of the ladder with several rungs requiring more investment in own infrastructure the higher the rung reached.

In case an SMP operators phases out its MDFs, the reactions from competitors can be different and the picture will become more differentiated. Some alternative operators will not move to the street cabinet, but make more use of such an enhanced BSA product, while others will invest in own infrastructure and move further down to the customers. However, even those who do invest, will not do so everywhere (as the incumbent), but only in those areas where the economics will allow a business case, i.e. to street cabinets with a minimum number of reachable customers. In order to reach national scale, these operators will draw on BSA products (and other access products) too in areas where they do not roll-out to the customers to complement their offers.

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

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

Part 2: Country Case Studies

2.1 Austria

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

In[2] Telekom Austria's managing director of platform and technology management, Helmut Leopold, is quoted declaring that the Austrian incumbent is planning a major restructuring of its access network. According to this article, Telekom Austria plans to roll out a fibre-to-the-curb (FTTC) infrastructure in cooperation with various municipalities and utilities. This roll-out supposedly should include the implementation of 20 - 30.000 fibre nodes significantly shortening the copper local loop to 600 - 800 m subsequently allowing the deployment of services with a minimum data rate of about 20 MBit/s. While Telekom Austria representatives in the meantime questioned the relevance of that article, an official confirmation or announcement of Telekom Austria was not given with regard to the issue.

Regarding services to be offered on an NGN access network, Telekom Austria already launched a triple play product comprising telephony, broadband Internet and TV services[3] [2]. An enhanced access network infrastructure as described above could significantly promote the success of the incumbent's triple play offerings.

Vienna utility operator Wienstrom in recent years performed trials offering fibre-to-the-home (FTTH) services to end customers in selected areas of Vienna. Meanwhile, Wienstrom has withdrawn from the retail market and is offering fibre access as a wholesale service to other operators (currently to Telekom Austria, NeoTel and Conova). Other utility operators like Grazer Stadtwerke[4] [4] have begun to offer triple play services based on FTTH infrastructure as well. In addition to retail broadband services, some local operators like Infotech Ried[5] [5] also started to distribute (local) TV services based on their own platform; in parallel, they have developed system solutions for carriers, service providers and wholesale operators[6] [6] to build and operate an IPTV platform based on a multi-access broadband Ethernet network.

2.2 Belgium

The process of decreasing of the number of switching points and increasing of the number of aggregation points is yet started in the legacy network that has 595 combined switching and aggregation locations in the past, to have now around 260 voice switch locations and around 1150 aggregation locations (VDSL excluded). This process has not drawn away closing of physical locations.

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

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

3 Cp. http://aonDigital.tv, 28.10.2006.

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

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

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

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

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

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

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

In 2007, Belgacom has launched managed Voice over IP residential service as option to Internet service and all-IP business services to replace all legacy ones. Begacom has announced that migration will be only on customer's demand for at least three years. There is not yet planning to phase out legacy network.

Cable TV have announced the launching of a 100Mbps offer based on EuroDocsis 3 at short term, that is increased the strategic interest of Belgacom for VDSL2. However VDSL causes degradation at ADSL services; to avoid this, the power transmission of VDSL must be reduced with as consequences the reducing of the downstream capacity. VDSL was thus frozen in waiting VDSL2, and ADSL2+ was launched to extend TV on ADSL coverage during this period. However ASDL2+ permits to receive simultaneously 2 TV channels which is too low in comparison with the cable that can provide all channels together. Generally, it is estimated that at least 3 channels must be available (living, bedroom and recording).

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

The BIPT Communication has imposed following deployment rules:

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

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

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

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

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

2.3 France

Situation of DSL

In the last years, most of operators focused on DSL technology to increase bandwidth access on the existing incumbent copper local loop. Currently ADSL2+ offers up to 24 Mbps downstream and up to 1 Mbps upstream bandwidth. Thanks to the bitrates available with DSL technology, internet service providers have been able to launch their triple play offers at the end of 2003. Currently, from a total broadband market of 14.25 million customers, 13.55 million use DSL and 700 000 use cable.

Introduction of VDSL2 technology on France Télécom's local loop, at the level of the street cabinet, is still under study in France. Theoretically, VDSL2 may deliver up to 70 Mbps downstream. However, no operator so far has announced any FttCab (Fibre to the Cabinet) deployment. One of the reasons seems to be that France Télécom's sub loop is too long, in average, compared to the situation in Germany or the Netherlands, so that greater bandwidth may not be attainable for a great part of the population.

FttH announcement

In 2006, the three main French DSL operators, France Télécom, Free and Neuf Cegetel, announced their plans to roll out their own FttH (Fibre to the Home = new optical local loop) networks in Paris and in the main cities. So far, alternative fibre rolls out in the local loop only concerned business customers with MAN deployed in the main cities.

Actually, regarding announcements made by alternative operators (Free and Neuf Cegetel), it appears that there is an opportunity, considering their market shares in the main cities, to shift from a LLU model to an asset-based model, climbing up to the last row of the ladder of investments by rolling out their own local loop. In particular, possibility to access to alternative infrastructures in Paris, the sewing systems, enabling them to roll out their own fibre cables till each buildings, has to be taken into account in those moves.

France Télécom:

- 270M€ till 2008 / 3 to 4,5 billions € till 2012
- deployments under process in Paris, Lille, Lyon, Toulouse, Poitiers, Marseille
- technology used: GPON
- … so as to massively reuse its own ducts inherited from the former monopoly

Free:

- 160M€ till 2008 / 1 billion € till 2012
- bought Citefibre (former FttH operator) in September 2006

- deployments under process in Paris, Lyon, Montpellier and Valenciennes
- technology used: point-to-point fibre

Neuf Cegetel:

- 300M€ till 2008
- bought Erenis (former FttB operator) in March 2007
- deployments under process in Paris, Pau, Toulouse, Rennes, Bordeaux, Strasbourg, Nancy
- technologies used : point-to-point fibre in Paris / GPON everywhere else

Numéricâble, the main cable operator, has also announced its objective to progressively improve its network in the main cities by rolling out fibre till the last amplifier (FttLA) so as to reach better downstream bandwidths (300M€ till 2008).

The map below, done by Tactis, illustrates the situation of FttH in France in 2013.

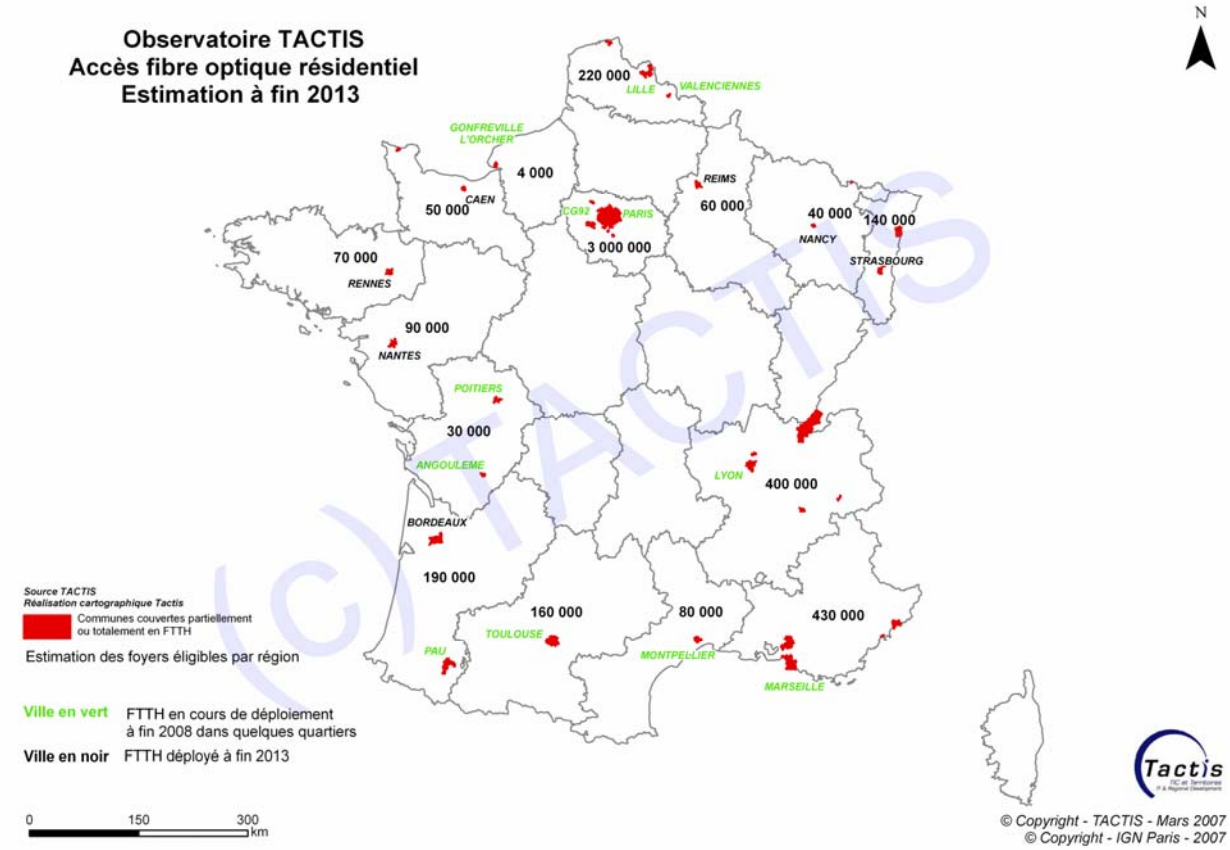

Figure 2.3.-1: FttH situation in France in 2013 (source: Tactis)

Works done by ARCEP

ARCEP has tackled the FttH issue for more than one year, precisely with three main subjects:

- access to existing civil works infrastructures
- sharing of the last part of fibre networks
- action of the local authorities

This summer, ARCEP launched two public consultations on FttH, the first dealing with the competitive situation concerning access to ducts and the possible regulation of ducts with a view to rolling out high-speed broadband local loops, the second dealing with the sharing among operators of the last segments of the optical local loop in order to limit the amount of work carried out in buildings.

Access to ducts

Digging trenches and laying cables to buildings accounts for approximately two thirds of the cost of rolling out the optical fibre local loop. In less densely built-up areas, the cost of such civil engineering work is higher and rapidly becomes prohibitive.

France Telecom is currently rolling out fibre in its ducts, which were inherited by the former monopoly. A certain number of these ducts are not occupied and can be used to roll out FttH networks.

The former telephone service monopoly has therefore given France Telecom a major advantage as far as the development of high-speed broadband networks is concerned. Against this, it is unlikely that competition will be able to develop in smaller towns if alternative operators are required to replicate all the necessary civil engineering work in such localities.

ARCEP has therefore written a public consultation with respect to the competitive situation concerning access to electronic communications ducts and the possible regulation of this access. The objective of this consultation is to enable all operators to have access to these infrastructures. It would then be possible to achieve fair competition, based on merit, between operators in the rollout of high-speed broadband networks.

The aim of such regulation, focused on these essential infrastructures, would be to encourage investment and to guarantee infrastructure-based competition in the local loop segment. It could reduce the need for asymmetric regulation of the higher network layers and avoid the functional separation which as has been proposed by certain players.

Sharing the last part of the fibre local loop

Several operators are currently rolling out their own optical local loops in the same main cities, till the buildings, but also, within a building, to the apartments.

In the long run it does not seem reasonable for each optical local loop operator to have its own dedicated cables and optical connectors in each building and each separate apartment. The amount of work involved would cause considerable inconvenience to the building's occupants and co-owners. However, people must be able to change broadband operator without having to move home!

The last part of the fibre local loop must therefore be shared by several operators. The second public consultation written by ARCEP concerns the technical, financial and legal issues raised by such shared usage. In view of the complexity of this subject, which affects a number of different aspects of the sector, certain questions require changes to the corresponding legal and regulatory framework.

Action of Local Authorities

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

Today, regarding FttH, adequate intervention of local authorities is likely to facilitate the rolls-out.

Their role of “facilitators” could be decisive:

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

2.4 Germany

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

Deutsche Telekom

Deutsche Telekom applies a strategy consisting of 3 subsequent phases:

Phase I “Connectivity” is focussed on enabling connectivity between the PSTN and the IP network through media gateway controller and media gateway thus ensuring interworking of different protocols (e.g. SIP or SS7). Centralized intelligence for managing voice (→ telephony application server) enabling call control and supplementary services like fault management. Basic call functionalities – and some further features – are implemented.

Phase II “NGN-Overlay Platform and New Services”: Border controller are implemented. Further service features are implemented through applications servers, also multi-vendor capabilities for certain network components like media gateway controller.

Phase III “Substitution for PSTN/ISDN”: The PSTN/ISDN migrates towards IP networks. Access gateways allow for connecting “old” PSTN end-customer devices. PSTN functionalities will be widely implemented in application servers.

According to the Deutsche Telekom the pace of migration is finally driven by customer demand and - closely related - the availability new services and features exploiting the potentials of NGNs. This holds true especially for Phase II where an overlay infrastructure is implemented thus allowing for new services.

In September 2005 Deutsche Telekom announced its plans to extend its fibre infrastructure to the street cabinet in order to offer VDSL products. Deutsche Telekom has adopted a two-step approach implementing fibre infrastructure in 10 big German cities[7] in a first step and additional 40 cities in a second step. The investment for the VDSL infrastructure projects amounts to € 3 bill (with € 500 million of these for the first stage of the project).

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

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

Deutsche Telekom has announced in its mid-year press conference 2006 to push the implementation of its IP-based Next Generation Network. Investments shall be made earlier than originally planned. It is intended to migrate the existing networks and all services provided over these networks into a single IP platform.

By the end of 2006 DTAG's VDSL network was deployed in 12 cities. It is envisaged to provide 27 cities with VDSL by the end of 2007 and the rest of the 50 cities from 2008 on a step-by-step basis. Besides this VDSL roll-out Deutsche Telekom plans to offer ADSL2+ in 750 cities by the end of 2007 allowing speeds of up to 16 Mbit/s. Thereby it is intended to further push IP-TV. Deutsche Telekom plans to have an IP-TV coverage of 17 million homes in 2007, either based on VDSL or ADSL2+ coverage.[8]

Deutsche Telekom offers three product bundles based on ADSL2+ (*"Entertain Basic", "Entertain Comfort", "Entertain Comfort Plus")* and two product bundles based on VDSL2 *("Entertain Comfort VDSL", "Entertain Comfort Plus VDSL").* [9] All bundles require a telephone access line (analogue or ISDN).

Netcologne

In July 2006 Netcologne[10] began constructing a fibre to the home network in Cologne. Based on this network Netcologne offers Internet access with up to 100 Mbit/s. Offers are available since December 2006. The first phase of the infrastructure roll-out covers an area in the city of centre of Cologne. For 2007 network deployment is envisaged in further parts of the city covering approximately 9.000 households. Within the next 5 years the whole city shall be covered with a focus on multi dwelling units and industrial buildings.[11] Netcologne intends to use existing in-house wiring. Netcologne offers bundles with access speeds of 10, 50 or 100 Mbit/s (with telephony either being part of the flat rate or charged on a per-minute basis).[12]

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

8 http://www.telekom.com/dtag/cms/content/dt/de/402710, http://www.telekom.com/dtag/cms/content/dt/de/443114.

9 http://entertain.t-home.de/c/11/84/28/78/11842878.html.

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

11 http://www.netcologne.de/unternehmen/presse/presse-archiv/pressemitteilung.html?tx_ttnews%5Btt_news%5D=2&tx_ttnews%5BbackPid%5D=388.

12 http://www.netcologne.de/privatkunden/glasfaser-dsl/glasfaser-dsl.html.

Netcologne plans to invest € 250 million over the next 3 threes.[13] Making investments in its own fibre access network enables Netcologne to save charges to Deutsche Telekom for the the local loop. According to press articles these costs amount to approx. € 30 million p.a. It is assumed that Netcologne which is owned by an energy utility may use the pipes owned by this utility to run fibre through thus saving substantial costs of digging its own trenches.

2.5 Greece

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

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

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

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

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

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

13 http://www.netcologne.de/unternehmen/presse/presse-archiv/pressemitteilung-achiv.html?tx_ttnews%5BpL%5D=31535999&tx_ttnews%5Barc%5D=1&tx_ttnews%5BpS%5D=1136070000&tx_ttnews%5Btt_news%5D=22&tx_ttnews%5BbackPid%5D=897.

Framework and is co-funded at 70% by the European Fund for Regional Development (EFRD) and at 30% by national funds.

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

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

2.6 Italy

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

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

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

Other Key Project Figures:

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

2.7 The Netherlands

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

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

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

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

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

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

- A regulated offer from KPN for unbundled access to the sub-network, as well as the

related facilities such as co-location at the street cabinet for purchasing Subloop Unbundling (SLU).

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

In the beginning of 2007 OPTA has called on KPN to produce a solution, which is acceptable to all parties involved, for KPN's proposed phase-out of MDF Access as part of its All-IP plan. This call was answered by KPN by starting talks with the three largest MDF customers. The talks resulted in three signed Memoranda of Understanding (MoUs) on 13 July 2007. The MoUs contain conditions under which MDF customers are willing to co-operate with moving out of the MDF locations. One of these conditions is that KPN will maintain MDF access for a coverage of 50% of Dutch households. Another condition is that KPN will develop an adjusted WBA offer, which gives market parties the opportunity to continue their MDF Access business model.

These MoUs will be worked out in Migration Agreements. Furthermore KPN has also started talks with the other MDF customers.

OPTA has already announced that it will take such agreements into account in its current market analyses. OPTA expects to publish its new market analysis draft decisions for national consultation before the end of 2007.

2.8 Portugal

Current status

The number of loops unbundled by alternative operators has reached 244 thousand in the second quarter of this year, an increase by 11% compared with the previous quarter and 68% YoY (from the 2Q2006). These figures demonstrate the increasing dynamism of the national electronic communications market, and the clear investment made by operators other than PT as regards offers with a more direct access to end customers. They also convey an improvement of regulatory conditions operated by ANACOM, which has clearly led to a decrease in barriers to the access to the basic telecommunications network.

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

Likewise, the number of exchanges where operators are co-located has increased, reaching now 206 exchanges, corresponding to a potential coverage of about 50% of the local loops.

PT Comunicações (PTC), the fixed historic operator, is actually upgrading its access network to offer ADSL2+ nationwide (100% coverage with ADSL is guarantied from the middle of

2006). PT Group companies, PTC (fixed incumbent) and TVCabo (cable operator) are upgrading their networks and both already offer triple-play services.

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

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

Publicly available information by PT Group

Detailed information on the technological evolution of the PT Group networks is scarce[14], being the main source the PT Innovation[15], according to which, its "mediaDSLAM"[16] equipment will allow, in the short term, to increase the bandwidth of the copper line for speeds of the order of 100 Mbps. In accordance with the press release, of September of 2006, this new solution will support a widened range of new advanced services in the existing infrastructure and with VDSL2 technology, exceeding the possibilities of triple-play (voice, data and video): beyond extreme-fast Internet access, several channels of conventional digital TV and high definition (HDTV)[17], fixed telephony and VoIP.

One still notices that, in accordance with an announcement of July of 2006, TVCabo announced the future upgrade of its IP-NGN platform to offer in the near future a bandwidth up to 100 Mbps to its customers, thus offering very high speed broadband access, voice over IP[18] and video contents in high definition (HDTV).

In a NGN workshop, organized by ANACOM in October[19], and with the presence of some of the most active players (main fixed operators and all three UMTS/3G mobile operators, and manufacturers), PTC mentioned that its strategy will continue to privilege the use of equipment and solutions normalized, in the scope of the ETSI/TISPAN in the case of NGN -IMS as architecture, and the access concept of the ITU-T's Recommendation G.902[20].

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

- Predominance of the copper for residential access;
- Low levels of optic transport and wireless use;

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

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

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

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

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

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

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

- Several units for specialized services (MUX for voice PSTN and for TDM data, DSLAM, VoIP and VoInternet, IP Data);
- ATM aggregation.

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

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

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

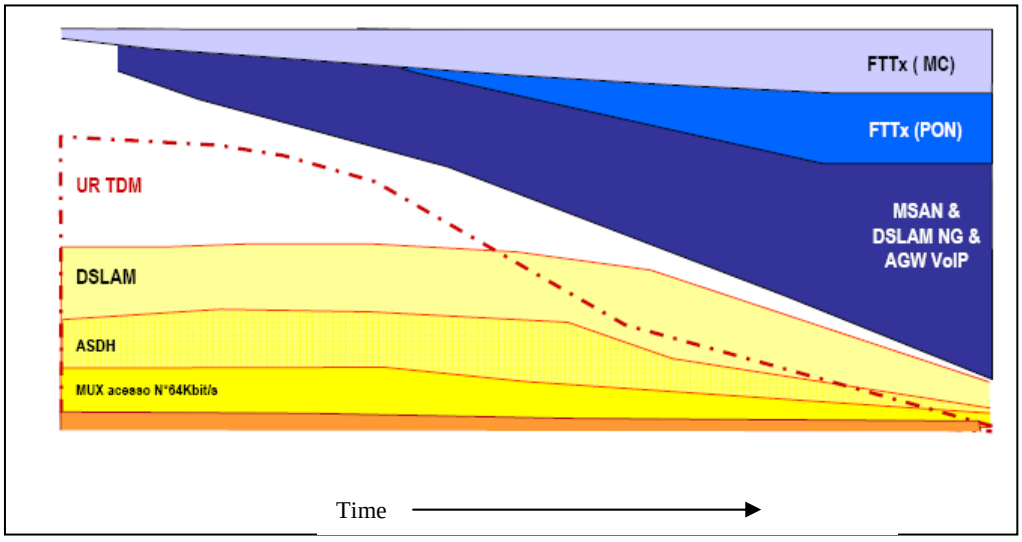

Figure 2.8-1: Evolution of access network in the medium-long term (source: PT Comunicações, 2006)

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

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

The evolution of the access network

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

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

Hence, having into account the probable increase of the traffic in the broadband access, PTC is evaluating the technical solutions (e.g. FTTN, FTTB) that may have a direct impact in the structure of the network, namely with the creation of new nodes/MDF/PA[21] where and when the demand emerge. In this initial phase, PTC does not have specific and definitive plans for the development of its access network. Nonetheless, for the year of 2007, and following an "*evaluation still preliminary and not stabilized*", PTC foresees the creation of only a few hundred new PA, affecting less than 1% of the total copper lines.

Also, the current number of optical and hybrid (copper/fibre) loops is reduced face to the universe of loops: inferior to 5% in total.

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

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

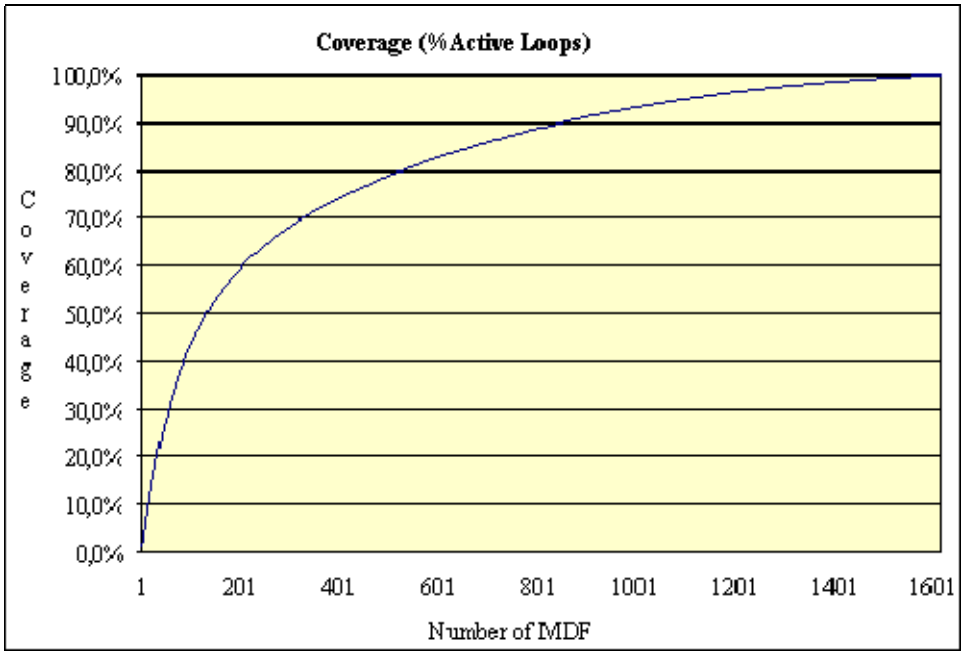

Figure 2.8-2: Operator (LLU) coverage (in % of active loops) according with the number of MDF.

Moreover, the majority of MDF are located in small buildings, remote units or even street cabinets. In these cases, the only form of co-location will be, probably, in an exterior space, which will cause increased costs to the operators. At this moment, it is not possible to affirm that they would recoup these costs, in case that they decide to advance for a broader covering. On the other hand, it might not be interesting for the operators to be co-located in nodes/MDF with reduced potential capacity (in the order of the tens of loops), being more efficient to use the bitstream offer (with 100% of national coverage for ADSL[22]) to offer its services. It should me noted, however, that the bitstream offer "only" allows broadband access, not being specifically suited to offer triple-play services at a wide scale[23].

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

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

2.9 Romania

NGN migration

As in most of the EU countries, the traditional TDM networks in Romania are gradually migrating towards IP-based Next Generation Networks (NGN). Although it is not clear today how the NGN networks will look like in detail, the strategies already employed by the incum-

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

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

bent operator may provide some useful indications. In 2005, Romtelecom made public its investment plans to migrate to a packet switched network, but did not disclose detailed information on the planned migration.

According to incumbent's public statements, it might invest half a billion euros over a three years period for the migration to NGN (with no details on the investment allocation between NGN core and access). In addition, there were indications that Ericsson and Alcatel would be the chosen vendors for the migration to NGN.

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

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

In relation to the access network, the incumbent plans to reduce the length of local loops to less than 1km (especially by deploying ONUs), to increase the number of broadband enabled lines, with 700,000 ADSL 2+ ports to be installed by the end of 2007, and to increase the number of deployed ADSL lines.

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

Regulatory aspects

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

However, the access to the incumbent copper access network (LLU) becomes problematic as it dramatically increases the number of access nodes and simultaneously decreases the number of subscriber lines per access node.

Furthermore, the access to street cabinets presents some physical difficulties like installing the OAO's HDF and DSLAM (due to the very limited space available inside the cabinets), ensuring the backhaul service (limited or lack of space/optic fibre capacities available inside the ducts), obtaining the necessary approvals from the local administration.

These were some of the findings of a working group for LLU issues established by ANRCTI in 2006. The WG studied various possibilities for viable access to ONU (regulated backhaul transmission services, dark fibre and duct sharing) and alternatives (such as regulated bitstream services). The introduction of a regulated bitstream market was found to probably be the best alternative to ensure some level of competition on the (shortened) local loop in the current regulatory framework.

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

- to notify the alternative operators any modification of its network that might affect the retail services offered by the alternative operators, including the removal of an MDF, not later than 12 months before carrying out that modification.

- to publish and to update quarterly the plans for modernization of the access network (including deployment of ONUs) at least with 12 months before proceeding to modify of the access network. This information must be updated quarterly.

Broadband market snapshot

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

The most common support for providing fixed high-speed access to Internet is UTP/FTP cable. These so-called neighbourhood networks consists of large LANs connected to the internet using a broadband connections purchased from the larger ISPs. The market share of UTP/FTP has increased significantly in the past year reaching 29.6% of the total broadband connections at the end of 2006.

According to the data available at 31st of December 2006, there were 393.514 coaxial cable subscribers. The share of cable modem in the broadband market, which reached 22.2% at the end of 2006, has slowly decreased in the last couple of years, mainly due competition from UTP/FTP cable. The modem cable had a growth of 20% in the last year becoming one of the most mature and affordable services in the market.

The DSL part of the retail market is dynamic in Romania with the number of subscribers increasing by 118% in the last 6 months of 2006. Still, the penetration rate of DSL in the total broadband access is about 5.5%, situation caused mainly by the competition from the UTP/FTP and cable operators, the late introduction of DSL services by the incumbent (in May 2005) and also of the LLU services (as a result of the regulatory measures, RUO was published in September 2004, but the first LLU contract was signed in March 2005). Furthermore, regulated bitstream services are not available yet.

2.10 Spain

Spain has a fixed telephone network with over 18 million lines in service, which represents a penetration rate on the total population of 41%. The number of users with broadband internet access amounted, in June 2007, to 7.4 million (residential and businesses, which represents a penetration of 16.6% on the total population), 21% of them via cable operators, and over 1.1 million users having an unbundled local loop. Telefónica, the incumbent operator, has a network with around 17 million copper pairs installed, with over 16 million in service.

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

Telefónica held in 2005 a limited FTTH trial based on PON in the outskirts of Madrid. A new trial, covering FTTx/VDSL2 and FTTH, has started in Madrid (from 16th April). Although alter-

native operators requested to stop it due to potential interference risks and lack of participation, discussions suggested by CMT have led to a process of information sharing in mutual agreement for the trial.

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

The CMT launched a public consultation on NGA, with end of June as deadline for answers. The target is to get feedback about how to improve conditions in order to promote a sustainable competition, fostering efficient investments. The answers are being analyzed.

2.11 Switzerland

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

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

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

The VDSL spread out is boosted by the new IPTV offer from Bluewin, the incumbent ISP. Bluewin TV's basic package covers over 100 regional, national and international television

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

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

2.12 Sweden

Fibre networks in Sweden

Compared to many other countries, a relatively large proportion of households and businesses in Sweden have the potential to receive broadband. However, according to previous reports from PTS, there are a number of geographical areas in Sweden that still lack access to broadband. In other parts of the country, competition is restricted as households only have access to one broadband access line provider.

Besides xDSL, the technologies that allow coverage mainly include fibre LANs and wireless networks. Taking consideration of this coverage and planned rollout, approximately 136 000 households and businesses still lack access to broadband infrastructure.

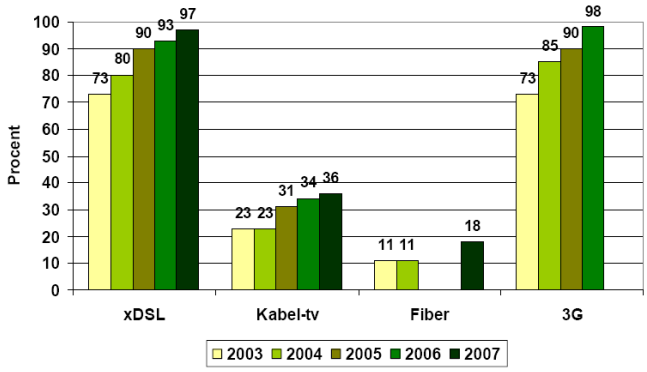

Figure 2.12-1: The development of coverage of different broadband access technologies in Sweden 2003-2007

PTS assess that the coverage of fibre access, defined as the percentage of households that has fibre cable to their home, to be approximately 18 % 2007. This corresponds to approximately 800 000 households that have fibre to their home. The coverage for years 2005 and 2006 is left out due to non-comparable statistics.

The urban (municipally) networks reach 1,3 million households with fibre access. In this context reaching means that the household is within 100 meters from a fibre cable, but in average they are rather within 25 meters.

Wireless and fibre networks in the municipalities with which PTS has been in contact offer additional coverage beyond that offered via xDSL. PTS has also observed that rollout of broadband infrastructure is taking place in certain municipalities, mainly through the remaining central government grants for broadband rollout.

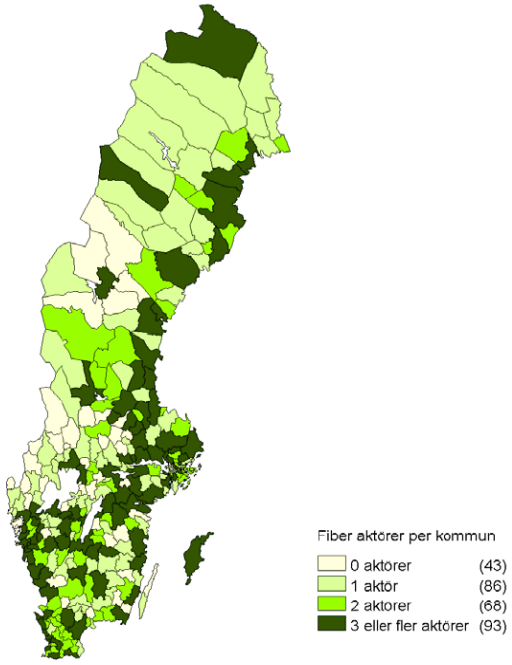

Figure 2.12-2: The number of actors owning and offering fibre access per municipality in 2007-09-04

In the PTS survey of 2007 there were 132 actors stating that they own and offer broadband access to end users via fibre-LAN or fibre directly in the home. They offer fibre access in 247 of Sweden's 290 municipalities (kommuner).

In 86 municipalities there was only one actor offering fibre access and 19 of these were the municipality itself that owned the fibre access.

Experiences and barriers

According to Swedish municipal authorities, collaboration between the local population and the various relevant bodies, such as municipalities and regional cooperative bodies, has been key to the successful rollout of broadband in many places. The municipal authorities also state that the broadband support from central government has been an important factor behind the establishment of broadband coverage.

There are factors that currently impede or prevent the establishment of new broadband networks in various ways. Experience of the municipal authorities interviewed by PTS shows that these barriers can be divided into four categories. Problems with sparsely populated areas, i.e., low population density and great distances, appear to be the most obvious barrier. Their relationship with TeliaSonera, financing problems and a lack of national coordination and technical support for broadband issues were other problems referred to by the municipalities.

The drivers for development of fibre networks in Sweden

A main driver for the development of fibre networks in Sweden is the broadband availability objective: 'Broadband for all by 2010' According to Swedish and European IT policy, a Swedish strategy that aims to increase accessibility to an infrastructure with capacity for broadband transmission should be drawn up with the short-term objective of broadband for all households (permanent housing) and business and public operations no later than 2010.

According to PTS, 'broadband' in this objective refers to connections that can be upgraded to a transmission rate downstream of at least 2 Mb per second. Sweden has shown good progress in terms of satisfying this objective. However, approximately 136,000 households and businesses do not have access to an established or planned broadband infrastructure of this type. On the other hand, there are various types of broadband technologies that could together bridge this digital gap and possibly satisfy modern requirements for broadband access lines. PTS has nevertheless noted barriers that currently prevent or at the very least seriously impede the continued establishment of broadband networks.

Government support has been an import driver for the deployment of fibre networks in Sweden. In the PTS report “Proposal for Swedish broadband strategy” there are four areas outlined

- Several government initiatives are needed to achieve the broadband availability objective
- TeliaSonera's (incumbent) last mile networks: a key to enhanced broadband competition
- Models for equal treatment: functional separation within TeliaSonera
- Open fibre networks may contribute to effective competition

In this country case study for NGA we would like to focus on the first and last bullets.

Government initiatives

PTS has proposed several government initiatives are to achieve the broadband availability objective . In the opinion of PTS, continued government support initiatives are needed for the rollout of broadband infrastructure. Furthermore, PTS proposes that the Swedish Government should impose minimum requirements on infrastructure established with public funds; for example, as regards the transmission rate. The Government should also prescribe that broadband networks financed with central government support should be open to other service providers during the lifetime of the networks. In order to ensure compliance with the requirements, PTS should be granted powers to impose openness requirements in regulations and be given a mandate to follow up the requirements and to take all of the measures resulting from the Electronic Communications Act (EkomL).

Municipal authorities should be given a social planning responsibility to ensure access to broadband infrastructure as well as the right to collect data from relevant stakeholders concerning the broadband networks available in the municipalities and any existing rollout plans. The Government should also consider drafting legislation to give municipalities more freedom to conduct cross-municipal collaboration in the broadband sector. In the opinion of PTS, municipal authorities that currently own broadband operations in areas where the commercial rollout of future-proofed broadband infrastructure has been carried out or is possible should consider disposing of such operations, or alternatively, taking special measures to ensure that competition is not distorted. The Government should also formulate a long-term objective (including preliminary objectives) for access to broadband infrastructure and strive for broadband to be perceived as a universal service when reviewing the USO Directive. The Government should also investigate whether there are reasons to change to a financing model for universal services based on the allocation of net service costs between the providers of electronic communications networks and communications services. Finally, the Government should rapidly investigate how to encourage the relevant parties to coordinate broadband lines with power lines, for example. PTS's view is that the proposed measures are necessary if the objective of broadband for all is to be realised by 2010 and so that Sweden can also strengthen its position in the long term as a leading IT nation.

Open fibre networks

However, in PTS's assessment, it will rarely be commercially feasible or socioeconomically desirable to install parallel fibre networks at an access line level. Infrastructure based competition at an access line level based on parallel fibre networks will probably only arise in exceptional cases. Under such conditions and if there is a lack of other broadband networks in the relevant areas, the objective of PTS's regulatory work must therefore be to enable the best possible service based competition (based on established fibre infrastructure). In this case, consideration should be given to ensure that the network owner receives sufficient incentives to maintain and upgrade its network. A lack of service competition in areas where there are no alternative broadband networks will jeopardise the objective of end users being given the greatest possible benefit in terms of the supply of electronic communications services as well as their price and quality.

However, a precondition for this type of service competition is for it to be possible for operators other than the operator controlling a fibre network to gain access to the network on non-discriminatory terms in order to offer broadband services to end users. In other words, fibre networks must be open at an infrastructural level.

PTS nevertheless considers that there are a relatively large number of owners of local fibre networks that only sell products to end users and thus do not allow other stakeholders access to the networks. These networks are often financed through broadband support in the form of funding from the central government or the European Union.

Subsequently, PTS considers that the lack of openness characterising local fibre networks jeopardises the objective of end users being given the greatest possible benefit in terms of the supply of electronic communications services as well as their price and quality. For this reason, PTS considers that measures must be taken in order to rectify the identified problems related to competition. PTS is very concerned about those cases where the described problems related to competition have arisen as a result of a lack of openness in networks set up with the help of central government or EU funding and/or are owned by municipal authorities. A publicly financed rollout that distorts or impedes competition clearly contravenes the overall IT policy objectives and acts against the best interests of society.

In order to rectify the described problems related to competition, PTS proposes that the Swedish Government should impose more stringent requirements on openness. These are to apply to new procurement processes for rollout financed by grants. The supervision of county administrative boards should be intensified for established networks, which should rectify a substantial number of existing problems. In cases where a local fibre network is controlled by a municipal authority, the municipality should exercise its ownership influence in order to ensure openness in the network. The Swedish Government should also consider whether specified requirements on openness in established municipal networks should be necessary in order to grant new central government funding for broadband rollout.

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Part 3: Summary of Business Case Studies

3.1 Analysys: "The business case for sub-loop unbundling in the Netherlands"[24]

Focus of the study

OPTA presented in its All-IP position paper[25] a possible equivalent alternative for MDF access, when MDF access will be phased out.[26] To get some more information about the economic viability of this alternative, OPTA has commissioned Analysys to investigate the business case for providers using sub-loop unbundling (SLU) and/or wholesale broadband access (WBA) following the implementation of KPN's All-IP network.

Analysys describes the market context in the Netherlands as follows: "*At March 2006, DSL accounted for just under 60% of broadband lines in the NL, cable accounted for just over 39%, and FttB accounted for around 1%. Within the DSL market, KPN holds an approximate 80% market share since its acquisition of Tiscali.*[27] *The three main alternative providers are bbned (DSL market share ca. 8%), Tele2/Versatel (DSL market share ca. 8%) and Orange (DSL market share ca. 4%). Currently, all these operators predominantly rely on LLU at the MDF to deliver service, and can reach 50-70% of the population by this means.*"

Analysys relied on a number of data sources: the current wholesale offers of KPN[28]; interviews with several market parties; data from OPTA; third-party demand forecasts; economic data from EIU; internal estimates for technical parameters and unit costs.

Assumptions

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

Results

Analysys identified a number of conclusions:

- Based on the current wholesale offers of KPN the use of SLU by an alternative provider is not economically viable as an alternative to continuing use of LLU, except under certain conditions. Analysys estimates that a business case for SLU with similar economic viability to that of continuing use of LLU for 60% of the population would require both:
  - a market share greater than 55% of all broadband lines (including cable) in areas served
  - Analysys' highest estimate for incremental revenue (an increase in ARPU across all broadband users of €10 per month by 2016)
- For an alternative provider with a 10% market share of all broadband lines in areas served, Analysys estimates that it may be economically viable to deploy SLU to around 1000 of the largest street cabinets in the dense urban areas, provided that:

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

  - the tariffs for SLU line rental, co-location and links to the street cabinets are reduced significantly (Analysys tested 50%)
  - an increase in ARPU of around €9 per user per month can be achieved for the entire period, which is considered reasonable if business customers are targeted.
- The strong local economies of scale effects that are evident in deployment at the street cabinet level mean that even if such significant cuts of 50% in KPN's tariffs were to be realised, the use of SLU would still not be economically viable as an alternative to LLU to reach the mass market, unless is assumed for example:
  - a market share of 25%, together with an increase of ARPU of €5 per month
  - a market share of 16%, together with an increase of ARPU of €10 per month
- The current offer from KPN for WBA is also unlikely to be economically viable as an alternative to continuing to use LLU to reach the mass market regardless of the market share, even with the highest estimate for ARPU increase.
- The prices which affect the viability of an alternative operator's business plan the most are those for the line rental, SDF co-location and SDF-MDF link. Furthermore, Analysys' assessment of the cost of building a competitive network to provide backhaul to street cabinets indicates that unless very substantial revenue streams can be generated from services other than SLU backhaul, then it will not be possible for a third party to provide such backhaul at prices at the same level as, or below, the current offer of KPN.

3.2 ARCEP: Case study FTTH

The case study regards the City of Clermont-Ferrand (France):
- 67 000 households
- 3 200 inhabitants / km²

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

Scenario 1

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

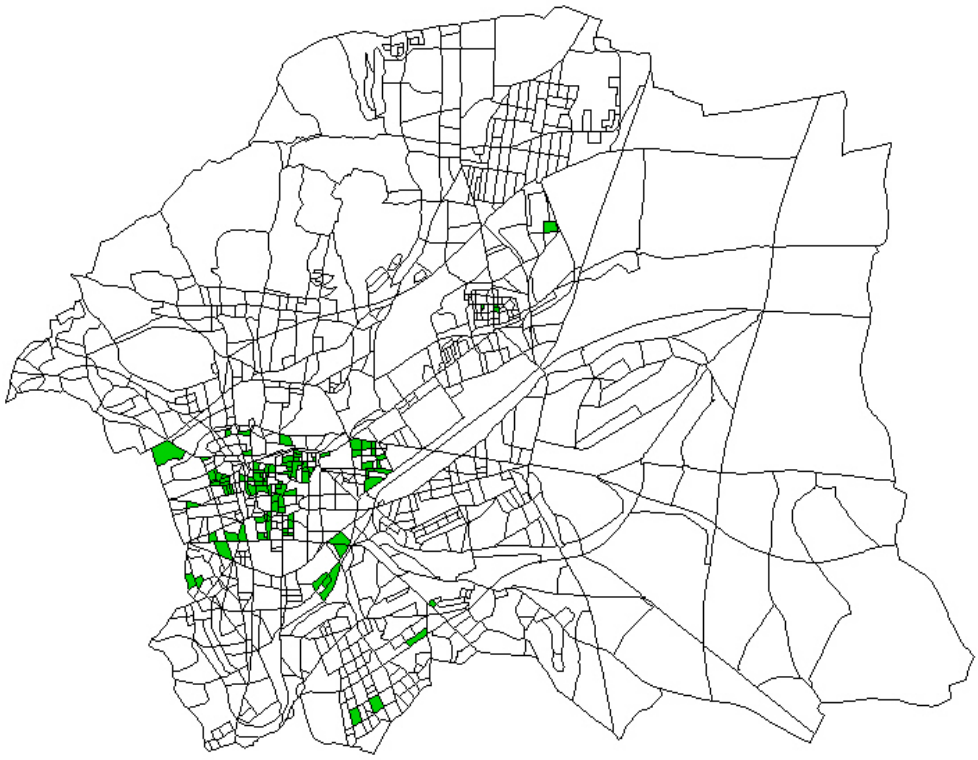

Figure 3.2-1: Clermont-Ferrand, Scenario 1 (source: AVISEM)

Scenario 2

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

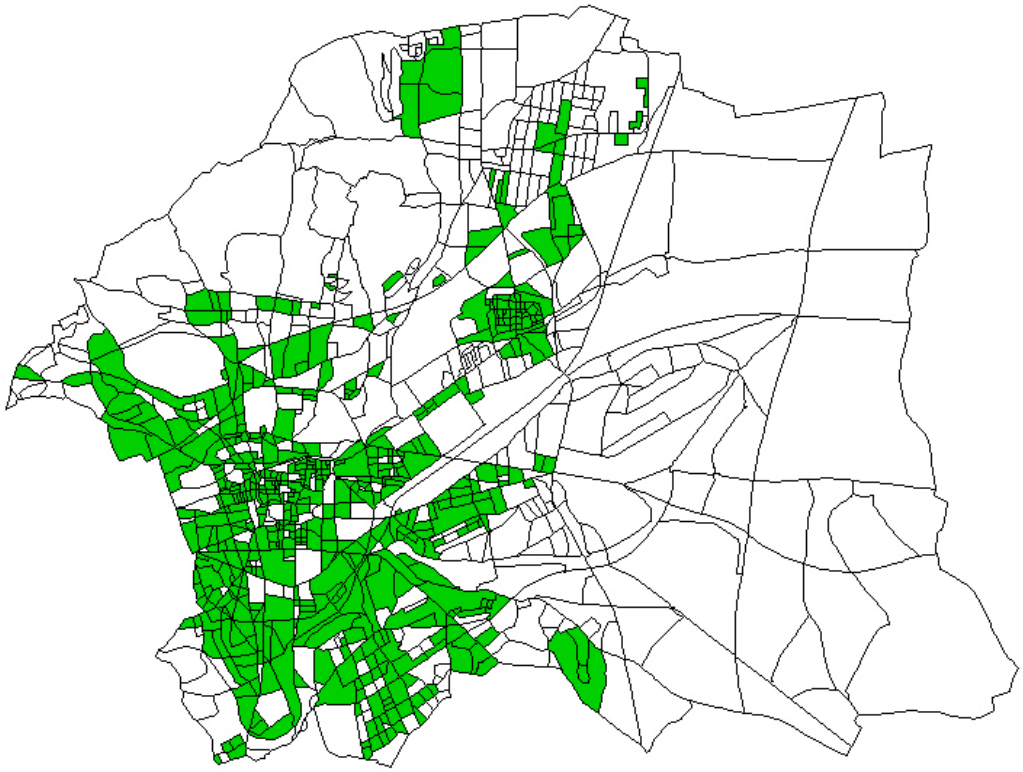

Figure 3.2-2: Clermont-Ferrand, Scenario 2 (source: AVISEM)

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

3.3 JPMorgan: "The Fibre Battle – Changing Dynamics in European wireline"

Focus of the study

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

(I) VDSL

Assumptions

The study assumes a typical average European broadband market with:

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

Results

For a market such as the Netherlands with 21 SC per CO the additional monthly costs per subscriber of VDSL compared to ADSL deployment account for € 10/month/customer (€2), assuming an unbundled operator with a 5 % market share (30 %).[29] The results differ significantly depending on the relation SC to CO. With a 10% market share the additional costs in France (10 SC per CO) amount to €2,6 compared to €12 in Germany (40 SC per CO). A German operator would have to have a market share of +40 % to achieve a similarly low additional cost as in France.

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

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

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

(II) FTTH

Assumptions

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

FTTH sensitivity scenarios

a) Density

Greenfield CAPEX costs per subscriber connected highly depend on the given density of population:[30]:

Density (Households/km²)	*CAPEX*
10000	€2000
5000	€3000
≤2000	€5000

b) Market Share

CAPEX costs per subscriber connected have a strong sensitivity with regard to changes of the wholesale market share. A 10% increase in market share (to 35%) would allow to break-even).[31]

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

c) Access to infrastructure

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

d) ARPU sensitivity

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

Results

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

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

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

3.4 OVUM: "FTTCab: an investment assessment"

Focus of the study

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

Basic network assumptions

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

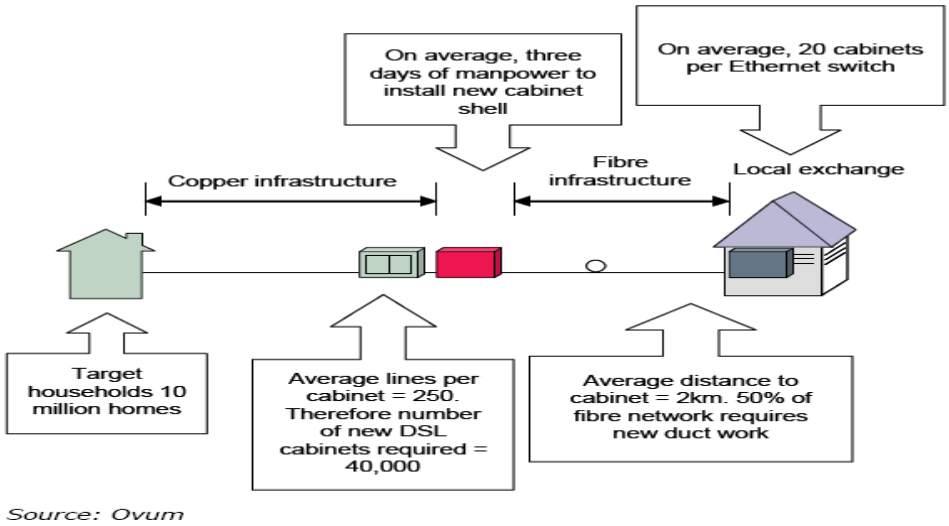

Figure 3.4-1: Generic FTTCab solution

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

Capex comparison (in $)	Unit cost	Cost per customer
DSLAM	12,000	24
DSL Port	35	35
Copper loop (per annum)	150	150
CPE	30	30
ADSL from the exchange		**239**
Local Exchange[32] - Ethernet switch	50,000[33]	7
Fibre infrastructure[34] - Fibre connection	60,000[35]	240
Cabinet[36] - Cabinet plus DSLAM	17,000[37]	68
Copper loop[38] (per annum)	170	170
CPE[39]	60	60
FTTCab[40]		**545**[41]

Results

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

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

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

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

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

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

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

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

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

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

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

bulk of these costs are associated with the fibre network[42,43] (e.g., using aerial deployments for 50% of the fibre network would reduce the total fibre investment from $2.5 billion to $1.5 billion).

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

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

Focus of the study

The study analyses the economic viability of rolling out fibre to the curb – as intended by Deutsche Telekom - applying VDSL technology in Germany. The focus is on the first phase of Deutsche Telekom's VDSL roll-out, with VDSL infrastructure deployment in 10 cities (in a second phase further 40 cities will be deployed. The study determines the break-even VDSL penetration rate just covering the average costs (per customer/month) from a given VDSL retail price. (34,99 €/month as assessed by DTAG). In a first step WIK identifies the investment and cost components necessary for implementing VDSL.[44]

Scenarios

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

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

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

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

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

Source: WIK

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

Assumptions

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

Results

The profitability of the VDSL roll out crucially depends on the demand for VDSL access. The figure below shows (for each scenario) the critical penetration rate where the average costs per month and customer are just covered from the assumed VDSL retail price (€34,99 € per customer and month).[45]

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

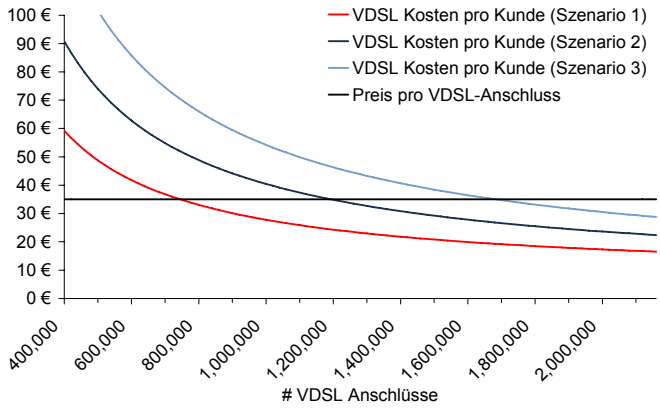

Figure 3.5-1: Average costs of VDSL roll-out

Source: WIK

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

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

Part 4: Fact Finding[46]

4.1 Time scale for NGN development

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

NRA answers:

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

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

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

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

Stakeholder answers:

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

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

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

4.2 Economic and Regulatory Aspects with regard to NGN

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

NRA answers:

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

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

Stakeholder answers:

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

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

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

ECTA mentions the following bottlenecks:

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

foreclosure strategies including bundling and discriminatory pricing (eg free on-net calls), which inhibit the development of competition and allow the incumbent to leverage its dominance as the technologies are upgraded.

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

NRA answers:

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

Stakeholder answers:

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

Foreclosure Strategy leveraging and all kind of bundling of servcices will become more and more important. Telekom Austria announced its (new) strategy to bundle all ressources available in its new holding structure in order to achieve the best possible synergies from broadband, fixed line and mobile services.[47]

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

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

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

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

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

NRA answers:

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

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

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

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

Stakeholder answers:

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

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

ECTA and EuroISPA describe the developments in some countries.

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

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

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

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

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

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

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

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

NRA answers:

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

According to Norway the new network structure is influencing some wholesale services, in particular interconnection and backhaul transmission.
No information is available on this issue from PO, ES.

Stakeholder answers:

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

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

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

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

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

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

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

NRA answers:

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

Stakeholder answers:

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

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

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