Commission for Communications Regulation

Submissions received in response to Consultation

Next Generation Access (NGA) Remedies in Wholesale Regulated Markets: Wholesale Physical Network Infrastructure Access (WPNIA) and Wholesale Broadband Access (WBA) Remedies in an NGA Environment

Non-confidential submissions received from respondents

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alternative operators in the communications market

Response Next Generation Access (NGA) Remedies in Wholesale Regulated Markets - Ref: 11/40

Submission By ALTO

Date: August 24th 2011

ALTO is pleased to respond to the Consultation on Next Generation Access – NGA, Remedies in Wholesale Regulated Markets.

ALTO welcomes the Consultation as a way of ensuring alignment of strategic priorities, price control, cost control, and transparency. It should also provide a degree of regulatory certainty, which can have the effect of encouraging investment in the communications market.

NGA deployment in Ireland is only in its infancy and there is considerable uncertainty about who will invest and where this investment will be targeted. As a result, ComReg may be premature in attempting to define markets and impose regulatory obligations in relation to NGA network infrastructure that is not yet in place.

The Consultation focuses solely on wired Next Generation Access – NGA, networks and not on equivalent mobile networks using Long Term Evolution – LTE, technologies. It appears to be the case that any proper analysis by ComReg of NGA deployment in Ireland should probably include LTE within its scope.

ComReg's regulatory policy must be framed such that it enables all NGA infrastructure investors to exact a fair return.

Competition is the best way to guarantee real consumer choice and the availability of innovative, differentiated, scalable and affordable products and services, including advanced broadband services, at the most competitive rates. In seeking to lay down the ground rules for NGA regulatory policy, ComReg should continue to promote strong competition.

Proposals by ComReg to mandate full access to eircom's duct facilities may currently be inappropriate and premature Instead, it would make much more sense that a full and proper consultation take place with industry and that duct sharing encompasses all forms of passive infrastructure and not just those within the communications sector to ensure that all such infrastructure is used to speed up and lower the cost of NGA deployment.

In assessing a future regulatory framework for wholesale NGA services, it would appear to be appropriate for ComReg to define wholesale markets for regulatory purposes that are national in scope. To the extent that ComReg might consider defining sub-national markets for such services, it should only do such as a trigger for deregulation in instances where multiple NGA networks have been deployed and ensure that any new measures do not undermine existing investments. ALTO believes that there is a strong risk that deregulation at the wrong time will create market and regulatory failures of catastrophic proportions.

eircom continue to enjoy enduring dominance, 68.0% of the DSL Retail Market and 97% of the WBA market when eircom self supply is included [ComReg Q2 2010 figures]. Through vertical integration eircom also control the supply of services to the Wholesale Physical Network Infrastructure Access – WPNIA, market (formally the market for wholesale unbundled access (including shared access) to metallic loops and sub loops – commonly known as the Local Loop Unbundling Market).

The WPNIA market equals circa 3% of the DSL Retail Market.

The supply problems to the LLU (now WPNIA) market are well documented on the ComReg Web site going back many years, and yet industry continues to experience what ALTO considers are supply restrictions in the WPNIA market limiting the ability of operators to compete. The lack of transparency of Equivalence of Input – EoI, between that which eircom supplies itself compared to that supplied to other operators remains a deep rooted problem in Ireland and we are seeking that ComReg establish a price control regime that provides the incentive for eircom to resolve the current issues. Moreover, eircom have indicated to industry that they are intending to maintain closed self supply of order handling and services for their own downstream businesses going forward for future WPNIA fibre products. This is unacceptable for the market in Ireland.

ALTO welcomes and supports the ComReg's price control proposals, which observe the need to limit eircom's ability to disrupt and potentially distort the market with price changes within those boundaries to suit eircom's commercial benefit. We consider the price change process should be regulated by ComReg so that eircom cannot alter their pricing without passing margin tests developed by ComReg and giving not less than three months prior notice to industry.

ALTO welcomes the clear and logical recognition that 'economic space' be maintained between NGA and other regulated offerings, e.g., WPNIA.

ALTO notes that the fixed market in Ireland has been subject to what can be characterised as aggressive *block and hold* behaviours by the incumbent over the past two to three years (some may suggest longer).

ALTO members have invested heavily in their own networks in Ireland, however this investment has not generated the returns that one would associate with a competitive market. We call on ComReg to strive to set relevant, measurable and attainable benchmarks that will make real differences and genuinely benefit consumers, competition and innovation in the Irish market.

It is ALTO's view that competition in Ireland has been severely hampered by the elements mentioned above, in addition to an incumbent operator whose owners have failed to make the appropriate investment to the benefit of their (wholesale) customers and ultimately to end users.

ALTO suggests that some form of funding or gap / digital dividend funding may be the most appropriate solution to the issues faced in Ireland at this time.

Response to Consultation Questions:

Facilitating competition and encouraging efficient investment

Q. 1. Do you consider that the risks identified above are those most closely relevant to investment in NGA? What might be the degree of impact of such risks, how might they change over time and how might they be quantified? Please explain your reasoning.

A. 1. Is addressed below under two distinct headings:

Investment in Key Urban Locations

Investment by certain new entrant operators in focussed NGA rollouts and the support of a vibrant triple play services including television, has created a new competitive dynamic in the most lucrative consumer customer locations in Ireland. We believe the clearest NGA risk to eircom is already being demonstrated in the market by natural loss and attrition of its customer base and revenue in certain locations. Our view is this will force eircom to commercially and incorrectly invest (the further €100 million recently announced) in NGA solutions in the same locations as new entrants, to the detriment of other locations. This in turn will force eircom's focus to protecting its own retail business and is a huge competitive risk to other providers using eircom's wholesale platform(s).

In terms of the risks identified, new entrant operators appear to be demonstrating NGA works in Ireland. The key issue for eircom is how to catch up and how do they build a package to compete with triple play including television. ALTO's key concern is how to ensure the key urban areas do not turn into battlegrounds or perceived duopoly environments to the detriment of the remainder of the national network, consumers and the national information society.

Other locations

Other than for niche solutions, the viability of a pure commercial return from NGA investment (without other strategic objectives) for the rest of Ireland is looking bleak. However in many areas the GAP to achieve commercial viability is small and various options could be considered to close this GAP, perhaps by some form of funding model initiative. This may result in changing the focus from specific areas to national coverage, where the Digital Dividend is reduced and logically so.

Remedies for Next Generation Wholesale Physical Network Infrastructure Access

Q. 2. Do you consider that, in the context of the terminology set out in the NGA Recommendation, the above Figures 3 and 4 provide an accurate representation of Eircom's proposed network architecture? Please explain your reasoning.

A. 2. We agree much of what ComReg has proposed. A number of issues are causing concern for the growth of the WPNIA market. Below are some comments:

1. The Unbundled FTTH – Fibre to the Home, high-level architecture described by ComReg is correct as we understand it from eircom.
2. The FTTC – Fibre to the Cabinet, high-level architecture needs to be amended to include the Next Generation Network Node as the service is not available from eircom without this. We appreciate that it may be argued the NGN node forms the Optical Line Terminal – OLT, which is correct for Ireland, but the node has many other features such as Quality of Service – QOS, features that come with the Node and effectively start to limit the openness of the service. ComReg need to ensure the unnecessary bundling of products is avoided.

3. We consider ComReg should include the Fully Unbundled Access – FUA, solution which is now included in the trial which has a different topology, i.e., eircom bring all the traffic from all operators from either the FTTC or the FTTH over the same ‘shared’ infrastructure and traffic is broken out at the local/first NGN node, i.e., sharing backhaul economies of scale with all providers.
4. Head Ends – With the Advent of eircom’s Advanced Digital Terminal – ADT, extension to the NGN and the limited access to eircom ADT sites we consider eircom should now additionally offer NGA local access at ‘Head Ends’ where local access is not possible and the various local areas are brought together.

Q. 3. Do any of Eircom’s proposed pilot wholesale products align to the potential access remedies set out in NGA Recommendation? Please explain your reasoning? This question should be addressed in light of the following discussion on WPNIA NGA and WBA NGA.

A. 3. In ALTO’s view eircom’s current trial in effect offers none of the access remedies set out in the NGA recommendation for the following reasons:

1. It does not offer Access to civil engineering infrastructure;
2. Although eircom provide technical information and say they will provide access to fibre and VDSL, its approach to backhaul pricing is exclusionary and there is no commercial incentive to invest other than to purchase eircom's end-to-end bitstream service; and
3. Eircom offer two fibre pairs however it’s not clear if the second is available for a second operator.

Q. 4. Are there any circumstances in which regulated access to civil engineering infrastructure would not be required? Please explain your reasoning.

A. 4. No. For other operators to viably compete in deploying their own NGA access solutions in Ireland (other than mobile), a viable civil engineering infrastructure (such as Duct) Offer will be required. The detail of the offer should be discussed between the interested parties when a better view of the requirements is known.

Q. 5. Having regard to market demand, technical, economic and other considerations, is there a requirement for a duct access remedy? Please explain your reasoning.

A. 5. There is a requirement for major infrastructure build in the access network to achieve NGA in Ireland, which will involve the use of new or existing ducts to provide connectivity. It would be inappropriate to block regulatory remedies that could assist such a requirement hence there is a need to have a duct access remedy in Ireland.

Q. 6. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to civil engineering infrastructure?

A. 6. While of the foregoing all are important, we consider clause (d) – *"the need to safeguard competition in the long term with particular attention to economically efficient infrastructure-based competition"* as a key requirement for Ireland. We are deeply concerned eircom have the ability and incentive to minimise infrastructure competition and we consider the recent example of the 'surprisingly low' pilot backhaul price supports this.

Q. 7. Should ComReg encourage Eircom to build additional duct capacity for use by third parties and, if so, how? Please explain your reasoning.

A. 7. We are not offering a view on this matter other than a viable Duct Offer should be made. Any other proposals should be subject to full consultation with industry and interested parties.

Q. 8. If a remedy requiring the provision of access to civil engineering infrastructure were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Would a risk premium be warranted? Please provide a reasoned response for each of the principles.

A. 8. Access to civil engineering and ducts is highly problematic with significant risks of unexpected costs and delay in Ireland, hence tight and strong regulatory remedies are essential for such to succeed. ALTO has been frustrated at the looseness of the definition of 'equivalence' in Ireland which over the years has damaged trust in the industry; the new EC more stringent approach to equivalence, where equivalence means 'strict equivalence' is welcome and long overdue. Our view is the greater risk to eircom is not implementing NGA at all. The NGA price is already in the market and it's now too late to be considering risk premiums. Of critical importance to the market is correctly valuing the products and not neglecting or throttling the existing markets.

Q. 9. What form of price control would be the most appropriate and proportionate means of establishing the price of access to civil engineering infrastructure? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

A. 9. eircom does not currently provide retail duct access and such is not a retail product by nature hence the retail minus approach to a price control is inappropriate as there is no retail price to act as a reference. The cost orientated approach is aligned with the European Commission NGA recommendation and should be built into the Duct offer addressed in our answers to answers: 4, 5, 6, 7 and 8, above.

Infrastructure costs are a component of NGA and whilst forming an input to the

NGA service price do not prohibit flexibility in pricing for the complete service.

Q. 10. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the terminating segment? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

A. 10. ALTO considers that there is a need for a strong regulatory remedy mandating access to the terminating segment. Our past experience is that eircom will refuse to supply or cause other service difficulties if there is no regulatory remedy. For example it took several years for eircom to be forced to provide and support Local Loop Unbundling – LLU, migrations as they argued it was not a regulatory obligation, and we are familiar with eircom's 'No' responses to industry Statements of Requirements – SORs, where eircom suggest that they don't have an obligation to provide.

Recently eircom refused LLU operators the ability to provide backhaul facilities to other LLU backhaul providers to assist competition and service resilience. We are aware of the eircom NGA pilot, but eircom themselves say it's a pilot and the final service may change.

ComReg ask how such remedies might this be achieved in light of eircom's proposed or alternative architecture. The fact that eircom has chosen a particular form of solution, which we now have serious concerns with, does not prevent the regulator putting in place regulatory remedies. Indeed it does not prevent ComReg mandating a Duct Access remedy.

At this time deployment model or models for NGA in Ireland are unclear, as key investment decisions have not yet been established, however a number of possibilities exist as below:

- New entrant operators will continue to roll out infrastructure
- eircom commercially deploy NGA where viable (mainly to compete with the

above new entrants and stem their losses)

- Approved State Aid (we suggest that a form of GAP funding) may be required to stimulate investment to deploy services in areas where commercial viability does not exist but where modest state funding could make a significant difference.

Q. 11. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the terminating segment?

A. 11. Per our response to question 6 and item (d) in the list, i.e., safeguarding infrastructure competition, is critical. Sustainable infrastructure competition is essential to stimulating inward investment and jobs in Ireland whilst significantly benefiting the consumer in choice and lower prices.

With reference to our response to question 10 we would expect any State funding to be supported by strict ComReg regulatory remedies to ensure such investment stimulates competition rather than restricts it.

Q. 12. Where is an appropriate distribution point to which access to the terminating segment should be provided, particularly given the need to ensure that it host a sufficient number of end-user connections to be commercially viable for an access seeker.

A. 12. The definition of the terminating segments within the NGA recommendation implies that the terminating segment exists to the first distribution point. In the copper world the street cabinet is the true first distribution point. In the fibre solution proposed by eircom the cabinet will also be the first distribution point for residential services. We therefore consider the cabinet to be the first distribution point.

The eircom pilot has two categories of cabinet solutions at this time as below.

1. Eircom offer space in their cabinet to locate either optical splitters of another operator, or space to provide a DSL solution. In this scenario eircom or the other operator can provide the backhaul fibre.
2. LLU Sub-loop unbundling (although no process yet exists to provide) has a potential application in NGA for very high-speed copper access; up to 80Mbit/s through technologies such as VDSL.

Rolling network to the cabinets for non-incumbent providers is difficult given the low market size of each cabinet and the costs and difficulty of providing electrical power and fibre backhaul. For most locations it is more viable to pick up the access at the local exchange or a head end as described in our response to question 2.

We also note recent eircom announcements that the majority of eircom's NGN platform will be what they term APT nodes. We have been told these APT nodes are not capable of direct interconnect with other operators, hence for many locations it will not be possible for operators to connect at the local eircom NGN nodes as had been envisaged in discussions to date. Therefore the scenario is emerging where interconnect with the services at an area or regional point will also be required where local access is not available.

Q. 13. Should ComReg seek to encourage Eircom to deploy multiple-fibre lines in terminating segments and, if so, how? Please explain your reasoning.

A.13. ALTO believes that ComReg should encourage this planned deployment. The real cost of adding a second or third fibre pair at installation is very small compared to the costs of a second and third new installation. It is not too late to mandate such a solution or process to give other parties access to such additional fibres as eircom is still only at a limited pilot stage of development.

In relation to how this should be done, ComReg could easily mandate eircom to publish where it is planning to deploy and to seek bids/offers for the 2nd and 3rd fibres.

Q. 14. If a remedy requiring the provision of access to the terminating segment were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Please provide a reasoned response for each of the principles?

A. 14. The measures set out in Annex II of the NGA Recommendation are welcome particularly the requirement for strict equivalence. The reason is that industry has requested sub-loop unbundling to be developed and a key aspect is fibre backhaul. We have requested such from eircom; however in cases where that is not straightforward we may require a viable duct supply Offer from eircom.

Implementation

We agree with the NGA recommendation that eircom should make a Civil Engineering Reference Offer and the recommendation sets out a minimum list.

Enforcement

ComReg is well able to oversee the development of strict processes however it will require strict enforcement to ensure it works correctly.

Supervision

In line with Implementation and Enforcement, ALTO looks on with interest at the work of the EAB – Equivalence of Access Board, in the UK. The board independently polices the various aspects of agreed activity centred around and focussing upon equivalence. Stakeholders include members of Ofcom's Wholesale compliance teams, BT and other independent parties.

Q. 15. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the terminating segment? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

A. 15. ALTO considers that a number of aspects need to be considered in setting the price control.

Retail minus price control allows a margin squeeze against existing exchange based LLU services and is not consistent with existing cost-orientated prices for LLU services. ALTO considers a modest NGA premium is warranted against existing services such as LLU as the Sub-loop components and prices are included in the NGA solution.

ALTO understands the pressure eircom Retail faces competing with new entrant operators and eircom simply have to reduce their cost base at all levels including LLU to improve its ability to compete, otherwise trying to manipulate prices as different levels in the price stack will quickly lead to margin/price squeezes against wholesale providers.

ALTO suggests that eircom select an ‘anchor’ price such as LLU and the pricing strategy is built up from that. This should enable existing competition to be maintained whilst factoring in an NGA premium and avoiding margin/price squeeze issues. If the anchor price is too high then eircom will have to reduce internal costs to get to it.

In terms of regulation, ALTO considers cost orientated prices at the component levels will be required (in line with the NGA requirement) to set the floor price and retail minus will be required to set the ceiling. Margin/Price squeeze tests will be required to prevent a squeezing out of LLU and wholesale services.

Q. 16. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled fibre loop? How might this be achieved in light of Eircom’s proposed or alternative network architectures? Please explain your reasoning.

A.16. There is demand for access to the unbundled fibre loop in Ireland, and regulatory remedies mandating such are essential for the development of Next

Generation Access. In the event the Government were to tender for deployment of NGA in non-economic areas it is plausible that other operators may offer competing bids. In this situation, regulation will need to mandate that eircom provide to those parties requiring access to its network the same facilities eircom would otherwise have provided to themselves.

Regulation has a critical role in bringing NGA to Ireland and access to the unbundled fibre loop and the ancillary services to enable the existence of the fibre loop are required.

Q. 17. Are obligations to provide access to associated facilities necessary and, if so, what should these encompass? Please explain your reasoning.

A.17. As per question 16, it is essential that regulation provides obligations to make available the ancillary services to support other operators providing NGA in the same way, i.e., in strict equivalence' as eircom would provide to itself.

Q. 18. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities?

A. 18. Addressing the various points raised in 12(2) as below. ALTO has reproduced the points for context:

> (*a) the technical and economic viability of using or installing competing facilities, in the light of the rate of market development, taking into account the nature and type of interconnection and/or access involved, including the viability of other upstream access products such as access to ducts;*
>
> **Response** - The technologies for NGA are now fairly well known and demonstrated to work, hence technical viability has been proven. Certain

new entrants have proven economic viability in Ireland so economic viability is feasible and now becoming proven.

(b) the feasibility of providing the access proposed, in relation to the capacity available;

Response - To date the decision to provide has been a commercial one so it can be done. With equivalence and high quality regulation other parties should be able to obtain a viable return in certain locations.

(c) the initial investment by the facility owner, taking account of any public investment made and the risks involved in making the investment;

Response - The solutions for other operators has been designed in from the start and the access provider will recover substantial revenue from other operators using is network.

(d) the need to safeguard competition in the long term, with particular attention to economically efficient infrastructure-based competition;

Response - Please see our response to question 6.

(e) where appropriate, any relevant intellectual property rights;

Response - This is has not been an issue in Ireland to date and is not expected.

(f) the provision of pan-European services

Response - European aspirations / targets are now for very high speed broadband and these actions support such.

Q. 19. What do you consider to be an appropriate point in Eircom's network for the provision of unbundled access to the fibre loop in a FTTH scenario? Please explain your reasoning, including views on associated technical and commercial considerations.

A.19. ALTO considers regulation should provide the ability for another operator to deploy NGA using eircom's existing physical infrastructure such as the Ducts (Civil Engineering Offer), and where eircom have already provided the ‘terminating segment’ from the customer to the cabinet then access at the cabinet should be made available to all on the same terms and conditions. In addition eircom should provide access to the fibre backhaul service as well as access at the local exchange.

Q. 20. If it is not possible for commercial or technical reasons to provide for unbundled access at this time, what factors might change this over time? What measures should ComReg take on a transitional basis to provide for the nearest equivalent alternative constituting a substitute to physical unbundling and what other safeguards might be necessary?

A. 20. eircom has already offered a pilot hence technical solutions are possible in Ireland. However, the backhaul pricing for the NGA pilot is proving exclusionary, as we believe removing the margin to encourage interconnect at the local level with eircom’s solutions. Pricing is thus absolutely critical for NGA competition and ALTO is in no doubt regulatory intervention is required to safeguard the industry. ALTO is not seeking for eircom to price NGA out of the market, however, there should be a possibility to connect locally and regionally and benefit from our own network investment. This does not appear possible for the pilot at present.

We have requested eircom to bring their sub-loop unbundling offer to a state where it can be purchased and sub-loop deployed by other parties.

Q. 21. Is a remedy requiring the development and publication of a reference offer for the provision of access to the unbundled fibre loop and associated facilities necessary and what specific issues should be detailed within it? Please explain your reasoning.

A. 20. eircom have already sought to offer a type of reference offer for their pilot hence they appear to support this concept and we would agree a reference offer should be mandated. However, what is not clear to ALTO is what eircom are offering to themselves and the conditions of such an offer. At the commencement of the pilot discussions industry made it clear that all, including eircom should use the same order and provision gateways. ALTO notes eircom eventually agreed on the provision side but some 7 months later have still not agreed the same for service assurance. ALTO considers any reference offer should apply to all including eircom itself and until such is done there will be no trust or confidence that eircom are acting fairly. eircom simply don't seem to understand this fairly basic point they must be seen to be treating all parties the same, including themselves to be a credible wholesaler. We consider a full Reference Offer is required and eircom downstream services should also be subject to the same offer.

Q. 22. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

A. 22. The reference offer should be drafted by eircom and then negotiated and agreed with industry. The offer should apply to all users of NGA including eircom's own downstream business (including wholesale businesses). The Reference Offer should be established with the other reference offers on the eircom wholesale website and a separate tab added to provide details etc of the service. i.e. The same process as the Access reference Offer – ARO, with the exception that if the doc is not agreed it is referenced to ComReg for decision, unlike the new ARO-2 which was published by eircom even though it was in a state of disagreement with the industry at the ComReg led formal industry group. The reference offer should include SLAs, service credits and Key Performance Indicators – KPIs.

Q. 23. What specific non-discrimination remedies are required with respect to the provision of access to the unbundled fibre loop and associated facilities? Please explain your reasoning.

A.23. The full set of non-discrimination remedies as per the WPNIA decision are required as this is also an access service and eircom have both the opportunity and incentive to discriminate in favour of their own downstream services.

Although ALTO welcomed the ComReg decision around eircom publishing details of their self supply offer, the quality and detail of what eircom produced was disrespectful to the regulator and the industry. To all intents and purposes ALTO considers it was meaningless. ALTO considers that this area needs to be urgently addressed to force eircom to act in a non-discriminatory way, and additionally to meet the ‘strict equivalence’ objectives of the European Commission in its NGA recommendations.

Q. 24. What form of price control would be the most appropriate and proportionate means of establishing the price of unbundled access to the fibre loop? e.g., cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

A.24. The Civil Engineering aspects such as the supply of duct should be cost orientated. We acknowledge eircom need to have some freedom as to the retail price they set, however eircom have the opportunity and the incentive to margin squeeze the wholesale price. Such a squeeze will limit infrastructure competition hence we consider a combination of a retail minus price control and or a margin squeeze control is required to protect the wholesale price. This is critical to support infrastructure competition.

Q. 25. Should any cost oriented price for FTTH based services attract a risk premium in principle? If so, to what types of network assets/investments should any premium apply and why?

A.25 The European Commission in its NGA recommendation advocates a cost orientated price for some aspects of NGA and it is recognised that such could be recovered over a period of time. As we have responded in question 8 eircom have no choice but to invest to protect their market share hence its now too late for a risk premium in Ireland as the pricing differential to protect against new entrants is unlikely to support such.

Q. 26. What types of co-investment arrangements might warrant a separate regulatory treatment in terms of remedies. Please address in your answer the types of commercial relationships and the type of control over physical infrastructure by multiple operators that you think would be necessary for ComReg to consider this option. If possible, please state if you think such an outcome is feasible or desirable.

A. 26. Eircom have now announced a further 80million investment to their 20million NGA pilot investment, however as yet no NGA services are available from eircom. As discussed earlier we are expecting this investment to largely be in the same geographical areas as other new entrants. The historic difficult relationship of industry with eircom appears to make a co-investment with eircom problematic. Consortia relationships are possible however no party appears to have made any public statements at this time and the regulation is still unstable in this area.

The alternative is Government funding which is understandably difficult given the current economic climate, however given the important of electronic communication to the economy some form of state assistance may be justified.

To minimise the cost of any such state investment a GAP funding model (i.e. providing the difference between what companies would commercially invest and the uneconomic value) would appear a plausible way forward which would stimulate commercial investment at very good value to the State. If such an approach were adopted, and projects tendered ALTO believes investment consortia would emerge.

Removing the dependence on eircom would enable parallel deployment and increased competition thus bringing forward services more quickly and stimulating competition.

In this scenario ALTO would anticipate such providers offering ‘regulated’ wholesale services and ComReg would be requested to oversee this as well as overseeing that eircom open its ‘terminating’ segments and ancillary services in the same way it would for itself.

Q. 27. Do you have any views as to how ComReg should view the evolution of the market for NGA services particularly in the presence of a rival cable network and its impact in supporting effective competition in downstream markets? How should remedies and regulation generally evolve over time and what criteria should ComReg apply to such decisions?

A. 27. There is now a small risk that competition issues may emerge between eircom and new entrants in key urban locations and regulation may be required to prevent this having a detrimental impact on the market. Establishing regulation to let other operators have access to eircom NGA at regulated prices is vital to sustaining competition in the downstream markets and should mitigate against a duopoly.

Q. 28. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in a FTTN scenario? How might this be achieved in light of Eircom’s proposed or alternative network architectures? Please explain your reasoning.

A. 28. The eircom pilot offers the fibre from the premises to the cabinet (i.e. the terminating segment) and for the OAO to provide filters in the cabinet or node. There is a requirement for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in a FTTN scenario so that other providers can maximise use of the fibre loop without having to use the eircom bitstream service.

Q. 29. What type of backhaul solutions do you consider are appropriate in an FTTN scenario?

A. 29. eircom are providing fibre for their own backhaul and it would be equivalent for them to provide the same fibre access for other providers without the eircom bitstream network. Indeed the FTTH provides this type of solution. We consider this is thus reasonable and proportionate.

Q. 30. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities.

A.30 Please see our response to question 18.

Q. 31. Is a remedy requiring the development and publication of a reference offer for the provision of access to the copper-sub loop necessary and what specific areas should be detailed within it? Please explain your reasoning.

A.31 – Please see our answer to question 21.

Q. 32. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

A.32 – Please see our answer to question 22. We need such to provide us the contractual terms and to ensure we are all receiving the same offer for fair competition.

Q. 33. What specific non-discrimination remedies are required with respect to the provision of access to the copper sub-loop, including those associated with co-location? Please explain your reasoning.

A.33. As we have proposed in the past non-discrimination linked with effective transparent regulation is key. It is only through transparency that non-discrimination regulation appears to work properly. ALTO therefore requests a tightening of the WPNIA regulatory remedy in ComReg Decision D05/10 to make eircom properly describe, in the same level of detail, services offered to OAOs and self provide. Only when this is complete and demonstrated will ALTO start to gain confidence that fair equivalence exists in eircom. In our view the current approach of eircom in describing what they offer themselves is disrespectful to ComReg and the industry.

LLU has an existence independent of NGA hence we want all the existing regulatory remedies to be maintained for the foreseeable future.

We are aware that eircom have chosen a path where NGA is obtrusive to the existing portfolio of services, for example it's not possible to supply WLR on line where VDSL is deployed. We consider the deployment of NGA solutions should not be destructive to existing services unless agreed by the industry.

Q. 34. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the copper sub-loop? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing commercial negotiation. Please explain your reasoning.

A. 34. We consider the same principles as described in our response to question 24 apply.

Q. 35. Should fibre or Ethernet backhaul associated with the provision of access to the copper sub-loop attract a risk premium? How might a risk profile associated with specific costs relating to such access to be determined in light of the principles set out in Annex I of the NGA Recommendation, and how should any difference in risk be reflected in a pricing methodology? Please explain your reasoning.

A.35. Assuming the question is only addressing the backhaul from the cab to the nearest (first) NGN aggregator node.

Please see our response to question 8.

Remedies for Next Generation Wholesale Broadband Access

Q. 36. What circumstances (i.e. degree of availability of effective access to the unbundled loop), would warrant the lifting or variation of WBA access obligations within a given geographic area? Please explain your reasoning.

A.36 ALTO have previously provided its view that a critical mass of customers on the LLU platform would be required prior to the consideration of a relaxing some of the WBA obligations on eircom. ALTO considers we are still a long way from reaching such a point and continued to be frustrated by eircom such as refusing two of our recent product requests to improve the LLU product. ALTO considers eircom were engaged in a ‘battleships’ approach to a key service request with obtuse answers to our request for a certain LLU facility. It feels that we have to ask exactly the right question using very precise terminology to get the correct answer, otherwise the answer is no. We don’t consider this to be negotiation in good faith and is not good enough from a wholesale supplier.

Concerning the potential for de-regulating geographic areas, ALTO believes eircom will either deliberately or inadvertently spend time chasing new entrants NGA offerings in preference its own bitstream and retail services and foreclose LLU in that area. To avoid such activity, the base price of LLU would need to fall considerably to enable the LLU operator to sustain a margin to sustain commercial activity.

At this time we need critical mass of LLU customers before the lifting of the WBA access obligations. We are a long way from that critical mass. Additionally, significant LLU rental reductions would be needed to avoid a margin/price squeeze.

Q. 37. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to WBA products and associated facilities (including backhaul) in a FTTH and FTTC scenario? Please explain your reasoning.

A. 37. Yes. The perception of industry over the years is eircom has preferred its downstream business to its wholesale business and this has been acknowledged by the eircom CEO[1].

"In the past, we tended to be inward looking, closed and retail oriented. But into the future we're going to need to be forward looking. This will mean more open partnerships and recognising that the provision of wholesale services will be a more important part of the strategy than it has been,"

ALTO is not convinced of eircom's desire to offer regulated wholesale components and absent regulation it cannot be predicted what eircom will do. ALTO's assumption is that regulated wholesale components will disappear in favour of end-to-end solutions, removing infrastructure competition in Ireland.

ALTO already notes that the backhaul pricing of the FTTX trial solutions is so low as to undermine the viability of other operators investing at the FTTX cabinets. In ALTO's view even though the FTTX trial is being portrayed as open, we don't see it as commercially viable hence it's not open.

Q. 38. In a FTTH or FTTC environment, what technical or enhanced service characteristics might need to be reflected in WBA access products? Please explain your reasoning including views on the extent, if any, to which product differentiation is a necessary characteristic of WBA access products.

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[1] http://www.siliconrepublic.com/comms/item/15230-eircom-to-embark-on-major-r

A. 38. We believe the following should be supported:

1. Ability to carry voice meeting any regulatory obligations for making 112/999 calls and location info;
2. Ability to carry QOS enabled traffic;
3. Ability to carry multi-casting – from local and national handover;
4. Improved service assurance. The greater the dependence a customer has, the more important service assurance becomes.

Q. 39. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to WBA products and associated facilities?

A. 39 Please see response to question 18 above.

Q. 40. How should the issue of technical protocols and interfaces serving the interconnection of optical networks be approached? Please explain your reasoning.

A. 40. eircom should be open from the outset and provide documents of the technical specifications and anticipated performance. The service should be as transparent as possible and include ways to manage and monitor the NTU for performance and faults.

We need this information to interoperate with eircom's network, use the eircom service, manage performance to our customers and compete with eircom in a fair and timely way.

Q. 41. Do you think that a requirement for the SMP operator to notify purchasers of WBA 6 months in advance of its launch of a retail products based on NGA inputs is necessary or adequate and, if so, how might it operate in practice? Please explain your reasoning.

A. 41. The underlying rules for notification stem from Competition Law and eircom should be providing sufficient information to enable other parties to be in a position to compete at the same time as their downstream businesses. In many cases six months will be adequate, however where automated system development is required, such as for order handling, the time required is almost always going to be longer.

Accurate and measured guidance relating to eircom's development timescales is that it takes eircom at least 12 months for eircom to meet industry requests for new products, hence in terms of equivalence it must be taking eircom a similar duration to meet in house product requests, otherwise discrimination is likely to be occurring.

In this respect it is clear the notification should be linked to the time it takes eircom to develop products for industry, i.e., at least 12 months.

Q. 42. What effective access, transparency or other safeguards are necessary to guarantee non-discrimination and how might such safeguards impact the need for of level of advance notification discussed above? Please explain your reasoning.

A. 42. It is ALTO's experience of the Irish market that non-discrimination is extremely difficult to detect without robust transparency obligations, scrutiny and regulation. Publication of reference offers and prices are a key element provided they are offered to all parties including the incumbents own downstream operations. ALTO also supports the publication of comparison performance information as provided in the recent Decision 11/45 of ComReg. Advance notification of prices, products and facilities is essential to enable other operators to use the incumbent's wholesale components to compete fairly at the retail layer.

Q. 43. What specific non-discrimination remedies are required with respect to the provision of wholesale broadband access? Please explain your reasoning.

A. 43. ALTO believes the current non-discrimination remedies in Ireland have been proven to be ineffective due to the difficulties faced by other operators in detecting non-discrimination, and once detected the incumbents legal arguments see the regulation further undermined by equivalence definition problems.

Given the problem above, the NGA recommendation, which advocates 'strict equivalence' as an approach, should be adopted in Ireland and a much tighter line taken in the remedies. Given the specific issues experienced by operators in Ireland, there is an argument that eircom should be functionally separated as the problems have become systemic over the years and ALTO considers there is little if any trust that eircom will act fairly. ALTO suggests functionally separating eircom and applying 'strict equivalence' rather than equivalent conditions.

Q. 44. Is a remedy requiring the publication of reference offers for specific NG WBA products necessary and if so, what should be contained within such a reference offer? Please provide reasons for your answer.

A. 44. ALTO believes a remedy requiring publications of reference offers for specific NG WBA products is necessary, and such should contain all the requirements of the existing Reference Offers including SLAs and KPIs the publication, to assist the industry and inform ComReg as to standards and performance information.

Q. 45. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

A. 45. ALTO believes that by eircom simply publishing a reference offer is not good enough, as it sets conditions that suit eircom retail and not its other customers. Recent experience of the ARO 2 reference offer for WPNIA LLU has highlighted serious flaws in the process for introducing reference offers. The process should encompass a stage where the content is agreed between eircom and the operators. Where agreement cannot be achieved, the regulator should determine the case, we make reference to the ARO 2 disagreement to exemplify our point. In the case of the ARO 2 the industry body formally disagreed with certain conditions. eircom published the ARO 2 anyway, and we are now in a situation with an ARO 2 that cannot be signed by operators. This is a ridiculous situation and ComReg should manage this more effectively.

Q. 46. What form of price control would be the most appropriate and proportionate means of establishing the price of WBA access? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

A. 46. Our view is that the most appropriate price control for NGA WBA at this time would be Retail Minus. Providers including new entrants will need some retail flexibility. However, that said, some aspects of NGA encompass regulated cost plus inputs (NGA Recommendation for Duct, etc.) and it is thus important to maintain economic space between the two types of price control. It would thus appear appropriate that some form of price/margin squeeze test will be required.

Q. 47. If an effective internal separation of Eircom were to be implemented how should this impact on ComReg's regulatory approach?

A. 47. ALTO does not believe eircom is capable of effective internal separation. We have heard fine words from eircom on numerous occasions in the past without any perceivable change in behaviour. There is nothing to suggest that this is about to change. In dealing with eircom wholesale ALTO actually considers some aspects, such as its Chinese walls between wholesale-regulated components and downstream wholesale solutions is getting worse rather than better at this time.

The New European Regulatory Framework now contains a regulatory remedy called Functional Separation. ComReg should consider whether this remedy is appropriate given the specifics of the market in Ireland should market forces and competition not to operate as they should.

Price controls for NGA Wholesale Products

Q. 48. Do you believe that the costing methodology options for determining NGA charges as outlined above are relevant and appropriate? Please provide NGA reasons for your response. Which is the most appropriate methodology and why?

A.48 We believe that the costing methodology options for determining NGA charges as outlined above are relevant and appropriate as they are based on standard regulatory methodologies and allow eircom sufficient freedom while also protecting infrastructure competition.

Q. 49. Should ComReg distinguish between new investment (such as NGA specific equipment) and legacy assets (such as trench), which are used in the provision of NGA services? Please explain your reasoning.

A. 49. ALTO expects that a considerable part of the existing infrastructure should be available for eircom to deploy NGA and cost savings should be taken, however it is important that equivalent services offered to others should be offered the same benefits.

Q. 50. What pricing issues might arise where the SMP operator is providing services over both copper and NGA networks concurrently? For example, duplicating infrastructure in the same geographic area for a temporary period or in different geographic areas. Please explain your reasoning.

A. 50. Firstly it is difficult to envisage changes to the existing service prices given the inconvenience and destabilisation such will cause to established customers. We acknowledge the new service cannot be priced at such a high level to prevent take up. The bitstream investment model offers one solution where forecast volumes are initially used to enable recovery over a reasonable number of years. Provided the service offers a significant additional benefit, which is expected, it should be possible to supply at a modest premium to the existing services and keep both running for a temporary period of years rather than months.

Q. 51. Do you agree with the application of a risk premium as envisaged in the NGA Recommendation? As part of your response please address, insofar as possible, your views on the nature of any such premium, whether and how it could be measured and what its relationship to Eircom's existing (or a potential split) WACC should be.

A. 51. ALTO considers a modest premium should be applied for a number reasons.

1. To reflect the additional costs;
2. To prevent the neglect of existing services;
3. To maintain the ability to re-invest and rollout further.

Q. 52. Do you agree with the NGA Recommendation that any risk premium should only be applied to NGA/fibre specific assets and not to legacy copper based assets (for example, FTTH versus FTTN)?

A. 52. ALTO agrees with this logic. We do not see why existing customers, not using the services, should pay a premium for others taking those services up.

Q. 53. Do you believe that the WACC ComReg Decision from 2008 remains appropriate and applicable for NGA investment and allows for sufficient return on investments made and to be made in the future? Please provide reasons for your response.

A. 53. ALTO considers the Weighted Average Cost of Capital – WACC, ComReg Decision from 2008 remains appropriate and applicable for NGA investment and at

10.21% in the current depressed environment in Ireland offers eircom a healthy return on investments. ALTO considers eircom are making a healthy retail return and the WACC is generous to eircom in the current environment.

Q. 54. Do you have any other observations or proposals in relation to NGA investment risk and whether there are mechanisms other that the WACC to account for risk in NGA wholesale pricing?

A. 54. The situation in Ireland has changed over recent times and its now looking that eircom's biggest risk is not investing and losing market share. eircom can mitigate their risk through choice of deployment location and also technology deployed. ALTO expects eircom's retail pricing will be influenced by new entrant pricing and given equivalence etc we would expect eircom's NGA wholesale pricing to be at a level to allow other providers the compete with both eircom retail and other new entrants.

Q. 55. Do you agree that the factors above identified are the most relevant mitigators of risk? Should such factors be taken into account when determining whole pricing arrangements and, if so how? Are any safeguards necessary?

A. 55. In other jurisdictions the State has intervened with limited (but required) GAP funding to bridge the gap between the uneconomic cost of investment and the point where investment is commercially viable. This approach minimises the cost to the State whilst at the same time stimulating the private sector (including the incumbent) to invest. If this approach were to occur in Ireland, the State would need to stipulate conditions (in compliance with Competition Law) and such would impact the level of risk.

Q. 56. In the context of upfront purchase commitments and volume discounts, are any safeguards necessary to ensure efficient investment and the development of effective competition? Please explain your reasoning.

A.56. eircom retail is clearly the largest customer for eircom NGA by a long margin and thus there is no need for upfront commitments and volume discounts and the main beneficiary will be eircom retail.

Q. 57. Do you believe that all the relevant and appropriate options were considered above regarding the main principles for a margin squeeze test? Please provide reasons for your response.

A. 57. NGA from eircom in Ireland is not yet available and only a pilot service is planned at this time. Without a service in place it is not possible for us to be definitive, however ALTO has concerns that the eircom pilot backhaul prices, which are different from their NGN prices, for what ALTO believes is the same service, are exclusionary and prevent others using the local service facilities eircom claim to be offering.

Q. 58. Are *ex-ante* price controls or measures required in order to prevent margin squeeze? If so, what is the appropriate methodology to address margin squeeze and what factors should be considered by ComReg when specifying an imputation test (if this approach is deemed to be necessary)? Please explain your reasoning.

A. 58. *ex-ante* price controls and measures will be required in order to prevent margin squeeze. The *ex-post* system is too slow unpredictable and damage is done to competition well before such could be resolved in the courts or via other Competition law remedies. Regulatory certainty both for the incumbent and all other operators is important to establish the required stability to invest.

Migrations from Current Generation Copper Products to NGA Products

Q. 59. Should Eircom be required to maintain existing copper network infrastructure in parallel with NGA network upgrades? If so, then for what period of time? Under what circumstances could a shorter period of parallel operation be appropriate?

A. 59. Incumbent operators are used to integrating new with legacy systems and NGA should be no different. A key financial issue is that eircom should not be tempted to rip out deployments not fully depreciated (unless absolutely necessary) as such could cause a significant adverse peak in the company accounts.

eircom are planning to pilot NGA over the next year and this will provide them with both practical and commercial information and thus it’s too early to consider pulling out existing infrastructure. Additionally, we should not underestimate the difficulty and cost of rolling out NGA, particularity if eircom intend to provide fibre to the customer premises. With eircom being financially constrained it’s likely to take several years to for eircom to get a sizable fibre footprint to the premises. At this time we cannot see any removal of the PSTN before the next 5 to 10 years in the key urban areas and a lot longer in areas where NGA is not deployed by eircom.

Q. 60. What forms of fully equivalent access at the points of interconnection (such as exchanges), might justify an advance notice period for decommissioning of less than 5 years? Please explain your reasoning.

A. 60. This question is coloured by the deployment of LLU services in exchanges where we would expect eircom to rollout NGA (given high customer densities). We note that eircom have unilaterally, with strong disagreement implemented an effective 7 month termination clause of LLU services should ComReg de-regulate LLU. Hence in situations where LLU footprints have been deployed, which increasingly are supporting interconnect to the NGN we consider 5 years is the absolute minimum advance notification unless a commercial settlement or undertaking can be agreed.

In other areas, past experience has shown the industry has been able to negotiate with eircom the closure and re-routing of traffic on a commercial basis and such should be possible to a limited degree. However, a widespread undoing of infrastructure competition is not seen as viable given other party investments.

Q. 61. In an NGA setting, what are the most appropriate migration paths that need to be put in place and what are the main technical, operational or commercial issues that would need to be addressed? Please explain your reasoning.

A. 61. Initially ALTO sees the migration to NGA through customers seeking to upgrade services rather than a bulk move approach. In later years where most customers have migrated a bulk approach it may be worth pushing for migration, but such would have to be reviewed nearer the time.

ALTO realises that the incumbent is not be the only provider of NGA in Ireland given the emergence of alternative providers, mobile LTE and even the possibility entrants who are not yet operating in Ireland. ALTO's view is that migration paths should be possible and exist between the numerous platforms. Given such alternative providers the industry should not be restricted to the migration solution of the incumbent as in many times such will not be involved, hence some form of central clearing system may be required. However, to avoid cost and complexity such should be simple and more of registry rather than a transactional system. Common migration protocols and processes could be developed for operators to communicate with each other as is the case with fixed number portability today.

Q. 62. Are commercial arrangements likely to lead to the most effective outcome in ensuring that an efficient and transparent migration process takes place? Please explain your reasoning

A.62 ALTO's experience in Ireland is that there are two reasons for eircom to negotiate. First is when eircom themselves want something, and second when there is a threat of regulatory intervention. Hence a set of regulatory requirements is the best way to ensure appropriate commercial discussions.

Q. 63. How should ComReg ensure that the systems and procedures put in place by Eircom, including operating support systems, are designed so as to facilitate the switching of alternative providers to NGA-based access products? Please explain your reasoning.

A. 63. As in per our answer to question 61, ALTO does not consider that eircom will be the only provider of NGA in Ireland going forward and as such eircom should be working with other providers and potential providers on migration solutions. ALTO has had poor experiences of eircom putting things in place without detailed agreement of the industry and eircom often does not meet the full needs of industry.

Q. 64. What would be an appropriate and proportionate regulatory approach for ensuring that information around Eircom's network and its extension plans are made available to WPNIA and WBA access seekers? Please consider issues regarding commercial sensitivity and network integrity when explaining your reasoning.

A. 64. ALTO's view is that the requirements of eircom retail basically drive eircom network development. Hence once eircom retail are aware the development is going ahead similar information should be made available to authorised access seekers on the basis of equivalence.

Without such an approach other providers cannot provide downstream services in a fair competitive environment.

Q. 65. What should be the format and level of detail to be contained in the network information above and how can the strict confidentiality of such information be maintained? Please explain your reasoning.

A. 65. ALTO has been dealing with such issues for many years without issue and we don't see an issue going forward. eircom could readily provide such info behind a password-protected gateway.

ALTO

24th August 2011

alto

alternative operators in the communications market

Response Next Generation Access (NGA) Remedies in Wholesale Regulated Markets - Ref: 11/40A

Submission By ALTO

Date: October 19th 2011

ALTO is pleased to respond to the ComReg supplementary Consultation on Next Generation Access – NGA, Remedies in Wholesale Regulated Markets.

ALTO welcomes this further Consultation as a way of ensuring alignment of strategic priorities, price control, cost control, and transparency. It should also provide a degree of regulatory certainty, which can have the effect of encouraging investment in the communications market. We stand over our response to the initial consultation submitted to ComReg on the 24 August this year. The below comments augment the initial response and should support our comments in the main.

Preliminary issue

ALTO has been contacted in recent weeks, about the concept of an independent adjudicator role being funded and facilitated by industry to deal with NGA related issues (similar to that of the UK market).

It is the ALTO position that we do not support a second round of an approach that failed in the context of the NISG, nor do we feel that such an approach is relevant to the needs of the Irish market.

ALTO does however support the concept of an Equivalence of Access Board – EAB, made up of various stakeholders to hold the incumbent to account in relation to equivalence and related transparency issues. Such a board could be established under the auspices of ComReg and the Department of Communications, but should not serve to add an unregulated layer of bureaucracy to the process of getting to NGA networks in Ireland, and in all of the relatively reasonable locations where NGA should be in Ireland, and within a reasonable timescale.

Further consultation issues

It is our intention to address this consultation in the following format:

1. Investment Environment
2. Eircom Wholesale rebranding/reorganisation and behaviours
3. NGA and the role of regulation
4. NGA pricing and regulatory framework
5. Specific product issues

Investment Environment

In our initial response we identified certain areas of the market and country that will require GAP funding. These areas are going to require strong and coordinated inputs from various industry stakeholders, including ComReg and the Department of Communications. The industry must take into consideration areas of the State that will require special attention, rather that supporting and facilitating a “gold rush” or land grab where NGA is concerned.

Since ALTO submitted our response to the initial NGA consultation on the 24 August 2011, it has become very clear that eircom’s investment strategy will be to only compete with current and existing investors in the Next Generation Access network – NGA, markets, to the detriment of the remaining market and players. This view became clear following an eircom Wholesale hosted stakeholder engagement that was held on the 20 September 2011.

ALTO believes that it not in anyone’s interest to create a digital divide, yet the behaviours that are apparent at present indicate that a digital divide will emerge in a very short timeframe, unless ComReg intervenes with a suite of regulations and pricing arrangements in a short timeframe.

Further, ComReg should take a very active roll in all discussions, industry, government or otherwise, where the subjects of investment, regulation and policy emerge.

It is ALTO's experience that in the more recent past we have seen the Next Generation Network Industry Steering Group – NISG, fail and perform as a layer of meetings which ultimately resulting in operators seeking recourse to ComReg over fairly important issues. ALTO input serious time and effort to the last NISG (including a detailed NGA Statement of Requirements) and as an industry, we were promised great things, prior to the next sale of eircom Limited to its current owners. Nothing resulted from our efforts, and that of the industry, to great disappointment (please see note about telecoms adjudicator role, above).

ALTO is firmly of the view that ComReg must take an active or even proactive roll in all NGA discussions from the outset.

Eircom Wholesale rebranding/reorganisation and behaviours

ALTO has publically and guardedly welcomed eircom Wholesale efforts to reorganise and potentially rebrand itself and its behaviours. In the context of NGA, its success or failure will rest on the success or failure of the efforts eircom suggest they are making to serve their wholesale customers, all of whom are ALTO members.

It is deeply disappointing to see a recent ComReg publication stating that a dispute for failure to negotiate in good faith had been lodged against eircom Wholesale related directly to the very behaviours industry seeks to dispatch as being normal and expected behaviour. This publication emerged after eircom Wholesale's efforts had been commenced to be better corporate citizens and providers to its customers.

ALTO members (without exception) express concern over corporate governance and the "Chinese walls" that we are told exist within eircom Limited. Time-after-time we see failure to observe acceptable standards and norms in respect of special bids for business and respect for Wholesale commercial confidentiality.

It is very often the case that priority is given to eircom retail customers, over eircom Wholesale customers, and that bid pricing and other sensitive data emerges from an unknown sources to eircom retail. While we have no hard evidence to back this up, it is the case that very competitively priced wholesale bids have been lost to eircom retail where orders and pricing has already been requested of eircom Wholesale.

ALTO accepts that certain development works have to be, and have been undertaken relating to the eircom Universal Gateway – UG, we expect to see Key Performance Indicators – KPIs, emerge in order that Wholesale operators be able and capable of seeing the quantitative data relating to the performance of the eircom group service, operations and network performance and management.

NGA and the role of regulation

The European Commission has made it very clear that National Regulatory Authorities – NRAs, are not to provide so called “regulatory holidays” to incumbent’s rolling out NGA networks.

ALTO is strongly of the opinion that ComReg should consult on and potentially impose a full set of regulatory remedies on the eircom NGA market and eircom NGA product sets where wholesale access will be made available, as a matter of course.

ALTO remains concerned over the sustainability and longevity of existing/legacy products in the market. It is our intention to continue to highlight any areas for concern or sustained investment in legacy product sets where we believe elements have not been maintained or are being jettisoned in favour of NGA products.

ALTO calls on ComReg to remain actively engaged in all facets of NGA development in Ireland and to bring forward a comprehensive set of remedies inline with your *ex-ante* regulation obligations to the benefit of the market as a whole.

Remedies for Next Generation Wholesale Physical Network Infrastructure

ALTO is of the view that ComReg should bring forward a consultation on the correct pricing structure for NGA services in Ireland. This must be done as a matter of priority. If eircom remain on target, delivering services to 100,000 homes by summer 2012, the pricing conditions must be set in order that operators know what the wholesale market for NGA services will look like.

Obviously, eircom will seek to have the maximum possible pricing preferences and freedoms within the NGA market, however, ComReg must focus on the concept of Equivalence of Input – EOI, in the context of elements and network that will go into the prices that will eventually emerge at the retail and whole market levels.

ALTO calls on ComReg to publish a further NGA pricing consultation in as short a timescale as possible in order to set appropriate pricing and regulatory controls.

Specific product issues

Since the closure of the Original NGA consultation on the 24th August 2011 the following three product issues have emerged which will impact competition for

NGA services going forward. We are seeking ComReg to address these issues as part of its review.

- **Sub-Loop Unbundling**

  Eircom has adopted what looks like a Sub-loop solution for its Fibre to the Cabinet Solution and we consider the Sub-Loop model should also be open to others that may wish to deploy NGA solutions. Given the recent introduction of Vectoring, which Eircom have suggested makes the VDSL exclusive to one location; we now need guidelines on who can deploy NGA. For example should it be first come first serve, including for Eircom, otherwise we may see Eircom sterilise locations for several years whilst it is concentrating on more commercially viable locations.

- **Exchange Direct Supply NGA services**

  Eircom's initial NGA roll-out will be predominately VDSL from the cabinets and they have acknowledges it will not be technically possible to launch VDSL from the exchange in the same access cable systems where VDSL is provided from the cabinets. This aligns with our understanding and we note Eircom is planning to supply GPON services to customer sites local to the exchange and which are directly supplied. Given the smaller exchange sizes and their physical location in the centre of towns we consider it would be preferable to provide individual fibres to directly supplied customers as many would be business customers in the middle of the town and such would future-proof high speed access to this group with minimal additional cost.

- **Network Management of NGA services**

  A key feature that is missing from eircom's current NGA plans is that of a Wholesale network management solution, or centre. This is in order that wholesale customers, such as ALTO members, are in a position to update, manage and resolve issues with their own customers directly. As this feature is currently deficient, ComReg should take a view and intervene in the current thinking in order that any major deficiencies are rectified at this point, rather than at some point in the future.

ALTO

19th September 2011

2 BT Communications Ireland Ltd.

BT Ireland ("BT") Response to the ComReg Preliminary Consultation entitled:

Next generation Access (NGA) remedies in Wholesale Regulated Markets

Wholesale Physical Network Infrastructure Access (WPNIA) and Wholesale Broadband Access (WBA) Remedies in an NGA Environment.

Issue 1 - 24th August 2011

NON CONFIDENTIAL VERSION

1. Introduction

This is a timely and welcome consultation given the industry discussions concerning investment in the deployment of Next Generation Network Access. The key issues we would like to address before responding to the detailed questions are as follows:

- Investment environment
- Types of Next Generation Access (NGA)
- Sustainability of existing services
- Regulatory Remedies
- Price controls

Investment environment

NGA is demonstrating a similar characteristic to that of the existing broadband as the incentive to invest can be split into three key categories:

- Key urban locations where there is a commercial return on investment.
- Lower population density urban locations where there is a modest gap to reach commercial viability.

- Rural locations where the prospect of a commercial return on investment is difficult.

Key Urban population locations - Private investment.

UPC has invested significantly in Next Generation Cable Services in the Key urban locations and Eircom have recently announced a further €80Million investment (above the €20million pilot investment) over the coming years in Next Generation services. Eircom have announced plans to reach 100,000 premises by summer 2012 which we anticipate for competition reasons will largely be in the same and similar locations as UPC. (Eircom has also publicly stated that the €100m investment is part of an overall €400m NGA programme - although funding for the remaining €300m has yet to be sourced). LLU investment and deployment has previously targeted the same locations. Hence in these locations the private sector is making and is likely to commercially invest. These locations should therefore be the priority focus for regulatory intervention.

Lower Population density locations

These areas are characterised by the prospect of reaching a substantial customer base, however the risk and the return on investment, particularly in the early years of deployment falls short of a level for commercial viability. The current difficult financial environment facing the State would appear to make intervention difficult. Whilst major business in these areas is already well served for high speed fibre access, business branches, home workers, SMEs and the consumer market will increasingly find limitations in broadband access. Our concern is not investing in NGA in these areas will see reduced business investment impacting opportunities for commerce and innovation.

To attempt to minimise the burden on State intervention we are suggesting that any State aid (assuming such is possible) should be limited to accelerating NGA rollout and/or funding the commercial viability GAP. This approach has been used in other jurisdictions and indeed BT's Northern Ireland investment was party facilitated through GAP funding. In only a couple of years BT's rollout of high speed broadband in NI is already close to 89%. If State 'GAP' funding were to be made available we believe such should contain contractual conditions to provide 'truly' open and fair wholesale access, as is the case in Northern Ireland and indeed was the case in the NBS programme.

Low 'rural' population density locations

Very high speed broadband services will become increasingly important to society over time and action is required to avoid widening the digital divide. Whilst it may be prohibitive at this time to roll-out fibre to all rural locations, other technological and potentially lower cost solutions should be considered such as fibre to the village type solutions and Long Term Evolution (LTE) mobile to create an 'inclusive' society. This category will need further review to understand the latest thinking in serving rural locations. It is highly likely that state intervention, ideally in the form of 'gap' funding, will be required in these areas.

Types of Next Generation Access (NGA)

Next Generation Access (NGA) is a generic term currently used in the communications industry to mean very fast broadband access – faster than historical broadband.

The technical solutions for deploying NGA vary and are a key component in the decision to invest. The common technical solutions are below:

Key NGA technical options:

- Fibre to the premises or home (100Mbits plus)
- Fibre to the cabinet (up to approx 80Mbit/s max) [upgradable to Fibre to the premises or home]
- Fibre Network to the Cable cab with Co-ax to the premise (100Mbit/s plus)
- Mobile LTE (54 Megabit plus)
- Fibre to the village / central rural hub solutions.

For locations where commercial investment is made, the operator decides the technical solution, however should state aid be required some of the solutions are considerably cheaper than others and in these times of austerity it may be prudent to focus on Fibre to the cabinet for the lower density areas and mobile/radio access becomes more attractive for the more rural locations.

Sustainability of existing services

As an operator of broadband services in Ireland we welcome the discussions and move towards NGA; however we are also keenly aware of the complexity of operating both traditional broadband services at the same time NGA services are being introduced.

From the investment discussions above it is notable that the environment in the key urban areas will become different to the rest of the country as, for the foreseeable future, without State assistance NGA will be limited to these areas. These are also predominantly the LLU areas.

We appreciate that the new NGA services must be marketed at a rate to encourage take up, however we are also aware that the traditional services still have considerable value in the market and should not be ‘trashed’ through poor regulatory or predatory pricing decisions. In reality the traditional services will provide much of the finance for the new NGA products. Our view therefore is that NGA services in Ireland should trade at a modest premium to the existing broadband services, as is the case in the UK. We also consider that ComReg should take a ‘holistic’ view to NGA price regulation as micro level regulation is likely to lead to unwelcome anticompetitive distortions.

We note the additional complexity in that Eircom, traditionally a double play operator (BB and Voice), is trying to compete against UPC, a triple play operator (BB, Voice and TV), which is pressurising Eircom's retail margins.

Eircom’s prices, such as line rental, have been amongst the highest in Europe and we do not believe that the industry is to blame for Eircom’s current debt pile or its significant interest payments.

We don’t believe that other operators should be driven out of the market due to Eircom's inefficiencies in costs and potential price squeeze activity to manipulate the market to suit Eircom retail. We therefore consider that if Eircom can find room to reduce its costs through its various cost saving campaigns, such reductions should manifest themselves in reduced line rental, llu unbundling rentals etc, rather than at the retail layer where little cost existed.

We therefore consider robust regulation will be key to maintaining competition during the transition to NGA and the benefit of Eircom cost reductions should be in the upstream infrastructure rentals to benefit all users of the Eircom platform.

Lessons to be learnt

We consider lessons learned from the NGA approach for key urban areas will benefit the lesser dense and rural deployments, and additionally we would seek that the Department of Communications and Natural Resources set stringent conditions to stimulate open and fair competition in any proposal for state funding.

Regulatory Remedies

As we have previously responded to the WPNIA consultation our view is that the full set of regulatory remedies, akin to those for copper access, determined in the ComReg WPNIA decision notice D05/10 should automatically apply. We now also consider (in light of new information such as problems with the NGA pilot pricing) that price controls and price regulation is required and we address this under the next heading ‘Price Controls’

The reasons for this position are as follows:

Maintenance of the existing rules

After some 12 years firsthand experience of dealings with Eircom, including its numerous owners, our view is little has changed in its poor behaviour towards its wholesale customers, particularly LLU operators. Recent Eircom proposals for LLU product and price improvements are too little too late, and exclude developments sought by BT, such as the ability for LLU operators to supply independent backhaul, the ability for LLU operators to novate footprints or subaccounts, and reductions in power charges.

There is a demonstrable need for ComReg regulatory remedies which have been drawn up following real experience (see a few examples below) to constrain poor Eircom behaviour.

Important examples of this behaviour are:

- It took years for ComReg to force Eircom to provide seamless migrations to LLU even though such existed for bitstream.
- It took two formal complaints from BT and separately COLT to force Eircom to offer Wholesale Ethernet services, and at least another year before we considered the offer fit for purpose.
- 10 years after the launch of LLU we still do not believe we have fit for purpose LLU backhaul offering (the recent proposal does not have any prices and cannot yet be ordered).
- We believe the NGA pilot eircom are planning is structured to disincentivise infrastructure competition at the local level in Ireland. This is against the European Commission NGA recommendation clause 26[1] that recommends NGA solutions should not be discriminatory or have an exclusionary effect. We note a variety of local handover products are available from Eircom, however we don't believe the backhaul prices proposed by Eircom will allow other parties to commercially benefit from the local handover options forcing the use of Eircom end-to-end national services. Whilst we accept a balance has to be achieved between keeping the price low enough to attract customers, such a price should not exclude competition in the market. We therefore consider that ComReg needs to urgently establish a set of price controls including Margin/Price squeeze models as part of their NGA regulatory pricing toolkit in Ireland.

Access is the highest level of regulated service other than Duct sharing and aligns with European 'ladder of investment' principles to encourage investment in upstream markets to foster competition in downstream markets.

We note Eircom's recent announcement to propose a wide ranging set of commercial reforms that will fundamentally enhance access to Eircom's national

[1] Commission Recommendation of 20 September 2010 on regulated access to Next Generation Access Networks (NGA) (Text with EEA relevance) (2010/572/EU)

infrastructure for all telecoms operators in Ireland. We are highly sceptical that anything will change and it will take considerably more than fine words or professionally constructed statements and presentations to convince us that Eircom will act as a true wholesaler. Eircom use the word ‘fundamental’ in its announcement and we agree a ‘fundamental’ change is required and Eircom must learn it is being judged by what it does and not what it says. We believe the communication consisted of a public press release - preceded by a series of hastily arranged telephone calls to a selection of its wholesale customers - in itself gives a good indication of Eircom’s primary motivation, i.e. to gain favour with the public and with its key external stakeholders (including ComReg and DCENR) rather than any fundamental customer-driven rationale.

Very recent announcements by Eircom cement our concerns of continuing problems, for example:

- Eircom have recently informed the LLU operators of service improvements for LLU; however it omits to say that aspects such as the publication of KPIs were recently mandated by ComReg, and more frustratingly it’s only after we have virtually completed a major task, at a significant cost and duration, that Eircom announces a fast track improved scheme. In addition, LLU product improvements requested by BT are not included in these developments (some of the BT requests have been refused by Eircom and others have had no response to date).This is not good enough and points to systemic regulatory problems requiring a systemic regulatory solution.
- Eircom’s announcement on ‘wholesale reform’ was followed a week later by a press release containing two significant items – a €100m investment on FTTx NGA, and an intention to launch a series of Entertainment services, including IPTV. We consider these two announcements being made in the same release demonstrates that Eircom, despite their statement only a week earlier, do not understand the meaning of true wholesale services. We believe their retail arm has had advance notice of the NGA developments prior to the press release, whereas the rest of the industry were completely unaware of the NGA plan (and continues to be unaware of this plan). If BT were to behave in this manner in the UK market, it would face serious consequences from Ofcom and also from its wholesale customers.

If Eircom’s behaviour were to change then it should have no issue with the current regulatory remedies as such are basically in place to force Eircom to act in a way customers would expect from a genuine wholesaler.

We are in absolutely no doubt ComReg must apply the full set of WPNIA access regulations on eircom for NGA and we will discuss price controls for NGA next.

We also consider ComReg should put Eircom on Notice that if the Eircom Wholesale reform is not successful it will need act to resolve the systemic problems.

Price Control

The pricing of NGA services will be critical to both the success of NGA and also the sustainability of competition in the Irish market both for existing and new products. We welcome ComReg's focus on this issue in the consultation.

We would like to address the common themes below.

- Duct Access and Physical infrastructure build. To support competition and to enable other providers to build their own NGA access, Eircom should be mandated 'when requested by an operator' to make a Civil Engineering Offer (such as duct access). The European commission would appear to support such a move through its NGA Recommendation.
- Backhaul Pricing – Eircom has proposed its pilot in Wexford and Sandyford and has made prices available. Whilst accepting that prices should be viable for the consumer market, we are concerned that Eircom is offering extremely 'cheap' backhaul over its own network to support NGA services. In our view such low pricing is foreclosing the ability of other providers to purchase local access to Eircom's exchanges to pick up the NGA services as they reach the first aggregator. This is a major disincentive to infrastructure competition and goes against recommendation 26 of the EC NGA Recommendations.
- Establishing a premium – NGA services will offer significantly higher bandwidths than existing broadband services and our view is that a modest premium is appropriate to recover the additional investments and to recognise the increased functionality. We are aware from experience that such is possible without pricing the product out of the market.

We consider that eircom have motive and the ability to constrain the wholesale market and ComReg should apply cost orientation for infrastructure aspects as recommended by the European Commission and also retail minus approach to setting the wholesale prices supported by margin squeeze tests,

2. Detailed Questions and Responses.

Facilitating competition and encouraging efficient investment

Q. 1. Do you consider that the risks identified above are those most closely relevant to investment in NGA? What might be the degree of impact of such risks, how might they change over time and how might they be quantified? Please explain your reasoning.

A. 1

Investment in Key Urban Locations

The investment by the cable operator UPC in NGA rollout and the support of a vibrant triple play service including television (with Sky Sports option) has created a new competitive dynamic in the most lucrative consumer customer locations in Ireland. We believe the clearest NGA risk to Eircom is already being demonstrated in the market, i.e. loss of customers and revenue in these locations. Our view is this will force Eircom to commercially invest (the further 80million recently announced) in NGA solutions in the same locations as UPC and Eircom's focus on protecting its own retail business is a huge risk to other providers using Eircom's wholesale platform. Hence our view is these locations are the priority for regulatory attention.

In terms of the risks identified, UPC appear to be demonstrating NGA does work in Ireland and the issue for Eircom is how to catch up and how do they build a package to compete with triple play including television. Our growing concern is how to ensure the key urban areas do not turn into a duopoly environment.

Investment in other locations

Other than for niche solutions, the viability of a pure commercial return from NGA investment (without other strategic objectives) in the rest of Ireland is looking difficult. However in many areas the GAP to achieve commercial viability is small and various options could be considered to close this GAP. ComReg must ensure that a 'digital divide' situation is not created, for example Eircom should not be given a level of commercial freedom to effectively 'de-average' or decouple pricing between areas where they face commercial threat (e.g. from UPC and LLU operators in Urban areas) and rural areas where the immediate threat is less so. Should Eircom decide to reduce its pricing to compete, then it must be mandated to do so for the entire market, particularly given their excessive level of EBITDA margin (40%+). The industry and the consumer must not be punished for a decade of mismanagement and lack of investment by Eircom.

Remedies for Next Generation Wholesale Physical Network Infrastructure Access

Q. 2. Do you consider that, in the context of the terminology set out in the NGA Recommendation, the above Figures 3 and 4 provide an accurate representation of Eircom's proposed network architecture? Please explain your reasoning.

A.2

- The Unbundled FTTH high level architecture described by ComReg is correct as we understand it from Eircom.
- The FTTC high level architecture needs to be amended to include the Next Generation Network Node as the service is not available from Eircom without this. We appreciate that it may be argued the NGN node forms the OLT which is correct for Ireland, but the node has many other features such as Quality of Service features that come with the Node and effectively start to limit the openness of the service. ComReg need to ensure that unnecessary bundling of products is avoided.
- We consider ComReg should include the FUA (Fibre unbundled Access) solution which is now included in the trial which has a different topology. I.e. Eircom bring all the traffic from all operators from either the FTTC or the FTTH over the same ‘shared’ infrastructure and traffic is broken out at layer 2/3 at the local/first NGN node. i.e. sharing backhaul economies of scale with all providers. We also believe that this product should be renamed, as it is clearly not an ‘unbundled fibre’ product.
- Head Ends – With the advent of Eircom’s ADT extension to the NGN and the limited access to Eircom ADT sites (i.e. they cannot support interconnect) we consider Eircom should now additionally offer NGA local access at ‘Head Ends’ where local access is not possible and the various local areas are brought together.

Q. 3. Do any of Eircom’s proposed pilot wholesale products align to the potential access remedies set out in NGA Recommendation? Please explain your reasoning? This question should be addressed in light of the following discussion on WPNIA NGA and WBA NGA.

A.3 In our view Eircom’s current trial in effect offers none of the access remedies set out in the NGA recommendation for the following reasons:

- It does not offer Access to civil engineering infrastructure.
- Although Eircom provide technical information and say they will provide access to fibre and VDSL, its approach to backhaul pricing is exclusionary and there is no commercial incentive to invest other than to purchase Eircom's end to end bitstream service.
- Eircom offer two fibre pairs however it’s not clear is the second is available for a second operator.

Q. 4. Are there any circumstances in which regulated access to civil engineering infrastructure would not be required? Please explain your reasoning.

A.4. No. For others to viably compete in deploying their own NGA access solutions (other than mobile) a viable civil engineering infrastructure Offer (such as Duct) will be required. The detail of the offer should be discussed between the interested parties when a better view of the requirements is known.

Q. 5. Having regard to market demand, technical, economic and other considerations, is there a requirement for a duct access remedy? Please explain your reasoning.

A.5. There is a requirement for major infrastructure build in the access network to achieve NGA in Ireland which will involve the use of new or existing ducts to provide connectivity. It would be inappropriate to block regulatory remedies that could assist such a requirement hence there is a need to have a duct access remedy in Ireland.

Q. 6. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to civil engineering infrastructure?

A.6. Whilst all are important, we consider clause (d) – "the need to safeguard competition in the long term with particular attention to economically efficient infrastructure-based competition;" as a key required for Ireland. We are deeply concerned Eircom have the ability and motive to minimise infrastructure competition and we consider the recent example of the 'surprisingly low' pilot backhaul price supports this.

Q. 7. Should ComReg encourage Eircom to build additional duct capacity for use by third parties and, if so, how? Please explain your reasoning.

A.7. We are not offering a view on this matter other than a viable Duct Offer should be made.

Q. 8. If a remedy requiring the provision of access to civil engineering infrastructure were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Would a risk

premium be warranted? Please provide a reasoned response for each of the principles.

A.8 Access to civil engineering and ducts is highly problematic with significant risks of unexpected costs and delay; hence a viable civil engineering offer (such as duct) is required. We have been frustrated at the looseness of the definition of 'equivalence' in Ireland which over the years has damaged trust in the industry; the new EC tight approach where equivalence means 'strict equivalence' is welcome and long overdue. Our view is the greater risk to Eircom is not implementing NGA. The NGA price is already in the market and it's now too late to be considering risk premiums. More important is correctly valuing the products and not 'trashing' the existing historic markets.

Q. 9. What form of price control would be the most appropriate and proportionate means of establishing the price of access to civil engineering infrastructure? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

A.9. Eircom does not retail duct access and such is not a retail product by nature hence the retail minus approach to a price control is a non starter as there is no retail price to act as a reference. The cost orientated approach is aligned with the European Commission NGA recommendation and should be built into the Duct offer addressed in our answers to A4, A5, A6, A7 and A8

Infrastructure costs are a component of NGA and whilst forming an input to the NGA service price do not prohibit flexibility in pricing for the complete service.

Q. 10. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the terminating segment? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

A.10. We strongly consider there is a need for a strong regulatory remedy mandating access to the terminating segment. Our past experience is that Eircom will refuse to supply or cause other service difficulties if there is no regulatory remedy. For example it took several years for Eircom to be forced to provide and support LLU migrations as they argued it was not a regulatory obligation, and we are familiar with Eircom's 'No' responses to industry Statements of Requirements where Eircom say they don't have an obligation to provide. Very recently Eircom refused LLU operators the ability to provide backhaul facilities to other LLU backhaul providers to assist competition and service resilience. We are aware of the Eircom NGA pilot, but Eircom themselves say it's a pilot and the final service may change.

ComReg ask how such remedies might this be achieved in light of Eircom's proposed or alternative architecture. The fact that eircom has chosen a particular form of solution, which we now have serious concerns with, does not prevent the regulator putting in place regulatory remedies. Indeed it does not prevent ComReg mandating a Duct Access remedy.

At this time the deployment model or models for NGA in Ireland is unclear as key investment decisions have not yet been established, however a number of possibilities exist as below:

- UPC continue to roll out their infrastructure
- Eircom commercially deploy NGA where viable (we assume this will mainly be in the same areas as UPC for competition reasons)
- State Aid (we suggest in the form of GAP funding) may be required to stimulate investment to deploy services in area where commercial viability does not exist but where modest State funding could make a significant difference.

Q. 11. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the terminating segment?

A.11. As per our response to question 6 item (d) in the list i.e. the safeguarding of infrastructure competition is key. Sustainable infrastructure competition is essential to stimulating inward investment and jobs in Ireland whilst significantly benefiting the consumer in choice and lower prices.

With reference to our response to question 10 we would expect any state funding to be supported by strict ComReg regulatory remedies to ensure such investment stimulates competition rather than inhibit.

Q. 12. Where is an appropriate distribution point to which access to the terminating segment should be provided, particularly given the need to ensure that it host a sufficient number of end-user connections to be commercially viable for an access seeker.

A.12. The definition of the terminating segments within the NGA recommendation implies that the terminating segment exists to the first distribution point. In the copper world the street cabinet is the true first distribution point. In the fibre solution proposed by Eircom the cabinet will also be the first distribution point for residential services. We therefore consider the cabinet to be the first distribution point.

The Eircom pilot has two categories of cabinet solutions at this time as below.

- Eircom offer space in their cabinet to locate either optical splitters of another operator, or space to provide a DSL solution. In this scenario the backhaul fibre can be provided by Eircom or the other operator.
- LLU Sub-loop unbundling (although no process yet exists to provide, and the current price levels are prohibitive) has a potential application in NGA for very high speed copper access; up to 80Mbit/s through technologies such as VDSL.

Rolling network to the cabinets for non-incumbent providers is difficult given the low market size of each cabinet and the costs and difficulty of providing electrical power and fibre backhaul. For most locations it is more viable to pick up the access at the local exchange or a head end as described in our response to question A2.

We also note recent Eircom announcements that the majority of Eircom's NGN platform will be what they term APT nodes. We have been told by eircom these APT nodes are not capable of direct interconnect with other operators, hence for many locations it will not be possible for operators to connect at the local Eircom NGN nodes, as had been envisaged in discussions to date. Therefore the scenario is emerging where interconnect with the services at an area or regional (head end) point will also be required where local access is not available.

Q. 13. Should ComReg seek to encourage Eircom to deploy multiple-fibre lines in terminating segments and, if so, how? Please explain your reasoning.

A13.

Yes – the cost of adding a second or third fibre pair at installation is very small compared to the costs of a second and third new installation. It is not too late to mandate such a solution or process to give other parties access to such additional fibres as Eircom is still only at a limited pilot stage of development. As regards the how question, ComReg could easily mandate Eircom to publish where it is planning to deploy and to seek bids/offers for the 2nd and 3rd fibres.

Q. 14. If a remedy requiring the provision of access to the terminating segment were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Please provide a reasoned response for each of the principles?

A.14. The measures set out in Annex II of the NGA Recommendation are welcome particularly the requirement for strict equivalence. The reason is that we have requested sub-loop unbundling to be developed and a key aspect is fibre backhaul. We have requested such from Eircom; however in cases where that is not straight forward we may require a viable duct supply Offer from Eircom.

Implementation - We agree with the NGA recommendation that Eircom should make a Civil Engineering Reference Offer and the recommendation sets out a minimum list.

Enforcement - ComReg is well able to oversee the development of strict processes however it will require strict enforcement to ensure it works correctly.

Q. 15. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the terminating segment? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

A.15. We consider a number of aspects need to be considered in setting the price control.

A retail minus price control allows a margin squeeze against existing exchange based LLU services and is not consistent with existing cost-orientated prices for LLU services. We believe a modest NGA premium is warranted against existing services such as LLU as the Sub-loop components and prices are included in the NGA solution.

We understand the pressure Eircom Retail faces competing with companies such as UPC and Eircom simply have to reduce their cost base at all levels including LLU to improve its ability to compete, otherwise trying to manipulate prices as different levels in the price stack will quickly lead to margin/price squeezes against wholesale providers.

We are suggesting Eircom select an ‘anchor’ price such as LLU and the pricing strategy is built up from that. This should enable existing competition to be maintained whilst factoring in an NGA premium and avoiding margin/price squeeze issues. If the anchor price is too high then Eircom will have reduce internal costs to get to it.

In terms of regulation, we consider cost orientated prices at the component levels will be required (in line with the NGA requirement) to set the floor price and retail minus will be required to set the ceiling. Margin/Price squeeze tests will be required to prevent a squeezing out of LLU and wholesale services.

Q. 16. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the

unbundled fibre loop? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

A.16. There is a clear demand for access to the unbundled fibre loop and regulatory remedies mandating such are essential for the development of Next Generation Access in Ireland. In the event the Government were to tender for deployment of NGA in non-economic areas it is plausible that other operators may offer competing bids. In this situation, regulation will need to mandate that Eircom provide to those parties requiring access to its network the same facilities Eircom would otherwise have provided to themselves.

Regulation has a critical role in bringing NGA to Ireland and access to the unbundled fibre loop and the ancillary services to enable the existence of the fibre loop are required.

Q. 17. Are obligations to provide access to associated facilities necessary and, if so, what should these encompass? Please explain your reasoning.

A.17. As in question 16, it is essential that regulation provides obligations to make available the ancillary services to support other operators providing NGA in the same way 'i.e. in strict equivalence' as Eircom would provide to itself.

Q. 18. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities?

A. 18. Addressing the various points raised in 12(2) as below. We have reproduced the points for context:

> (a) the technical and economic viability of using or installing competing facilities, in the light of the rate of market development, taking into account the nature and type of interconnection and/or access involved, including the viability of other upstream access products such as access to ducts;
>
> Response - The technologies for NGA are now fairly well known and demonstrated to work, hence technical viability has been proven. UPC has proven economic viability in Ireland and numerous operators around the world are deploying NGA solutions so economic viability is feasible and now becoming proven.
>
> (b) the feasibility of providing the access proposed, in relation to the capacity available;

Response - To date the decision to provide has been a commercial one so it can be done. With equivalence and high quality regulation other parties should be able to obtain a viable return in certain locations.

(c) the initial investment by the facility owner, taking account of any public investment made and the risks involved in making the investment;

Response - The solutions for other operators has been designed in from the start and the access provider will recover substantial revenue from other operators using is network.

(d) the need to safeguard competition in the long term, with particular attention to economically efficient infrastructure-based competition;

Response - Please see our response to question 6.

(e) where appropriate, any relevant intellectual property rights;

Response - This is has not been an issue in Ireland to date and is not expected.

(f) the provision of pan-European services

Response - European aspirations / targets are now for very high speed broadband and these actions support such.

Q. 19. What do you consider to be an appropriate point in Eircom's network for the provision of unbundled access to the fibre loop in a FTTH scenario? Please explain your reasoning, including views on associated technical and commercial considerations.

A.19. We consider regulation should provide the ability for another operator to deploy NGA using Eircom's existing physical infrastructure such as the ducts (Civil Engineering Offer), and where Eircom have already provided the 'terminating segment' from the customer to the cabinet then access at the cabinet should be made available to all on the same terms and conditions. In addition Eircom should provide access to the fibre backhaul service from the cabinets to the exchange, as well as interconnect access at the local exchange.

Q. 20. If it is not possible for commercial or technical reasons to provide for unbundled access at this time, what factors might change this over time? What measures should ComReg take on a transitional basis to provide for the nearest equivalent alternative constituting a substitute to physical unbundling and what other safeguards might be necessary?

A.20. Eircom has already offered pilot hence technical solutions are possible in Ireland. However, the backhaul pricing for the pilot is proving exclusionary as we believe its removing the margin to encourage interconnect at the local level with Eircom's solutions. Pricing is thus absolutely critical for NGA competition and we are in no doubt regulatory intervention is required to safeguard the industry. We are not seeking for Eircom to price NGA out of the market, however, there should be a possibility to connect locally and regionally and benefit from our own network investment. This does not appear possible for the pilot at present due to the low value Eircom has placed on backhaul versus access.

We have requested Eircom to bring their sub-loop unbundling offer to a state where it can be purchased and sub-loop deployed by other parties.

Q. 21. Is a remedy requiring the development and publication of a reference offer for the provision of access to the unbundled fibre loop and associated facilities necessary and what specific issues should be detailed within it? Please explain your reasoning.

A.20. Eircom have already sought to offer a type of reference offer for their pilot hence they appear to support this concept and we would agree a reference offer should be mandated. However, what is not clear to us is what Eircom are offering to themselves and the conditions of such an offer. BT and the industry at the start of the pilot discussions made it clear that all, including Eircom should use the same order and provision gateways. We note Eircom eventually agreed on the provision side but some 7 months later have still not agreed the same for service assurance (contrary to their public position on becoming a true wholesale operator). We consider any reference offer should apply to all including Eircom itself and until such is done there will be no trust or confidence that Eircom are acting fairly. Eircom simply don't seem to understand this fairly basic point they must be seen to be treating all parties the same, including themselves to be a credible wholesaler. There are no commercial or technical reasons for resisting this, particularly in an NGA environment where new systems and process are being developed on new platforms. We consider a full Reference Offer is required and Eircom downstream services should avail of the same offer.

Q. 22. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

A.22. The reference offer should be drafted by Eircom and then negotiated and agreed with industry. The offer should apply to all users of NGA including Eircom's own downstream business (including wholesale businesses). The Reference Offer should be established with the other reference offers on the Eircom wholesale website and a separate tab added to provide details etc of the service. i.e. The same process as the Access reference Offer (ARO) with the exception that if the doc is not agreed it is referenced to Comreg for decision, unlike the new ARO-2 which was published by Eircom even though it was in a state of disagreement with the industry at the ComReg led formal industry group. The reference offer should include SLAs, service credits and performance KPIs.

Q. 23. What specific non-discrimination remedies are required with respect to the provision of access to the unbundled fibre loop and associated facilities? Please explain your reasoning.

A.23. The full set of non-discrimination remedies as per the WPNIA decision are required as this is also an access service and Eircom have both the opportunity and motives to capitalise on discrimination opportunities.

Although we welcomed the ComReg decision around Eircom publishing details of their self supply offer, the quality and detail of what Eircom produced was meaningless and disrespectful to the regulator and the industry. We consider this area needs to be urgently addressed to force Eircom to act in a non-discriminatory way, and additionally to meet the 'strict equivalence' objectives of the European Commission in its NGA recommendations.

Q. 24. What form of price control would be the most appropriate and proportionate means of establishing the price of unbundled access to the fibre loop? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

A.24. The Civil Engineering aspects such as the supply of duct should be cost orientated. We acknowledge Eircom need to have some freedom as to the retail price they set, however as a vertically integrated business Eircom have the opportunity and the motive to margin squeeze the wholesale price. Such a squeeze will limit infrastructure competition hence we consider a combination of a retail minus price control and or a margin squeeze control is required to protect the wholesale price. This is critical to support infrastructure competition.

Q. 25. Should any cost oriented price for FTTH based services attract a risk premium in principle? If so, to what types of network assets/investments should any premium apply and why?

A.25 The European Commission in its NGA recommendation advocates a cost orientated price for some aspects of NGA and it is recognised that such could be recovered over a period of time. As we have responded in question 8 Eircom have no choice but to invest to protect their high market share hence it is now too late for a risk premium in Ireland as the pricing differential against UPC is unlikely to support such.

Q. 26. What types of co-investment arrangements might warrant a separate regulatory treatment in terms of remedies. Please address in your answer the types of commercial relationships and the type of control over physical infrastructure by multiple operators that you think would be necessary for ComReg to consider this option. If possible, please state if you think such an outcome is feasible or desirable.

A. 26. Eircom have now announced a further 80million investment to their 20million NGA pilot investment, however as yet no NGA services are available from Eircom, and no details have been provided to industry on these plans. As discussed earlier we are expecting this investment to largely be in the same areas as UPC. The historic difficult relationship of industry with Eircom, compounded by Eircom's high market share, appears to make a co-investment problematic. Consortia relationships are possible however no party appears to have made any public statements at this time and the regulation is still not stable in this area.

The alternative is Government funding which is understandably difficult given the current economic climate, however given the important of electronic communication to the economy some form of state assistance may be justified particularly in rural areas.

To minimise the cost of any such State investment, a GAP funding model (i.e. providing the difference between what companies would commercially invest and the uneconomic value) would appear a plausible way forward which would stimulate commercial investment at very good value to the State. If such an approach were adopted, and projects tendered we believe investment consortia would emerge.

Removing the dependence on Eircom would enable parallel deployment and increased competition thus bringing forward services more quickly and stimulating competition.

In this scenario we would anticipate such providers offering 'regulated' wholesale services and ComReg would be requested to oversee this as well as overseeing that Eircom open its 'terminating' segments and ancillary services in the same way it would for itself.

Q. 27. Do you have any views as to how ComReg should view the evolution of the market for NGA services particularly in the presence of a rival cable network and its impact in supporting effective competition in downstream markets? How should remedies and regulation generally evolve over time and what criteria should ComReg apply to such decisions?

A.27. There is now a small risk that a duopoly will emerge between Eircom and UPC in key urban locations and urgent regulation will be required to prevent this having a detrimental impact on the market. Establishing regulation to prevent margin squeeze on LLU, and to let other operators have access to Eircom NGA at regulated prices, is vital to sustaining competition in the downstream markets and should mitigate against a duopoly.

Q. 28. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in a FTTN scenario? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

A.28. The Eircom pilot offers the fibre from the premises to the cabinet (i.e. the terminating segment) and for the OAO to provide filters in the cabinet or node. There is a requirement for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in a FTTN scenario so that other providers can maximise its use of the fibre loop without having to use the Eircom bitstream service.

Q. 29. What type of backhaul solutions do you consider are appropriate in an FTTN scenario?

A.29. Eircom are providing fibre for their own backhaul and it would be equivalent for them to provide the same fibre access at an appropriate cost for other providers without the need for them to use the Eircom bitstream network. Indeed the FTTH provides this type of solution. We consider this is thus reasonable and proportionate.

Q. 30. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities.

A.30 Please see our response to question 18.

Q. 31. Is a remedy requiring the development and publication of a reference offer for the provision of access to the copper-sub loop necessary and what specific areas should be detailed within it? Please explain your reasoning.

A.31 – Please see our answer to question 21.

Q. 32. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

A.32 – Please see our answer to question 22. We need such to provide us the contractual terms and to ensure we are all receiving the same offer for fair competition.

Q. 33. What specific non-discrimination remedies are required with respect to the provision of access to the copper sub-loop, including those associated with co-location? Please explain your reasoning.

A.33. As we have proposed in the past non-discrimination linked with good transparency regulation is key. I.e. it is only through transparency that non-discrimination regulation appears to work properly. We therefore request a tightening of the WPNIA regulatory remedy in ComReg Decision D05/10 to make Eircom properly describe, in the same level of detail, services offered to OAOs and self provide. Only when this is complete and demonstrated will we start to gain confidence that fair equivalence exists in Eircom. In our view the current approach of Eircom in describing what they offer themselves is disrespectful to the industry and demonstrated that we are not dealing with a true wholesaler.

LLU has an existence independent of NGA hence we want all the existing regulatory remedies to be maintained for the foreseeable future.

We are aware that Eircom have chosen a path where NGA is obtrusive to the existing portfolio of services, for example it’s not possible to supply WLR on line where VDSL is deployed. We consider the deployment of NGA solutions should not be destructive to existing services unless agreed by the industry.

Q. 34. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the copper sub-loop? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing commercial negotiation. Please explain your reasoning.

A.34 We consider the same principles as described in our response to question 24 apply.

Q. 35. Should fibre or Ethernet backhaul associated with the provision of access to the copper sub-loop attract a risk premium? How might a risk profile associated with specific costs relating to such access to be determined in light of the principles set out in Annex I of the NGA Recommendation, and how should any difference in risk be reflected in a pricing methodology? Please explain your reasoning.

A.35

Assuming the question is only addressing the backhaul from the cab to the nearest (first) NGN aggregator node.

Please see our response to question 8.

Remedies for Next Generation Wholesale Broadband Access

Q. 36. What circumstances (i.e. degree of availability of effective access to the unbundled loop), would warrant the lifting or variation of WBA access obligations within a given geographic area? Please explain your reasoning.

A.36 We have previously provided our view that a critical mass of customers on the LLU platform would be required prior to the consideration of a relaxing some of the WBA obligations on Eircom. We consider we are still a long way from reaching such a point and continued to be frustrated by Eircom such as refusing two of our recent product requests to improve the LLU product. We perceived Eircom were engaged in a ‘battleships’ approach to a key service request with obtuse answers to our request for a certain LLU facility. It feels that we have to ask exactly the right question using very precise terminology to get the correct answer, otherwise the answer is no. We don’t consider this to be negotiation in good faith and is not good enough from a wholesale supplier.

Concerning de-regulating a geographic area we believe Eircom will either deliberately or inadvertently in chasing UPC prefer its own bitstream and retail services and foreclose LLU in that area. To avoid such the base price of LLU would need to fall considerably to enable the LLU operator to sustain a margin to sustain commercial activity.

At this time we need critical mass of LLU customers (~150K, equivalent to 10% of the broadband market) before the lifting of the WBA access obligations. ---Text deleted. --- Additionally, significant LLU rental reductions would be needed to avoid a margin/price squeeze.

Q. 37. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to WBA products and associated facilities (including backhaul) in a FTTH and FTTC scenario? Please explain your reasoning.

A.37. Yes. The perception of industry over the years is that Eircom has preferred its downstream business over its wholesale business and this has been acknowledged by the Eircom CEO[2].

"In the past, we tended to be inward looking, closed and retail oriented. But into the future we're going to need to be forward looking. This will mean more open partnerships and recognising that the provision of wholesale services will be a more important part of the strategy than it has been,"

We are not convinced of Eircom's desire to offer regulated wholesale components and absent regulation it cannot be predicted what Eircom will do, our assumption is that regulated wholesale components will disappear in favour of end to end solutions, removing infrastructure competition in Ireland.

We already note the backhaul pricing of the FTTX trial solutions is so low as to undermine the viability of other operators investing at the FFTX cabinets. In our view even though the FTTX trial is being portrayed as open, we don't see it as commercially viable hence it's not open.

Q. 38. In a FTTH or FTTC environment, what technical or enhanced service characteristics might need to be reflected in WBA access products? Please explain your reasoning including views on the extent, if any, to which product differentiation is a necessary characteristic of WBA access products.

A.38 We believe the following should be supported.

- Ability to carry voice meeting any regulatory obligations for making 112/999 calls and location info.
- Ability to carry high speed data.
- Ability to carry QOS enabled traffic
- Ability to carry multi-casting (TV) – from local and national handover.
- Improved service assurance. The greater the dependence a customer has the more important service assurance becomes.

[2] http://www.siliconrepublic.com/comms/item/15230-eircom-to-embark-on-major-r

We would preferably like to see an open high capacity communications ‘pipe’ to the customer where we can configure our own services to support any level of differentiation. Where the services are handed over through the bitstream service (local) and (national) the transmission characteristics are limited although differentiation above this level is possible. We note the availability of the ‘do-it-yourself’ options where the operators use their own optics/DSLAMs and the backhaul fibre is presented to the operator. Although there are current questions of the commercially viability for other operators to use these options, they should be maintained as they provide the greatest opportunity to differentiate.

We have raised the issue of 112/999 access during discussions on NGA, and consider ComReg needs to make a clear statement regarding such over NGA to bring certainty to the market.

Q. 39. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to WBA products and associated facilities?.

A.39 Please see our response to question 18.

Q. 40. How should the issue of technical protocols and interfaces serving the interconnection of optical networks be approached? Please explain your reasoning.

A.40 Eircom should be open from the outset offering supporting documents of the processes, technical specifications and anticipated performance. The service should be as transparent as possible and include ways to manage and monitor the NTU for performance and faults. Industry discussions of the protocols and issues should continue until solutions are agreed.

We need this information to interoperate with Eircom’s network, use the Eircom service, manage performance to our customers and compete with Eircom in a fair and timely way.

Q. 41. Do you think that a requirement for the SMP operator to notify purchasers of WBA 6 months in advance of its launch of a retail products based on NGA inputs is necessary or adequate and, if so, how might it operate in practice? Please explain your reasoning.

A.41 The underlying rules for notification stem from Competition Law and Eircom should be providing sufficient information to enable other parties to be in a position to compete at the same time as their downstream businesses. We would like to make this observation and recommendations about Eircom development processes and notifications.

The industry often requests Eircom to develop new products or to update existing ones and Eircom adopts a fairly standard industry practice of using scheduled 'software drops' three or four times a year to introduce new product or service software. Our experience and observation is that it normally takes about a year for Eircom to develop and launch a new product. This means Eircom wholesale has knowledge of a new product for about 12 months prior to launch and could easily inform industry in ample time, if only to provide a roadmap and outline of its plans.

From an alternative operator view, larger operators also align with industry practice of software drops several times a year, and for operators using this approach six months is very tight to find out about a new key service from scratch. i.e. Where a 'cold' six months is provided (i.e. no prior knowledge) requiring a significant development there will be difficulties and longer notice should have been provided.

Where the development requirements or changes are small or already well sign posted, resource and finance will be in place and six months notification will work in most cases.

In practice we need road maps; outline plans well ahead of the details and the notification should align with time it will take to enable others to launch at the same time as Eircom's downstream businesses, but not less than 6 months.

Q. 42. What effective access, transparency or other safeguards are necessary to guarantee non-discrimination and how might such safeguards impact the need for of level of advance notification discussed above? Please explain your reasoning.

A.42 Our experience of the Irish market is that Non discrimination is extremely difficult to detect without robust transparency regulation. As we have commented on is other consultations, Non-Discrimination does not work properly without strong and effective 'transparency remedies'. For example, Eircom have the motives and opportunities to keep its internal trading issues secret, and indeed Eircom and its wholesale customers have the same motives to keep 'favourable' arrangements, (whatever they maybe) secret for commercial gain. Hence transparency remedies that force publication are very helpful and effective for flushing out discrimination.

For advance notification other providers should be given sufficient formal notice to enable them to compete at the same time as Eircom's downstream business, or other parties availing of favourable solutions.

In our view notification should therefore comply with the above principle and all operators should be informed at the same time of new proposals and with the same detail. Initial notification maybe a plan or statement of intention, with more detail and prices published later. For a major service offering a reference offer should be published for information and comment and agreed with industry giving it will form the contract between the parties. These steps provide transparency so operators can compete fairly and given the reference offer forms the basis of the contract it's reasonable and proportionate the other party should allowed to comment to it.

We also support the publication of comparison performance information as provided in the recent Decision (Ref D05/11) of ComReg to ensure all are being treated fairly for provision and assurance.

Q. 43. What specific non-discrimination remedies are required with respect to the provision of wholesale broadband access? Please explain your reasoning.

A.43 We believe the current non-discrimination remedies in Ireland have been proven to be virtually ineffective due to the difficulties for other operators to detect non-discrimination, and once detected the incumbent's regulatory and legal departments may work to undermine the regulation further.

Given the problem above, the NGA recommendation which advocates a 'strict equivalence' approach should be adopted in Ireland and a much tighter line taken in the remedies. Ideally Eircom should be functionally separated as the problems have become systemic over the years and we consider there is little if any trust that Eircom will act fairly. In the absence of functional separation ComReg should start applying Eircom 'strict equivalence' obligations rather the current 'loose' equivalence conditions.

Q. 44. Is a remedy requiring the publication of reference offers for specific NG WBA products necessary and if so, what should be contained within such a reference offer? Please provide reasons for your answer.

A.44 Yes a remedy requiring the publication of reference offers for specific NGA WBA products is necessary and such should contain all the requirements of the existing copper based Reference Offers including SLAs and performance targets.

This remedy is required to reduce non-discrimination and provide a workable and legal commitment (the reference offer is the basis for contracts) to wholesale customers.

To ensure the reference offer process is working, ComReg should introduce a new remedy to Audit Eircom's contractual agreements to ensure they align with the

Reference Offer. The reason for requesting this is we are concerned to ensure all use the same agreement.

Q. 45. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

A.45 Eircom simply publishing a reference offer is not good enough as it sets the conditions that suit Eircom and not its customers. Recent experience of the ARO 2 reference offer for WPNIA LLU has highlighted serious flaws in the process for introducing reference offers. The process should encompass a stage where the content is agreed between Eircom and the operators. Where agreement cannot be achieved, as was the case with the ARO 2 the disagreement should be determined by the regulator. In the case of the ARO 2 the industry body formally disagreed with certain conditions, Eircom published anyway and we are now in a situation with an ARO 2 that can't be signed by operators. This is ridiculous.

Q. 46. What form of price control would be the most appropriate and proportionate means of establishing the price of WBA access? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

A.46. Our view is that the most appropriate price control for NGA WBA at this time would be Retail Minus combined with cost plus civil engineering access and margin squeeze tests.

There is some indication that the market will bear the current UPC pricing for a triple play service including fixed voce, broadband and television, however it is not clear what price the market for Eircom NGA services will sustain and providers including Eircom need some retail flexibility. However, that said, some aspects of NGA encompass regulated cost plus inputs (NGA Recommendation for Duct etc) and it is thus important to maintain economic space between the two types of price control. It would thus appear appropriate that some form of price/margin squeeze test will also be required.

Q. 47. If an effective internal separation of Eircom were to be implemented how should this impact on ComReg's regulatory approach?

A.47 We simply don't believe Eircom is capable of effective internal separation as the behavioural issues have become systemic over the years. We have heard fine words from Eircom on numerous occasions in the past without any perceivable change in behaviour and there is little to suggest to us this is about to change. In dealing with Eircom wholesale we actually consider some aspects, such as its Chinese walls between wholesale regulated components and downstream wholesale solutions are worse rather than better at this time.

Fine words and professional slide-ware should not be the basis for impacting ComReg's regulatory approach and it could be argued that such would breach the regulations. ComReg should judge the need for regulatory remedies on market impact and not what Eircom says. The alternative approach (providing it's allowed under Irish law) is for ComReg to establish a legal agreement with Eircom to establish regulatory certainty.

Price controls for NGA Wholesale Products

Q. 48. Do you believe that the costing methodology options for determining NGA charges as outlined above are relevant and appropriate? Please provide NGA reasons for your response. Which is the most appropriate methodology and why?

A.48 We believe that the costing methodology options for determining NGA charges as outlined above are relevant and appropriate for consideration as they are based on standard regulatory methodologies. We agree with ComReg that there is a forward looking element to NGA investment as it will not be possible to take all the costs in the year the investment is made. i.e. the pricing will have to be set based on forecast costs and revenues over time and setting a current price. We consider that ComReg should consult separately on the pricing methodologies given the complexity involved.

Q. 49. Should ComReg distinguish between new investment (such as NGA specific equipment) and legacy assets (such as trench) which are used in the provision of NGA services? Please explain your reasoning.

A.49. We would expect a considerable part of the existing infrastructure should be available for Eircom to deploy NGA and cost savings should be taken, however it is important that equivalent services offered to others should be offered the same benefits.

Q. 50. What pricing issues might arise where the SMP operator is providing services over both copper and NGA networks concurrently? For example,

duplicating infrastructure in the same geographic area for a temporary period or in different geographic areas. Please explain your reasoning.

A.50. Firstly it is difficult to envisage changes to the existing service prices given the inconvenience and destabilisation such would cause to established customers. We acknowledge the new service cannot be priced at such a high level to prevent take up and the bitstream investment model offers one solution where forecast volumes are initially used to enable recovery over a reasonable number of years. Provided the service offers a significant additional benefit which is expected, it should be possible to supply at a modest premium to the existing services and keep both running for a temporary period of years rather than months. With regards to different geographic areas, i.e. outside the areas where Eircom will commercially invest in NGA, there is no certainty as to how NGA investment will be made and by who, such as the state, mobile industry consortia etc hence it's too early to discuss a solution other than we expect existing Eircom services to continue for many years in these areas.

Q. 51. Do you agree with the application of a risk premium as envisaged in the NGA Recommendation? As part of your response please address, insofar as possible, your views on the nature of any such premium, whether and how it could be measured and what its relationship to Eircom's existing (or a potential split) WACC should be.

A.51 In Ireland where others are setting the retail price for NGA its now too late to be discussing adding a risk premium as we believe the greater risk to Eircom is not investing. We agree a modest premium should be applied for a number of reasons.

- To reflect the additional costs
- To prevent the 'trashing' of existing services.
- To maintain the ability to re-invest and roll-out further.

Q. 52. Do you agree with the NGA Recommendation that any risk premium should only be applied to NGA/fibre specific assets and not to legacy copper based assets (for example, FTTH versus FTTN)?

A.52. Please see our answer to question 51. We believe it is too late to apply a risk premium given another player has already set the market price.

Q. 53. Do you believe that the WACC ComReg Decision from 2008 remains appropriate and applicable for NGA investment and allows for sufficient return

on investments made and to be made in the future? Please provide reasons for your response.

A. 53 We consider the ComReg WACC Decision from 2008 remains appropriate and applicable for NGA investment and at 10.21% in the current depressed environment in Ireland offers Eircom a healthy return on investments. We consider Eircom are making a healthy return and the WACC is generous to Eircom in the current environment.

Q. 54. Do you have any other observations or proposals in relation to NGA investment risk and whether there are mechanisms other that the WACC to account for risk in NGA wholesale pricing?

A.54 The situation in Ireland has changed over recent times and its now looking that Eircom's biggest risk is not investing in NGA as UPC take market share. Eircom can mitigate their risk through choice of deployment location and also technology deployed. We expect Eircom's retail pricing will be influenced by UPCs pricing and given equivalence etc we would expect Eircom's NGA wholesale pricing to be at a level to allow other providers the compete with both Eircom retail and UPC.

Q. 55. Do you agree that the factors above identified are the most relevant mitigators of risk? Should such factors be taken into account when determining whole pricing arrangements and, if so how? Are any safeguards necessary?

A.55. UPC has gone ahead and commercially deployed NGA solutions without the need for regulatory controls etc. Eircom is also not being forced to deploy NGA and we believe is having to respond to save its market share in the UPC areas. Hence our view is the key risk to Eircom in UPC NGA locations is not investing.

We agree with ComReg that both UPC and we expect Eircom will be mitigating their risk by only deploying in the most lucrative locations and not deploying where they don't believe a commercial return can be made. For Eircom their risk can be further mitigated by providing high quality open wholesale services so that where they don't make the retail sale, they still take wholesale revenue. ---Text deleted----.

For other locations where commercial deployment is not immediately viable we believe the most likely way to achieve investments is with GAP funding to bridge the gap between the uneconomic cost of investment and the point where investment is commercially viable. This approach minimises the cost to the state whilst at the same time stimulating the private sector (not just the incumbent) to invest in a viable prospect. We would expect the State involvement to impact the price charged.

Q. 56. In the context of upfront purchase commitments and volume discounts, are any safeguards necessary to ensure efficient investment and the development of effective competition? Please explain your reasoning.

A.56. Eircom retail is clearly the largest customer for Eircom NGA by a long margin and thus there is no need for upfront commitments and volume discounts as the main beneficiary will be Eircom retail.

Q. 57. Do you believe that all the relevant and appropriate options were considered above regarding the main principles for a margin squeeze test? Please provide reasons for your response.

A.57. NGA from Eircom in Ireland is not yet available and only a pilot service is planned at this time. Without a service in place it's not possible for us to be definitive, however we have concerns that the Eircom pilot backhaul prices, which are lower than their NGN prices for the what believe is the same service are exclusionary preventing others using the local service facilities Eircom claim to be offering.

Q. 58. Are ex-ante price controls or measures required in order to prevent margin squeeze? If so, what is the appropriate methodology to address margin squeeze and what factors should be considered by ComReg when specifying an imputation test (if this approach is deemed to be necessary)? Please explain your reasoning.

A.58 Yes. The exPost system is too slow and unpredictable and the damage from a margin squeeze will be done to competition well before such could be resolved in the courts. Ex-ante price control regulatory certainty both for the incumbent and the operators is important to establish the required stability to invest. Please also see our responses to question 15.

Migrations from Current Generation Copper Products to NGA Products

Q. 59. Should Eircom be required to maintain existing copper network infrastructure in parallel with NGA network upgrades? If so, then for what period of time? Under what circumstances could a shorter period of parallel operation be appropriate?

A. 59. Incumbent operators are masters of integrating new with legacy systems and NGA should be no different. A key financial issue is that Eircom should not be tempted to rip out deployments not fully depreciated (unless absolutely necessary) as such could cause a significant adverse peak in the company accounts.

Eircom are planning to pilot NGA over the next year and this will provide them both practical and commercial information and thus it’s too early to consider pulling out existing infrastructure. Additionally, we should not underestimate the difficulty and cost of rolling out NGA, particularity if Eircom intend to provide fibre to the customer premises. With Eircom being financially constrained it’s likely to take several years to for Eircom to get a sizable fibre footprint to the premises. At this time we cannot see any removal of the PSTN before the next 5 to 10 years in the key urban areas and a lot longer in areas where NGA is not deployed by Eircom.

Q. 60. What forms of fully equivalent access at the points of interconnection (such as exchanges), might justify an advance notice period for decommissioning of less than 5 years? Please explain your reasoning.

A.60. This question is coloured by the deployment of LLU services in exchanges where we would expect Eircom to roll-out NGA (given high customer densities). ---Text deleted----.

For other services, past experience has shown the industry has been able to negotiate with Eircom the closure and re-routing of traffic on a commercial basis and such should be possible to a limited degree. However, a widespread undoing of infrastructure competition is not seen as viable given other party investments.

Q. 61. In an NGA setting, what are the most appropriate migration paths that need to be put in place and what are the main technical, operational or commercial issues that would need to be addressed? Please explain your reasoning.

A.61 Platform Migration - Initially we would see the migration to NGA through customers seeking to upgrade services rather than a bulk move approach. In later years where most customers have migrated a bulk approach may become financially viable but such would have to be reviewed nearer the time.

Service Migration - We know the incumbent will not be the only infrastructure provider of NGA in Ireland given the emergence of alternative platforms such as UPC, mobile LTE and even the possibility of other operators or consortia rolling out parts of the country. Our view is migration paths should be possible and exist between the numerous platforms. Given such alternative providers the industry should not be restricted to the migration solution of the incumbent as in many instances such will not be involved, hence some form of central clearing system may be required. However, to avoid cost and complexity such should be simple and more of a registry rather than a transactional system. Common migration protocols and processes could be developed for operators to communicate with each other as is the case with fixed number portability today.

Q. 62. Are commercial arrangements likely to lead to the most effective outcome in ensuring that an efficient and transparent migration process takes place? Please explain your reasoning

A.62. Our experience in Ireland is that there are two reasons for Eircom to negotiate. The first is when Eircom want something and the second is when there is a 'regulatory stick'. Hence the existence of a regulatory requirement is the best way to ensure commercial discussions are conducted to the benefit of industry and the market.

Q. 63. How should ComReg ensure that the systems and procedures put in place by Eircom, including operating support systems, are designed so as to facilitate the switching of alternative providers to NGA-based access products? Please explain your reasoning.

A. 63. As in per our answer to question 61 we do not consider that Eircom will be the only provider of NGA in Ireland going forward and as such Eircom should be working with other providers and potential providers on migration solutions. We have had poor experiences of Eircom putting things in place without detailed agreement of the industry which often don't meet the needs of industry. Therefore we need a regulatory remedy to ensure systems and procedures are put in place, but the remedy should also oblige Eircom to discuss and agree the solutions with industry.

Q. 64. What would be an appropriate and proportionate regulatory approach for ensuring that information around Eircom's network and its extension plans are made available to WPNIA and WBA access seekers? Please consider issues regarding commercial sensitivity and network integrity when explaining your reasoning.

A.64 Our view is that the requirements of Eircom retail basically drive Eircom network and product development, with wholesale access seekers subsequently being informed that the development is going ahead. Despite Eircom's public statements on wholesale separation, we have seen this practise continue with the recent joint NGA/IPTV announcement without any fore notice of the NGA programmes to Industry. It is our view that, in parallel to Eircom retail being made aware a development is going ahead, the exact same information should be made available to authorised access seekers on the basis of equivalence.

Without such an approach other providers cannot provide downstream services in a fair competitive environment.

Q. 65. What should be the format and level of detail to be contained in the network information above and how can the strict confidentiality of such information be maintained? Please explain your reasoning.

A. 65 We have been dealing with such issues for many years and Eircom could readily provide such information behind a password protected gateway.

End

3 Eircom Ltd.

ANNEX 2 – Response to ComReg Consultation Questions (1-65)

1. **Do you consider that the risks identified above are those most closely relevant to investment in NGA? What might be the degree of impact of such risks, how might they change over time and how might they be quantified? Please explain your reasoning.**

1.1 eircom agrees with ComReg's observations of NGA investment risk under headings of demand uncertainty, sunk investment and the cost of deployment, technological uncertainty, uncertainty around competitive pressures, macro-economic uncertainty, and regulatory risk.

1.2 However, it is important to bear in mind that these are not independent risks. Moreover, the regulatory risk associated with particular remedies can significantly increase (or mitigate) the impact of other types of risk.

Demand uncertainty

1.3 ComReg's description of demand uncertainty reflects the normal unavoidable commercial risk that an NGA operator faces.

1.4 However, demand itself will be impacted by potential regulatory remedies. For example, if "economic space" is imposed within margin squeeze tests to compensate for the comparatively lower efficiencies of smaller operators in the provision of downstream services, this will result in either (i) the retail prices offered by eircom being higher than necessary, which would reduce demand, or (ii) wholesale prices being lower than appropriate, thus reducing economic returns to eircom on its NGA investment to an unacceptably low level.

Sunk investments and the cost of deployment

1.5 ComReg's description of sunk investments and the cost of deployment places heavy emphasis on the potential benefits of adopting a "wait and see" approach. While this strategy can avoid some early technology adoption risks, it does not recognise that it is not possible to await clarity and that investment decisions will be become unavoidable even in the face of considerable uncertainty. As a consequence of a decision by eircom to commence investment when market demand is unclear and at a time when NGA regulation is only now at an early stage of consultation means that eircom will be subject to major risk components of sunk (stranded) investments and the cost of deployment. The majority of sunk investment risk cannot be avoided under a wait and see strategy, as market and commercial imperatives will require that significant capital must be invested that may be largely unrecoverable.

1.6 Paragraph 2.13 of the Consultation Document states:

> *"For this reason, the 'lower rung' wholesale products on the 'ladder' such as resale of bitstream services allow for alternative operators to reduce their own initial exposure to risk by gauging consumer demand and establishing an initial customer base via access*

> *options that require less up-front investment (and utilise the SMP operator's existing infrastructure, which is subject to lower risk since the investment is already sunk)."*

1.7 This statement is fundamentally flawed insofar as it suggests that risk can be avoided. Once investment is made by the NGA investor, it is sunk and that creates investment risk for all parties investing in services, equipment and facilities utilising NGA. What is described in the text above is a mechanism whereby an alternative operator can avoid risk by shifting it to, and leaving it with, the SMP operator. Overall risk is distributed between the NGA investor and the alternative operator. This risk shifting, however, actually increases the risk for the NGA investor by making it more difficult to predict demand, in the absence of a mechanism designed to mitigate that risk (such as a minimum up-front volume commitments from OAOs).

Technological uncertainty

1.8 The description of technology uncertainty also places heavy emphasis on the potential benefits of adopting a wait and see approach. Technology choice is not an unconstrained choice. It is strongly linked to other uncertainties such as demand uncertainty and economic uncertainty.

1.9 Technology must be chosen within the constraints of what is likely to be affordable and practical. In an ideal world, investment in point to point fibre would offer the lowest technological risk, but it may simply not be affordable or practical. As a consequence, business and investment choices must be made on the basis of combinations of multiple factors.

Uncertainty around competitive pressures

1.10 Paragraph 2.37 of the Consultation Document states:

> *"While competitive pressure is likely to be present in some geographic areas of Ireland, the scope of competitive threat is relatively predictable (compared to overall demand uncertainty). Ireland has a low population density, with 39% of the population living in rural areas with a population density of less than 60 people per square kilometre. Given the relatively sparse population spread in Ireland, the replication of fixed NGA networks is unlikely outside the medium to high density areas (at least in the short term)."*

1.11 The implications of this statement are that the risk to NGA investment posed by competitive pressures is relatively low in Ireland. This, however, is a complete misreading of the actual situation on the ground. In fact:

(i) UPC is nearing completion of upgrading its cable network to DOCSIS 3.0, supporting broadband speeds of 100 Mbps and higher, and their network covers most if not all of the CVAs that will be covered by NGA;

(ii) moreover, broadband is not a core service offering for cable television networks but an "add-on" service that is offered as part of the core pay-television offerings of UPC ; and

(iii) as recognised in the above statement, NGA will be commercially viable in urban medium and high density areas and, therefore, any new deployment will face competition from an existing ubiquitous ultra-fast broadband network that has already captured the overwhelming share of the market in CVAs. In these same areas, self-build will also be commercially viable for OAOs in the most cost-effective locations.

Consequently there is a high level of certainty that competition will be intense when NGA is rolled out in CVAs.

1.12 More generally, the uncertainty around the risk of competitive pressure is very closely related to demand uncertainty (as discussed above) and is also susceptible to being impacted by potential regulatory remedies.

1.13 Paragraph 2.16 of the Consultation Document states that the application of the ladder of investment principle is based on the assumption that:

"… ultimately competition is the main driver of investment, and that appropriate access products are a pre-condition for competition in an industry still characterised by the continued dominance of incumbent firms as well as by large economies of scale."

1.14 It is clear from the reference to "… dominance of incumbent firms …." that the assumption refers to European markets more generally. Accepting this generality in the case of Ireland is flawed for several reasons:

(i) the scale of the majority of eircom's European neighbours' markets far exceeds that of Ireland, and their incumbents (and in some cases, alternative network operators) enjoy greater scale than eircom ; and

(ii) competition in Ireland is now dominated by multi-national competitors that have much greater scale on a regional basis than eircom, including UPC, BT, Vodafone and O2. This gives these competitors significant efficiency advantages in terms of the downstream retail costs of providing both legacy fixed-line and NGA-based services in Ireland compared to eircom, which is not part of a regional European group and must develop products and marketing solutions on a stand-alone basis.

1.15 For these reasons, the assumption in Paragraph 2.16 ignores the unique circumstances of the Irish marketplace - in particular, in CVAs where OAOs are likely to offer NGA-based services. This should be a key input in ComReg's competitive assessment and its consideration of proportionate NGA remedies.

Macro-economic uncertainty

1.16 The Consultation Document's description of macro-economic uncertainty does not adequately reflect the risks that an investor faces in Ireland, as indicated in Section 1 of the Preliminary Response. In particular, it should be noted that the macro-economic risks in Ireland are significantly greater than those faced by the majority of our European neighbours. Ireland's economy has been more severely impacted by the economic recession and by particular issues such as the banking and property crisis.

1.17 Paragraph 2.24 of the Consultation Document states:

> *"These factors are all taken into account explicitly in the weighted average cost of capital (WACC), which is used by ComReg when costing products provided by eircom on its network."*

1.18 Paragraph 2.39 states:

> *"Any impact of the macro-economic uncertainty may fall to be considered as part of the future examination of the WACC."*

1.19 These statements do not reflect the macro-economic uncertainty that already exists. That is:

(i) although ComReg set the WACC to include economic uncertainty in May 2008, that work was completed before the full depth of the economic recession became apparent; and

(ii) paragraph 2.39 refers only to '…may fall to be considered …. '.

1.20 In any event, as in indicated in section 1 of the Preliminary Response, UPC has already secured a significant head-start and has already captured a larger market share than eircom Retail within the CVAs. The result is that retail market prices are set by the UPC offers. This has impacted the economic value of eircom's existing assets as the market is now willing to pay lower prices for broadband than before. This means that UPC's retail price effectively precludes a high WACC that could compensate eircom for its investment risks, economic or otherwise.

Regulatory risk

1.21 The Consultation Document describes regulatory risks as the lack of clarity or certainty about the intended or future regulatory approach, and the long useful life of the assets concerned. This is an incomplete assessment of the actual regulatory risks involved in deploying a new NGA network.

1.22 In particular, very considerable regulatory risk arises from the process of regulation itself. For example, even if there is certainty about the type of economic model to be employed, the actual implementation will require decisions on multiple subjective elements. The choices made by the regulator can create serious market distortions, for example, through the specific application of the cost standards and methodologies chosen, or through the extent to which forward-looking market developments can be foreseen and modelled.

1.23 Seeking to protect efficient investment at all levels of the ladder of investment introduces further distortions, particularly when there is no apparent endpoint for the "protection" of competitors operating comfortably at the lowest rungs on the basis of an artificial arbitrage play created by regulation. For example, after more than a dozen years of competition in the Irish marketplace, the imposition of "sufficient" economic space within one layer of the market to compensate smaller, less-efficient operators for their lack of scale, puts eircom as the SMP operator at a competitive disadvantage to multi-national competitors operating downstream, which are now the norm in Ireland. When the ladder of investment becomes a crutch for competitors whose business models hold no prospect of viability without regulatory protection, it is impossible to avoid distortion in multiple layers of the wholesale and retail value chains. This is of particular concern in CVAs, since all of these wholesale layers with "economic space" between them must fit below, and be consistent with, the aggressive retail prices that are increasingly set by competitive platforms (cable broadband and also mobile broadband).

1.24 While the regulatory process as a whole is intended to protect competition for the benefit of end users, there are inherent distortions in conducting multiple competitive assessment cost modelling exercises, and in developing remedies at multiple layers within the wholesale and retail businesses, since for various reasons, the process is far from scientific and necessarily relies on estimates and subjective decision-making. As previously explained, the risks are particularly acute in the Irish market where demographics are very challenging. Consequently there is a significant risk that regulation will reduce rather than increase NGA investment incentives and the scope of its deployment in CVAs.

1.25 To the extent that regulated intermediate service components exist within the wholesale and retail layers of the market, judging business and investment risk becomes much more difficult and business prospects become more uncertain.

1.26 Another aspect of the regulatory risk associated with NGA investment for an SMP operator is that associated with regulatory price controls, which affect the return that the investor can achieve. A price control for wholesale access services will apply as a remedy to limit the market power of the investor – and this pricing control will move towards "cost orientation" at some point. As the NGA network will share facilities with eircom's legacy copper access network, a critical decision in setting cost-orientated prices for NGA access services is the basis for sharing the costs of common infrastructure between NGA and LLU access services. Across the EU, access seekers are mounting a concerted campaign calling for NGA investments to be accompanied by LLU price reductions. This is not a justifiable approach, as there is a significant risk, if adopted, that either that the allocation of infrastructure costs away from copper towards fibre access will lead to wholesale NGA prices above the competitive level required to achieve sufficient penetration to generate a return, or that NGA infrastructure costs will become stranded. Both options create strong disincentives for the deployment of NGA in any but the highest density areas.

2. **Do you consider that, in the context of the terminology set out in the NGA Recommendation, the above Figures 3 and 4 provide an accurate representation of Eircom's proposed network architecture? Please explain your reasoning.**

2.1 The figures 3 and 4 represent a reasonable if somewhat simplified view of the unbundled access products being made available by eircom for the current industry pilot with one significant clarification as outlined below.

2.2 It is incorrect to suggest that the "terminating segment" as defined in the NGA Recommendation would run between the eircom fibre cabinet and the customer premises ONT as is depicted in Figure 3. "The 'terminating segment' is defined as the segment of an NGA access network which connects an end-user's premises to the first distribution point". In eircom's FTTH pilot architecture the DP is the first distribution point.

2.3 In the context of the NGA Recommendation the terminating segment does not extend for any great distance into the distribution network, rather it starts either in the same building as the customer or in an underground chamber near the customer's premises. The buildings envisaged in the recommendation are high density multi-dwelling units. This point is elaborated upon below.

2.4 The NGA Recommendation defines the terminating segment as:

> *"The 'terminating segment' means the segment of an NGA access network which connects an end-user's premises to the first distribution point. The terminating segment thus includes vertical in-building wiring and possibly horizontal wiring up to an optical splitter located in a building's basement or a nearby manhole."*

2.5 The definition clearly states that the first distribution point is near to the customer's premises, while the fibre cabinet will typically be hundreds of meters away from the customer's premises.

2.6 In the context of eircom's pilot FTTH architecture, the terminating segment is the "Drop" which connects the ONT in the customer's premises to the first DP. The DP will typically be located in a manhole or mounted on a pole close to the customer's premises. In turn, all of the first DPs serving an area are connected back to the eircom fibre cabinet.

2.7 Under the recent DCENR consultation document, DCENR11/01, the terminating segment for new houses would run between an open access meet me chamber within the curtilage of the residence and the ONT in the customer's premises.

2.8 It is also incorrect to suggest that the "terminating segment" as defined in the NGA Recommendation runs between the eircom FTTC cabinet and the customer premises ONT/NTU as is depicted in Figure 4. The term "terminating segment" is only used in the context of FTTH in the NGA Recommendation. In any event, if it were appropriate to consider FTTC, the terminating segment would run between the DP and the NTU in the customer's premises and not between the FTTC cabinet and the NTU.

3. **Do any of Eircom's proposed pilot wholesale products align to the potential access remedies set out in NGA Recommendation? Please explain your reasoning? This question should be addressed in light of the following discussion on WPNIA NGA and WBA NGA. Do any of Eircom's proposed pilot wholesale products align to the potential access remedies set out in NGA Recommendation? Please explain your reasoning? This question should be addressed in light of the following discussion on WPNIA NGA and WBA NGA.**

3.1 Yes, all of the eircom proposed pilot wholesale products align with access remedies set out in the NGA recommendations.

3.2 However, as explained in the *Section 2: Overview of eicom's plan for the deployment of Next Generation Access*, eircom's proposed rollout will be based on a hybrid fibre-copper solution and will be based on Virtual Unbundled Access (VUA).

3.3 Accordingly, in our response we focus on the services that will be included in the NGA rollout and explain how these offer the best approach to meeting OAO and end-user customer needs.

Proposed *NGA* wholesale products
Virtual Unbundling Access (VUA), FTTC-based • Down/Up broadband speeds of up to 50Mb/s:20Mb/s • A VUA service based on shared access infrastructure - Fibre to the Cabinet (FTTC) - Direct Fibre from the exchange to a kerbside cabinet - Individual customers served using VDSL2 connections over a copper sub-loop • Product terminates at the Master Socket in the customer's premises • Ethernet handoff to operator with Traffic aggregation at local exchange • QoS enabled to support Video and VOIP services; Traffic-based, Dot1p Marking • Supports distribution of multi-cast services • Range of local handoff options - Within the local exchange (In-building) - In-Span - Customer-sited
Wholesale VDSL2-based Bitstream Product, a significantly enhanced BitStream service with new features and higher speeds supported by FTTC. • Ethernet transport service • QoS enabled to support Video, VOIP and other value added products being delivered over the Bitstream product Multi-cast distribution service offered in parallel **Option 1: High Speed Internet** (Up to 50 Mb/s Downstream, 20Mb/s upstream), Rate adaptive, Max Speed, Min Latency, RealTime CoS for VOIP **Option 2: Stable, to support IPTV services etc** (Up to 35 Mb/s Downstream Fixed Profile, Up to 16Mb/s Upstream Rate-Adaptive) **FTTC Bitstream Multicast** - Shares Unicast Downstream bandwidth
Virtual Unbundling Access (VUA), GPON FTTH-based • Down/Up broadband speeds of 150Mb/s:30Mb/s • Supports distribution of multi-cast services Similar to FTTC, including Ethernet handoff and options, with the following product specific characteristics - GPON Fibre-to-the-home (FTTH) access - Over a Gigabit Passive Optical Network - Product terminates at the ONT in the customer's premises - Fixed speed (Downstream/Upstream; 150Mb/s:30Mb/s)
FTTH Bitstream Plus (150Mb/s Downstream, 30Mb/s Upstream), a significantly enhanced BitStream service with new features and higher speeds supported by FTTH with an Multi-cast distribution service offered in parallel

VUA is optimal in the Irish context for a variety of reasons:

(1) VUA offers the best potential to maximize broadband speeds for all users of eircom's network because it enables deployment of new technologies (e.g. vectoring, bonding, etc.);
(2) VUA is vastly more cost-effective than actual unbundling;
(3) an appropriate VUA pricing structure can pass the benefits of LLU economics on to OAOs; and
(4) as a feature of the VUA offering, eircom will provide Ethernet backhaul services to OAOs.

The products proposed will allow Operators to:

- Differentiate their broadband portfolio into consumer and business markets
- Develop triple and multi-play offerings
- Concentrate on developing innovative value-added propositions
- Launch broadband products with different quality levels
- Choose their own approach to customer authentication and management

Notes:

1. Carrying forward a number of products from those that have been under development for the Fibre Pilot has distinct advantage. Considerable development work has already been undertaken and much information on those products that will carry through from the Fibre Pilot to the NGA rollout has already been developed and published. Specifically, product specifications, technical manuals, inter-operator process manuals, systems interface specifications and user training material has been productised and reviewed by industry through the industry pilot leadership group. These documents are published on the eircom Wholesale website.

2. While it is expected that eircom will in the future develop further proposals for removal of legacy copper products, it is intended to maintain copper-based PSTN services and their wholesale equivalents for the foreseeable future. Eircom also recognises that current regulatory obligations on exist that restrict the withdrawal of wholesale services, and any changes to these obligations would have to be endorsed by ComReg.

4. **Are there any circumstances in which regulated access to civil engineering infrastructure would not be required? Please explain your reasoning.**

4.1 eircom intends to deal with each request for access to civil engineering infrastructure on a case-by-case basis. Where spare civil engineering infrastructure is available for use by the OAO, eircom could provide access to the same (i.e. where space already exists). Where eircom is building new ducts, trench sharing arrangements could be agreed that involve the user paying a proportion of the costs based on the capacity taken. It would be counterproductive, by unreasonably increasing eircom's investment risk, to require eircom, when building out the NGA, to construct spare infrastructure so as to allow OAOs access to the terminating segment on a speculative basis, i.e. where demand remains uncertain.

4.2 It is also highly unlikely that an access seeker will find it commercially viable to connect to customers via access to the terminating segment. The commercially viable option for access seekers for the foreseeable future is to connect to customers via Virtually Unbundled Access ("VUA"). As eircom is committed to providing its VUA product from the main exchange, there should be no need to impose a requirement to offer access to civil engineering infrastructure.

5. **Having regard to market demand, technical, economic and other considerations, is there a requirement for a duct access remedy? Please explain your reasoning.**

5.1 In general it is hard to see where demand for duct access will arise in the context of eircom's NGA investment. As discussed in eircom's Preliminary Response (see in particular, section 2.1), its investment will primarily be in FTTC architecture.

5.2 It is possible that duct access could be used for an OAO considering unbundling the eircom NGA on the D-side - between the eircom cabinet and the customer. This only has the potential to yield an economic return if eircom deploys FTTH. Where eircom deploys FTTC, there is no economic case for a single FTTH investment – and far less for FTTH in parallel with the eircom VDSL service. For the FTTH D-side, the OAO might rent eircom ducts to deploy competing fibre. But because this form of deployment will be limited – both within exchanges and by exchange – the risks to the OAO of not reaching sufficient potential customers will be high.

5.3 For all these reasons duct access is unlikely to be a service with an economic role for OAOs in delivering NGA services. To the extent that a commercial case can be made and space is available (or will be co-financed by the requesting OAO), eircom will commit to negotiate a commercial arrangement with OAOs, with resort to ComReg if a mutual agreement cannot be reached in a reasonable period of time.

6. **What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to civil engineering infrastructure?**

6.1 It should be recognised that one of the aims of the Access Directive is to support the progressive reduction of *ex ante* regulation as competition develops and, ultimately, for electronic communications to be governed by competition law only. Any proposed remedy governing access to civil engineering infrastructure must have this principle at its core.

6.2 The most relevant factors identified in Article 12(2) of the Access Directive are:

(i) the feasibility of providing the access proposed, in relation to the capacity available;

(ii) the initial investment by the facility owner, taking account of any public investment made and the risks involved in making the investment; and

(iii) the need to safeguard competition in the long term, with particular attention to economically efficient infrastructure-based competition.

6.3 ComReg must also consider, in circumstances where access to the civil engineering infrastructure is not technically or economically viable, that the provision of non-physical or virtual network access offering equivalent functionality may be the only proportionate remedy.

7. **Should ComReg encourage Eircom to build additional duct capacity for use by third parties and, if so, how? Please explain your reasoning.**

Please see responses to questions 4 to 6 and eircom's Response (section 2.5).

8. **If a remedy requiring the provision of access to civil engineering infrastructure were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Would a risk premium be warranted? Please provide a reasoned response for each of the principles.**

8.1 There are two possible approaches to a remedy requiring eircom to provide access to civil engineering for future NGA investments as a remedy to eircom SMP in the market for wholesale physical network infrastructure access. The approach selected will determine the level of risk premium appropriate in setting access charges for OAO use of the eircom civil engineering. One approach is to allow eircom to build civil engineering works that are necessary to carry its own cables and electronics in accordance with normal eircom engineering rules and enter into commercial arrangements with OAOs where there is sufficient (committed) demand.

8.2 An alternative approach to the remedy would be to require eircom - when building out the NGA – to construct spare infrastructure so as to allow the OAO access to the eircom terminating segment using its own cable and electronics. For reasons previously explained in response to questions 5 and 7, this is not a solution that is economically viable.

8.3 If eircom has discretion as to where and when to build additional civil works for the NGA roll out, then no risk premium should be applied to the charge for the access seeker based on the average cost to eircom of providing the facility used. If the access remedy requires eircom to build additional civil infrastructure at deployment to anticipate access seeker demand then a substantial risk premium is justified, as failure by access seekers to avail of the additional capacity will increase eircom's unit costs.

9. **What form of price control would be the most appropriate and proportionate means of establishing the price of access to civil engineering infrastructure? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.**

9.1 As noted above, ComReg has asked a question on the form of price control for several different elements. There should be serious consideration of the need for internal consistency across these elements.

9.2 As a preliminary matter, eircom believes that there is no reasonable way to impose an *ex ante* price control on civil infrastructure works. The pricing should be left to commercial negotiation, with ComReg intervening if the parties are unable to reach a mutual agreement in a reasonable period of time.

9.3 Theoretically, there are three possible approaches to *ex ante* price controls:

(i) Cost-oriented benchmarking;

(ii) retail minus; and

(iii) cost orientation

9.4 Cost-oriented Benchmarking can be ruled out immediately, as the nature of telecommunications civil infrastructure pricing is that it largely depends on local factors such as wage rates, carriageway and footway building practices, and population dispersion. Prices from other countries are unlikely to be an indication of costs in Ireland.

9.5 Retail minus pricing is complex enough when applied to active wholesale service pricing, and extremely complex when applied to passive wholesale products such as LLU because of the range of assumptions required for calculation of the retail service usage per unit of infrastructure, it should be excluded *a priori* as a potential methodology for infrastructure pricing.

9.6 Cost orientation based on the average costs of building and operating civil infrastructure would be appropriate if all cost factors could be foreseen in advance (which is rarely possible where civil engineering works are concerned).

10. **Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the terminating segment? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.**

10.1 By the terminating segment eircom understands this to mean that part of the access network from the last distribution point to the end user premises, typically the nearby serving pole or underground chamber.

10.2 In any event, having regard in particular, to market demand, technical, economic and other considerations (as indicated elsewhere in eircom's Response), eircom believes that there is no requirement for a remedy mandating access to the terminating segment.

11. **What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the terminating segment?**

Please see the response to question 6 above. As discussed in eircom's Response, the provision of non-physical or virtual network access offering equivalent functionality is a proportionate and reasonable requirement, and there is no justification for mandating access to the terminating segment.

12. **Where is an appropriate distribution point to which access to the terminating segment should be provided, particularly given the need to ensure that it host a sufficient number of end-user connections to be commercially viable for an access seeker?**

    See response to question 11. (Access to the terminating segment would need to be *at* the terminating segment by definition i.e. the DP in eircom's access network).

13. **Should ComReg seek to encourage Eircom to deploy multiple-fibre lines in terminating segments and, if so, how? Please explain your reasoning.**

    As discussed in eircom's Response (section 2.1), deploying multiple fibre lines in terminating segments will add cost and inefficiency to the network build.

14. **If a remedy requiring the provision of access to the terminating segment were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Please provide a reasoned response for each of the principles.**

14.1 eircom has offered unbundled access to the terminating segment in the context of the current FTTH pilot in Sandyford and Wexford. To improve the economics of this access service eircom has also offered use of eircom E-side fibre and fibre cabinet splitters to backhaul the unbundled fibre optical streams to the eircom exchange where the OAO electronics are located. None of the access seekers has even chosen to trial this option. So, in the context of the limited FTTH deployment proposed for the eircom NGN investment, it is highly unlikely that an access seeker will find it commercially viable to connect to customers via access to the terminating segment. The commercially viable option for access seekers for the foreseeable future is to connect to customers via a virtually unbundled leased line access. As eircom is committed to providing its VUA product from the main exchange there should be no requirement to provide access to civil engineering infrastructure.

14.2 The measures set out in Annex II of the NGA Recommendation would, if applied in this context, place a disproportionate burden on eircom. Looking at each of the principles in more detail:

Principle of equivalence

14.3 By providing its VUA product, eircom would be using its civil engineering infrastructure under the same conditions for internal and third-party access seekers. In providing its VUA service there is no requirement to share information pertaining to infrastructure characteristics.

Information on the civil engineering infrastructure and the distribution points

14.4 By providing its VUA service there is no necessity for eircom to share with OAOs the organisation of eircom's civil engineering infrastructure as well as the technical characteristics of the different elements of which the infrastructure consists. eircom will however provide a Technical Manual containing all the necessary technical details of the wholesale products that it sells.

14.5 Not only is it not currently feasible, there is also no real benefit to eircom providing information on the geographical location of the civil engineering infrastructure or distribution points (i.e. ducts, poles and other physical assets (e.g. maintenance chambers), or the available space in ducts).

Ordering and provisioning of access

14.6 By providing its VUA service there is no requirement to implement the procedures and tools necessary for ensuring efficient access and use of its civil engineering infrastructure and distribution points.

Service level indicators

14.7 In providing its VUA service there is no need for eircom to share civil engineering infrastructure information with OAOs. There is therefore no requirement to measure the responsiveness of the SMP operator to perform those actions necessary to provide access to its civil engineering infrastructure.

Reference offer

14.8 In providing its VUA service there is no need for eircom to share civil engineering infrastructure information with OAOs. There is therefore no requirement to develop a reference offer containing the relevant procedures and tools for retrieving civil engineering asset information; describing the access and usage conditions to the different elements which make up the civil engineering infrastructure; describing the procedures and tools for access ordering, provisioning and fault management; or fixed target service levels and the penalties for breach of those service levels.

Monitoring by the NRA

14.9 In providing its VUA service there is no requirement for ComReg to ensure that eircom keeps track of all elements necessary to monitor compliance with the equivalence of access requirement.

Asymmetry of information

14.10 By working closely with OAOs, eircom already has knowledge of third-party access seekers' deployment plans and has the structure in place to prevent such information being shared with its downstream retail arm.

14.11 In any event and as previously indicated, eircom will deal with each request for access to civil engineering infrastructure on a case-by-case basis. Where spare civil engineering infrastructure is available for use by the OAO, eircom could provide access to the same. Where eircom is building new ducts, the existing trench-sharing arrangements could take place where the user pays a proportion of the costs based on the capacity taken. It is not appropriate to require eircom, when building out the NGA, to provide spare infrastructure so as to allow the OAO access the eircom terminating segment using their own cable and electronics.

15. **What form of price control would be the most appropriate and proportionate means of establishing the price of access to the terminating segment? e.g. cost model (cost plus or**

retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

15.1 As noted above, ComReg has asked a question on the form of price control for several different elements. There should be serious consideration of the need for internal consistency across these elements.

15.2 The Commission recommendation on regulated access to NGA identifies several forms of access to the terminating segment of the SMP operator NGA network. ComReg has identified these in ComReg 11/40 Figure 3 and Figure 4 as:

(i) Access to the terminating segment in the case of FTTH at the "eircom Fibre cabinet"; and

(ii) Access to terminating segment in the case of FTTC at the "eircom FTTC cabinet" being the copper sub loop.

These definitions are not consistent with the definition of the Terminating Segment defined in the NGA Recommendation as quoted in 3.35 of ComReg 11/40.

15.3 As indicted above, eircom does not propose to provide FTTH except in those niche areas where FTTC is not feasible. Furthermore, eircom will not be able to provide access to the terminating segment and still provide the kinds of speeds called for in the Digital Agenda due to the vectoring issue. However, eircom has nonetheless responded to this question on pricing below, given that pricing issues arise in any event in the NGA context.

15.4 The price for access to eircom copper sub-loops accessed at the cabinet has already been offered at cost-orientated rates on the same basis as MDF access to full copper loops. Eircom proposes that this continues to be the basis for pricing access to FTTC rather than access at the terminating segment.

15.5 Prices for access to the sub-loop at the cabinet, rather than at the terminating segment in the case of FTTH could also be set on the basis of the LLU cost model but for three matters that require serious additional consideration. These are:

(i) the incremental cost above the costs of copper access in connecting a premises once passed by the FTTH infrastructure;

(ii) the penetration of FTTH services with resulting impact on unit costs; and

(iii) a premium return above the eircom WACC to recognise the FTTH investment risk.

15.6 **The incremental cost of connecting a home**: the initial investment in all FTTH access networks introduces fibre optic cable into the network of trenches, ducts, and distribution points that passes each house. There is a substantial additional investment required to provide the fibre link from the distribution point into the house to be served. Depending on the mix of underground and overhead feeds into the houses served, the cost may be between €300 and €500 per house connected. For this reason this investment is not likely to be made until the customer orders the super-fast Broadband service. There are two ways to treat this cost when setting prices for access to the sub-loop. The simplest treatment would be to charge the OAO the cost of connecting the house at the time of connection; however, a connection fee averaging €400 runs the risk of suppressing wholesale demand. The alternative treatment is to capitalize the cost of the customer connection; however, then eircom would have to consider how to generate an appropriate annual charge – with no advance information on the lifetime of such a connection.

15.7 **Penetration of FTTH services**: the initial investment in all FTTH access networks introduces fibre optic cable into the network of trenches, ducts, and distribution points that passes each house. To develop cost-orientated pricing for access to the sub-loop we need to project a unit capital cost per service delivered. There are two large elements of uncertainty among the factors that determine this unit cost. One is the basis for sharing the costs of the network of trenches, ducts, and distribution points that delivers both copper and fibre services to the houses passed. The other is the take-up level by the customers in those houses of the fibre-delivered services. ComReg can – and should now – indicate clearly the consistent basis for treating these assets in pricing unbundled access to copper and fibre loops in the resulting NGA network.

15.8 **Risk premium**: the issue of a risk premium relates to both of the uncertainties described above – take-up rates and service lives for fibre services. The use of any cost model to set the price for wholesale access to the sub-loop early in the NGA deployment will require ComReg to project the ultimate stable levels for these two key parameters. This pricing approach will require eircom to take the risk that these levels will never be reached, so that the resulting wholesale access is provided below cost to OAOs. Given that these access prices will be the underlying cost for providing next generation services into a competitive retail market there will be no meaningful opportunity to raise the access charges in the future. Conversely, if the cost per house connected and the service penetration rate are better than projected, the access price will fall after review. So the risk associated with projecting the key parameters are all on the eircom side. This must be recognized in the returns available from the NGA investment – particularly in the return available from regulated access to the sub-loop.

15.9 The combined effect of these three factors is to render the cost model that has been appropriate for pricing LLU full and sub-loop access not a suitable basis for setting FTTH prices in the medium term. Even quite favourable assumptions around the matters raised above would lead to cost-orientated charging above the level that would support access at competitive retail rates.

Unbundled access to the fibre loop

16. **Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled fibre loop? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.**

Please see eircom's Response for a detailed description of eircom's proposed network architecture (section 2.3).

17. **Are obligations to provide access to associated facilities necessary and, if so, what should these encompass? Please explain your reasoning.**

Please see eircom's Response for a detailed description of eircom's proposed network architecture.

18. **What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities?**

Please see the responses to questions 6 and 11 above.

19. **What do you consider to be an appropriate point in Eircom's network for the provision of unbundled access to the fibre loop in a FTTH scenario? Please explain your reasoning, including views on associated technical and commercial considerations.**

19.1 As explained above, eircom will provide its VUA product for FTTC (and, to a limited extent, FTTH) based access seekers.

19.2 The MPoP is an appropriate point in eircom's network for access to this service. The eircom VUA product can be handed off to the OAO at the NGN node in the MPoP or can be transported across the NGN and handed off at an agreed NGN node elsewhere in eircom's network. eircom will deploy an NGA solution in CVAs.

19.3 Technically, there will be many challenges to deploying NGA, not least of which will be deploying fibre alongside copper cables and within the space constraints of the existing copper infrastructure. Other technical issues include reaching industry agreement on the type of FTTH network to be deployed and the evolution path for these networks. GPON networks, favoured by eircom have a number of space and cost advantages over point to point networks. The likely evolution path of GPON towards NG-PON, WDM-PON or point to point is still uncertain and this evolution path will have a bearing on future fibre and infrastructure requirements.

20. **If it is not possible for commercial or technical reasons to provide for unbundled access at this time, what factors might change this over time? What measures should ComReg take on a transitional basis to provide for the nearest equivalent alternative constituting a substitute to physical unbundling and what other safeguards might be necessary?**

Please see the eircom's Response for a detailed description of eircom's proposed network architecture.

21. **Is a remedy requiring the development and publication of a reference offer for the provision of access to the unbundled fibre loop and associated facilities necessary and what specific issues should be detailed within it? Please explain your reasoning.**

21.1 A remedy requiring the development and publication of a new reference offer for the provision of access to the unbundled fibre loop and associated facilities for NGA would be neither necessary nor proportionate. For reasons stated above, eircom does not believe that access to the unbundled fibre loop should be mandated. eircom is committed to providing its VUA product, which provides the same capability to the OAOs to customise the broadband type services they provide to their end users. The documentation associated with the VUA product offering could be included in the current Access Reference Offer.

21.2 It should be noted that eircom has offered unbundled access to the sub-loop in the context of the current FTTH pilot in Sandyford and Wexford. To improve the economics of this access service, eircom has also offered use of eircom E-side fibre and fibre cabinet splitters to backhaul the unbundled fibre optical streams to the eircom exchange where the OAO electronics are located. None of the access seekers has even chosen to trial this option. So, in the context of the limited FTTH deployment proposed for the eircom NGA investment, it is highly unlikely that an access seeker will find it commercially viable to connect to customers via access to the sub-loop with the terminating segment being totally unviable. The commercially-viable option for access seekers for the foreseeable future is to connect to customers via a virtually unbundled leased line access.

22. **What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.**

Notwithstanding eircom's response to question 21, the existing ARO could be updated to cater for any new products and would be updated based on market requirements as per the current process for updating the existing ARO.

23. **What specific non-discrimination remedies are required with respect to the provision of access to the unbundled fibre loop and associated facilities? Please explain your reasoning.**

Notwithstanding eircom's response to question 21, there are no specific non-discrimination remedies required with respect to the provision of access to the unbundled fibre loop and associated facilities on the basis that eircom provides the same capabilities to access seekers through the VUA product as eircom provides to itself.

24. **What form of price control would be the most appropriate and proportionate means of establishing the price of unbundled access to the fibre loop? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.**

24.1 As noted above, ComReg has asked a question on the form of price control for several different elements. There should be serious consideration of the need for internal consistency across these elements.

24.2 For the period immediately after NGA investments prices for access to fibre loops should be determined on a retail-minus basis. The cost basis for prices can only be determined once substantial deployment and take-up of services has established investment levels required to provide coverage and unit costs of serving end users. In the initial phase access prices set at cost plus will not allow sufficient economic space for users of the eircom FTTH products to offer competitive retail services.

24.3 eircom proposes that prices for unbundled access to the fibre loop be set initially on a retail minus basis so as to allow both eircom and the access seekers to compete on an equal basis in the downstream retail markets. As discussed above, eircom will offer several levels of access pricing depending on the level of commitment shown by the access seekers. The discounts will be available to access seekers prepared to share the NGA investment risk. The retail minus control will correctly apply between the eircom retail price and the discounted wholesale access price. This form of control is the appropriate way to recognise the risk premium during the term of the retail minus price control.

24.4 When the NGA deployment is sufficiently advanced to have a good understanding of the investment levels per house passed, per house connected, and the service penetration, it should be feasible to move to a cost-based price control.

25. **Should any cost oriented price for FTTH based services attract a risk premium in principle? If so, to what types of network assets/investments should any premium apply and why?**

Where prices are set at retail minus the issue of risk premium (on the investor's regulated ROCE) does not arise. By the time prices can be set on a cost plus basis the level of risk associated with the investment should be clear. This level of risk can then be reflected in the size of discount available to access seekers prepared to commit to volume purchase of access services in advance – and so share the NGA investment risk with eircom.

26. **What types of co-investment arrangements might warrant a separate regulatory treatment in terms of remedies. Please address in your answer the types of commercial relationships and the type of control over physical infrastructure by multiple operators that you think would be necessary for ComReg to consider this option. If possible, please state if you think such an outcome is feasible or desirable.**

26.1 eircom notes that this question is repeated in several related sections in the ComReg consultation that explore risk sharing and co-investment, e.g.

(i) 'Risk premium and the WACC' from 5.45 to 5.54; and

(ii) 'Accounting for other factors that affect risk' from 5.71 to 5.83.

26.2 Several forms of co-investment can be envisaged as follows:

(i) Direct co-investment;

(ii) Long-term up-front contracts and volume discounts; and

(iii) Risk-sharing through long-term supply contracts.

Direct co-investment

26.3 If an OAO were to directly co-invest in NGA, allowable WACC should be assessed in the same way as for eircom's investment, unless the structure of the OAO investment would have a different risk exposure to the overall NGA investment.

Long-term up-front contracts and volume discounts

26.4 It is conceivable that OAOs would enter into long-term commitments with eircom to purchase wholesale or network services from eircom's NGA network. If they did, this could reduce investment risk to eircom to the extent that eircom would have certainty of some revenues.

26.5 However, eircom believes this option to be unlikely as in the absence of a meaningful discount from standard access pricing, the business and 'investment' risks of such long term commitments would be assessed by OAOs in much the same way as capex investments.

26.6 The Consultation Document's discussion on 'Accounting for other factors that affect risk' (paras. 5.71 to 5.83) seems reasonable at a theoretical level. However, it would be extremely challenging and complex in practice. The extent of burden on the calculation of margins on products for a co-investor operator, and the associated uncertainties that they would face, would be likely to be strongly off-putting to OAOs considering co-investment in association with long-term discounts and volume discounts. All such potential investors are likely to be reluctant to invest in association with eircom as the SMP operator, as such investments would inevitably become subject to complex regulatory review, remedies and uncertainties.

Risk sharing through long-term supply contracts

26.7 It is conceivable that equipment or infrastructure suppliers might consider offering long term financing for their equipment. In these circumstances, an equipment vendor is likely to look for an enhanced return for the 'investment risk' that it would assume. Such long-term financing does not reduce total risk. Although long-term financing could theoretically lower the risk to eircom by shifting some of the risk to suppliers, eircom will ultimately end up paying for this risk in any event.

27. **Do you have any views as to how ComReg should view the evolution of the market for NGA services particularly in the presence of a rival cable network and its impact in supporting effective competition in downstream markets? How should remedies and regulation generally evolve over time and what criteria should ComReg apply to such decisions?**

27.1 The fact that UPC has already secured a significant head-start and secured a larger market share than eircom Retail within the UPC footprint should be recognised. This means that remedies need to be designed to ensure that competitors using eircom's NGA network – and eircom itself -- are not disadvantaged by comparison with UPC.

27.2 It is clear that an urban market that is delineated by more favourable economics has already emerged, in which UPC has invested in upgrading its network to DOCSIS 3.0 capable of supporting 100Mb/s broadband and higher. Within its footprint, UPC has already secured a retail market share of about 40% of Fixed Line Broadband, compared to eircom's retail share of about 38%. OAOs using eircom's current ADSL wholesale services hold about 18% retail market share, with the balance of about 4% held by FWA operators.

27.3 Despite its market share, UPC currently has no regulatory obligations to offer wholesale services to other operators, so those operators are likely to be dependent on investment by eircom in NGA to create a competitive platform.

27.4 Retail market prices are set by the UPC offers, and their prices are competitive reflecting the relatively low cost of upgrading their co-ax network. Investment by eircom in a new NGA network must be done at a low enough cost to enable competitively priced retail services to be offered by all operators utilizing eircom's NGA network. Because FTTC offers a significantly lower investment option, it offers the most affordable NGA option.

27.5 The fact that the retail price of fibre will be constrained by the retail price of cable (especially given that the cable broadband price within a bundle may be based on short- run incremental costs only and so be very low), means that the retail price that eircom will be able to charge for fibre services may not cover the BU-LRAIC+ costs. Thus retail minus regulation would lead to a wholesale regulated price below a cost- (LRIC-) orientated access price. However, the total amount of risk would remain the same and the OAO would likely seek a term or volume discount to reflect their contribution to sharing this risk.

27.6 In terms of remedies, this implies that it should therefore be enough to require only that eircom's wholesale fibre access price passes a margin squeeze test, even though this will lead to an access price below LRIC. A cost-orientated access price would make it impossible for third parties to compete with cable using the wholesale product. It would also make it impossible for eircom to compete with cable if eircom also had to pass a margin squeeze test on the retail price of fibre broadband and the cost-orientated wholesale access price. Cost-based regulation would therefore be of benefit only to UPC, as it would restrict effective competition from eircom and OAOs.

27.7 ComReg should assess the current and prospective UPC market share of Fixed broadband by (i) assessing its current footprint and market share within that footprint, (ii) projecting the expected growth of UPC's cable network, and (iii) projecting UPC's market share within its growing network footprint, so that a prospective assessment can be made.

27.8 Remedies should reflect the current and prospective impact of UPC's DOCSIS 3.0 network. Separate geographical markets should be identified. Even if such separate markets are not defined, differentiated remedies may need to be applied to reflect differences in the competitive constraints faced by eircom in different geographic areas.

27.9 The indirect constraint from cable at the retail level may be strong enough to ensure that eircom does not have market power that it can exploit to raise prices at the wholesale level. If the retail pricing of cable products represents a binding constraint on eircom's retail pricing, and if retail minus access pricing leads to wholesale prices below LRIC, this undermines the idea that eircom has market power, and that there should be competition concerns that eircom could ever abuse that power.

27.10 Indeed, if retail prices are constrained to the competitive level by cable competition, then eircom should have an incentive to supply any efficient entrant, even in the absence of regulatory obligation, since eircom will benefit from efficient distribution of its wholesale product. Refusing wholesale access is a profitable approach only if the benefits – of higher retail profits – outweigh the foregone wholesale profits. This is less likely to be the case if retail competition is in any event intense due to the presence of a competitor that does not require access to eircom's network (i.e. UPC, potentially pricing broadband on an incremental cost basis). This is because such competition will limit the retail profits that are gained from a foreclosure strategy: partly because UPC will share the benefit (in terms of additional retail custom) of the foreclosure of another rival; and partly because competition downstream will, all else being equal, mean lower retail prices and hence lower retail margins.

28. **Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in a FTTN scenario?**

How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

Please see eircom's Response concerning FTTC (see in particular section 3.2).

29. **What type of backhaul solutions do you consider are appropriate in an FTTN scenario?**

Please see eircom's Response concerning FTTC (see in particular section 3.2).

30. **What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities.**

Please see the response to questions 6, 11 and 18 above.

31. **Is a remedy requiring the development and publication of a reference offer for the provision of access to the copper-sub loop necessary and what specific areas should be detailed within it? Please explain your reasoning.**

Please see the response to question 21 above.

32. **What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.**

Please see the response to question 22 above. The publication requirements should follow the existing WPNIA requirements as per ComReg's response to Market Review: Wholesale Physical Network Infrastructure Access (Market 4), Decision No: D05/10, Document No:10/39 of 20 May 2010.

33. **What specific non-discrimination remedies are required with respect to the provision of access to the copper sub-loop, including those associated with co-location? Please explain your reasoning.**

There are no specific non-discrimination remedies required with respect to the provision of access to the sub loop on the basis that eircom provides the same capabilities to access seekers through the VUA product as eircom provides to eircom Retail.

34. **What form of price control would be the most appropriate and proportionate means of establishing the price of access to the copper sub-loop? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing commercial negotiation. Please explain your reasoning.**

34.1 As noted above, ComReg has asked a question on the form of price control for several different elements. There should be serious consideration of the need for internal consistency across these elements.

34.2 As discussed above (and in section 3.2 of the Response), SLU is not technically or economically viable for purposes of NGA solutions using FTTC architecture. Copper sub-loops are already available and prices are currently set at cost-oriented levels derived from the BU-LRAIC+ LLU model. There are several reasons why cost orientation remains appropriate for sub-loop access prices from the initial deployment of an FTTC investment, although other services should be priced at retail-minus.

34.3 The first is that all the costs associated with the copper sub-loop are well understood and have been modelled extensively in the recent past. The costs of a D-side pair used to deliver PSTN are the same as the costs of a D-side pair used to deliver super-fast NGA Broadband.

34.4 The second is that the cost-based price is already published in the eircom ARO Price List and so this price level is the one that access seekers have been using in building their business plans for sub-loop unbundling. To move from this price to some unknown level to be set on a retail minus basis with reference to retail services that eircom does not yet offer will cause considerable disruption. An OAO must be able to assess with some certainty the costs they will face if they proceed with their own VDSL deployment and forego the higher speeds available from D-side binder management technologies. It is also important that OAOs know the basis upon which ComReg will set the retail minus price for the FTTC VUA service before they form a view on whether to pursue SLU. This is a good example of a situation in which an inappropriate hierarchy of margin squeeze tests could end up stranding eircom's NGA investment by requiring "space" between all hypothetical wholesale entry levels despite the impossible economics of service provision at several levels.

35. **Should fibre or Ethernet backhaul associated with the provision of access to the copper sub-loop attract a risk premium? How might a risk profile associated with specific costs relating to such access to be determined in light of the principles set out in Annex I of the NGA Recommendation, and how any difference in risk be reflected in a pricing methodology? Please explain your reasoning.**

No, fibre or ethernet backhaul associated with the provision of access to the copper sub-loop should not attract a risk premium. The costs and risks to eircom of providing E-side fibre connecting exchange sites to fibre cabinets are already well understood and are adequately covered in the standard eircom ROCE. Aside from connecting eircom VDSL equipments deployed at these cabinets back to the serving exchange, this fibre is used to provide business access services.

36. **What circumstances (i.e. degree of availability of effective access to the unbundled loop), would warrant the lifting or variation of WBA access obligations within a given geographic area? Please explain your reasoning.**

In exchange areas where (i) there is an alternative network provider of Broadband services in the retail market; (ii) VUA is available and (iii) the Access Seeker has full freedom to innovate, there should be no regulatory requirement to provide WBA.

37. **Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to WBA products and associated facilities (including backhaul) in a FTTH and FTTC scenario? Please explain your reasoning.**

Please see eircom's Response (see in particular section 3.2).

38. **In a FTTH or FTTC environment, what technical or enhanced service characteristics might need to be reflected in WBA access products? Please explain your reasoning including views**

on the extent, if any, to which product differentiation is a necessary characteristic of WBA access products.

38.1 As previously explained, FTTC offers enhanced speeds and stability features. These allow the development of products for faster broadband services and also facilitate stable profiles that support IPTV. The technical features of the cabinet DSLAM also support Multicast capability. Therefore, high speed products supporting triple play services can be developed. These will be offered in the NGA Pilot.

38.2 For FTTH the GPON product has stable high-speed capability and inherent multicast features. Both of these features allow for enhanced service characteristics. Again high-speed products supporting triple play services can be developed. These will be offered in the NGA pilot and include the utilisation of the GPON multicast features.

39. **What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to WBA products and associated facilities?**

39.1 eircom accepts that in general, access to a WBA product will be required in the short to medium term. However, as explained in response to question 36, eircom does not believe that access to the WBA products should be mandated in exchange areas where VUA is available and there is an alternative network provider at the retail level.

39.2 Please see also the responses to questions 6, 11, 18 and 30 in respect of Article 12 of the Access Directive.

40. **How should the issue of technical protocols and interfaces serving the interconnection of optical networks be approached? Please explain your reasoning.**

40.1 The issue of technical protocols and interfaces serving the interconnection of optical networks is best approached through a process of seeking initial industry agreement on guiding principles for product development leading to documented protocol and interface definitions in the product descriptions. Discussions with OAOs on these issues are already well underway in Ireland.

40.2 The guiding principles would include: cover bandwidths, backhaul bandwidths, QoS mechanism, separation and prioritisation of customer traffic streams, handling of layer 2 control protocols, handling of multicast services, available interconnect points, fibre termination practices, service provisioning mechanisms and service management mechanisms.

41. **Do you think that a requirement for the SMP operator to notify purchasers of WBA 6 months in advance of its launch of a retail products based on NGA inputs is necessary or adequate and, if so, how might it operate in practice? Please explain your reasoning.**

eircom does not believe that a lead time of six months is necessary or proportionate in the context of eircom's NGA deployment. eircom will work with ComReg to establish a reasonable set of milestones and lead times for the various phases of the roll-out process (for example, publication of product, pricing and systems information and launch of the wholesale offerings for test purposes). In such circumstances, OAOs and eircom Retail will have time to adjust to new interfaces, systems, and processes on a phased basis. eircom would expect that no more that three to four months will be required following the publication of product and pricing information for the NGA products, and the launch of eircom's and OAOs' retail offerings.

42. **What effective access, transparency or other safeguards are necessary to guarantee non-discrimination and how might such safeguards impact the need for of level of advance notification discussed above? Please explain your reasoning.**

See response to question 40.

43. **What specific non-discrimination remedies are required with respect to the provision of wholesale broadband access? Please explain your reasoning.**

Products should be available at same time in both the retail and wholesale markets. As provided for by Regulation 11 of the Access Regulations, eircom will continue to apply equivalent conditions in equivalent circumstances to eircom Retail and other OAOs providing equivalent services, and it will provide services and information to others under the same conditions and of the same quality as it provides for its own services.

44. **Is a remedy requiring the publication of reference offers for specific NG WBA products necessary and if so, what should be contained within such a reference offer? Please provide reasons for your answer.**

For exchanges covered by NGA, the existing WBA reference offer should be updated to cover any new NGA WBA products.

45. **What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.**

45.1 A remedy requiring the development and publication of a new reference offer for the provision of NG WBA is not necessary. The documentation associated with this NG WBA product offering could be included in the current Wholesale Bitstream Reference Offer.

45.2 The publication requirements should follow the existing Bitstream requirements as per ComReg's response to Market Review: Wholesale Broadband Access (Market 5), Decision No: D06/11, Document No:11/49 of 08 July 2011.

46. **What form of price control would be the most appropriate and proportionate means of establishing the price of WBA access? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.**

46.1 As noted above, ComReg has asked a question on the form of price control for several different elements. There should be serious consideration of the need for internal consistency across these elements.

46.2 For the period immediately after NGA investments, prices for NG WBA should be determined on a retail minus basis. The cost basis for prices can only be determined once substantial deployment and take-up of services has established investment levels required to provide coverage and unit costs of serving end users. In the initial phase, access prices set at the high unit cost reflecting initial take-up levels will not allow sufficient economic space for users of the eircom WBA to offer competitive retail services.

46.3 For the period when WBA prices are set on a retail minus basis eircom will offer two levels of WBA price. One will be the standard price where an OAO that has made little or no investment – and no term or volume commitment to consume eircom NGA WBA services can purchase WBA to each customer served as they are connected. The second, and discounted, price level will apply to the OAO that makes the investment to purchase committed volumes of eircom NGA WBA services in advance. This discount will reflect the extent to which the OAO shares the risk of the eircom investment in NGA assets in the presence of high broadband penetration and competing infrastructures. The retail minus price control will apply to the margin between eircom retail NGA services and the discounted WBA price. When the eircom investment matures an investment per house passed, investment per house served, service penetration are known more definitely – and when we have an indication of service lives, unit costs will fall to stable levels an provide an appropriate basis for cost oriented prices. Only then should ComReg move from retail minus to cost orientated pricing for NGA WBA services.

47. **If an effective internal separation of eircom were to be implemented how should this impact on ComReg's regulatory approach?**

47.1 Paragraph 4.23 states:

"As it currently stands, eircom is not functionally or otherwise separated and, in light of this, guarantees regarding the equivalence of access are not present or likely to be present in the short to medium term."

47.2 eircom is committed to enhancing its wholesale performance by means of organisational change, including new governance and behavioural measures. There is no basis for implementing any form of functional separation which, in a company the size of eircom, would be wholly disproportionate.

47.3 eircom plans to provide further details concerning its wholesale reforms to OAOs and ComReg at the September briefing. The main elements are as follows:

(i) to have an 'access product' product line in Wholesale;

(ii) for eircom Retail to interface with eircom Wholesale for access products in the same way as OAOs for NGA products;

(iii) for the aggregation and prioritisation of access product demand and development to be supervised by an industry board and submitted via Wholesale. From there development will be subject to the eircom Business Prioritisation Group;

(iv) for legacy product systems to be "rebalanced" such that OAOs can get comparable functionality to Retail or Equivalence of Outputs. For future products and NGA to be on the same systems or Equivalence of Inputs; and

(v) for independent systematic monitoring of relevant KPIs and culture changing behaviour including a code of practice and incentives.

48. **Do you believe that the costing methodology options for determining NGA charges as outlined above are relevant and appropriate? Please provide reasons for your response. Which is the most appropriate methodology and why?**

48.1 A fundamental issue is the fact that one cannot simply equate costing models and pricing models. A cost model cannot, and should not, be used directly as a pricing model. Many factors, including cost, should be used to determine price levels and price structures.

48.2 ComReg has asked a question on the form of price control for several different elements. There should be serious consideration of the need for internal consistency across these elements. If one were to pick and choose approaches from historic Cost, Current cost, TD-LRAIC, BU-LRAIC or DCF then there would need to be very good reasons for choosing each approach.

48.3 There is no costing methodology currently appropriate for determining the initial NGA charges as prices should be set on a retail minus basis. Depending on the compression impact of UPC pricing over time, it may be feasible at a later stage when investment levels and customer take-up rates are known – to use unit costs derived from a BU-LRIC model used to inform prices. A price ceiling could be set on the basis of this costing methodology with an appropriate mark-up for fixed and common costs.

48.4 We note that the setting of regulated access charges using different costing methodologies for various elements risks giving rise to inconsistent pricing, and sending inappropriate economic signals around the efficient migration to NGA services, with the consequent risk of stranded investments (or indeed over-recovery of efficient cost levels).

49. **Should ComReg distinguish between new investment (such as NGA specific equipment) and legacy assets (such as trench) which are used in the provision of NGA services? Please explain your reasoning.**

No. ComReg should treat all investments on the same basis in costing models. Any pricing issues such as risk premium can be addressed by the annualisation methodology applied to the modelled investment.

50. **What pricing issues might arise where the SMP operator is providing services over both copper and NGA networks concurrently? For example, duplicating infrastructure in the same geographic area for a temporary period or in different geographic areas. Please explain your reasoning.**

50.1 If strict cost-oriented prices were applied, a transition period might result in increased unit costs. As a simple example, suppose system A currently has a unit cost of 20, and its replacement system B will also have a unit cost of 20 after a full changeover. At some mid-point, with both systems running at half capacity, the unit costs may double to 40 for both systems. This type of anomaly needs to be smoothed out to avoid creating severe distortions. The additional cost associated with delivering both generations of access service in parallel may not be recoverable during the transition period of retail-minus pricing for NGA wholesale access. Any under-recovery could be considered at the point of the subsequent move to cost based pricing when sustainable levels of demand have been established.]

50.2 Retail minus pricing approaches, or taking a sufficiently long view of the Modern Equivalent Asset in a BU-LRAIC model, will minimise the problem of transitional periods.

50.3 In practical terms, retail users have experienced static or slowing declining retail prices, while capability has improved rapidly.[1] As operators move to NGA products, this practice of automatic upgrade at a constant or marginally declining price is likely to continue. The underlying wholesale prices must facilitate this.

50.4 Regarding different geographic areas, the BU-LRIC model informing LLU prices has the capability to calculate cost levels by geography (exchange area). Any modelling approach for NGA costing should maintain this capability to allow for geographic pricing, as this will ensure deployment with the maximum economic reach. However, the primary requirement is for competitive retail prices. It is probable that operators may well sell a product called "superfast Broadband" at a national or regional prices, but that it would be underpinned by the best available network product (whether that is FTTH, FTTC, ADSL2+ or ADSL –all subject to limitations imposed by line length). It is less likely that each technical solution would give rise to a separate retail product, each with a unique price. This again argues for some flexibility in setting prices.

50.5 The BU-LRIC model informing LLU prices has the capability to calculate cost levels by geography and the modelling approach for NGA costing should maintain this capability to allow for geographic pricing, as this will ensure deployment with the maximum economic reach. The additional cost associated with delivering both generations of access service in parallel may not be recoverable during the transition period of retail minus pricing for NGA wholesale access. This under-recovery should be recognised in the subsequent move to cost based pricing.

51. **Do you agree with the application of a risk premium as envisaged in the NGA Recommendation? As part of your response please address, insofar as possible, your views on the nature of any such premium, whether and how it could be measured and what its relationship to Eircom's existing (or a potential split) WACC should be.**

The issue of recovering a risk premium from wholesale charges for access to an eircom NGA investment will simply not arise in the initial phase as prices will be set on a retail minus basis. This issue is important as it concerns the basis for risk sharing by access seekers achieving discounted access prices when committing to sufficient volume in advance so as to mitigate the investor's risk. The investor's risk can also be addressed by the structure of the access pricing.

52. **Do you agree with the NGA Recommendation that any risk premium should only be applied to NGA/fibre specific assets and not to legacy copper based assets (for example, FTTH versus FTTN)?**

The NGA Recommendation is fundamentally flawed in distinguishing between "risky" and "non-risky" NGA investment. The risks of NGA are not associated with any single piece of infrastructure that is added to or upgraded in the investor's access network. The risks are

[1] For example, a retail customer with a 512k broadband service originally paid €39.99. Gradually the service was upgraded to 1Mb, 2Mb, 7Mb and up to 24Mb, while the price declined to €34.99.

associated with the move from traditional to NGA services coupled with the associated changes in the investor's portfolio and business model. The Recommendation's incorrectly-drawn distinctions should provide no basis for setting cost oriented access charges in the context of NGA.

53. **Do you believe that the WACC ComReg Decision from 2008 remains appropriate and applicable for NGA investment and allows for sufficient return on investments made and to be made in the future? Please provide reasons for your response.**

This question is irrelevant as access charges should be set on a retail minus basis for the initial period after an investment.

54. **Do you have any other observations or proposals in relation to NGA investment risk and whether there are mechanisms other than the WACC to account for risk in NGA wholesale pricing?**

As mentioned above, risk can be addressed in the structure for NGA wholesale access prices. During the retail minus phase of price setting the discounted levels available to OAOs that commit to substantial NGA service volumes in advance will reflect the sharing of the eircom risk. When the price setting moves to cost orientation the risk level will have crystallised and the price for single uncommitted accesses will include this risk in the full level of unit cost exposed. The discounted level from the cost-orientated price for large committed volumes will reflect (at least) the degree to which such commitments can drive down unit costs.

55. **Do you agree that the factors above identified are the most relevant mitigators of risk? Should such factors be taken into account when determining wholesale pricing arrangements and, if so how? Are any safeguards necessary?**

In theory, safeguards are necessary to ensure that the use of volume discounts and term commitments to mitigate risk does not lead to discriminatory behaviour by the investor in favour of its own retail arm. However, it is now clear to any incumbent contemplating an NGA investment that an adequate return can only be achieved by attracting substantial wholesale demand at prices that allow access seekers to serve the downstream market profitably. eircom therefore believes that light-touch regulation is all that is needed at this stage.

56. **In the context of upfront purchase commitments and volume discounts, are any safeguards necessary to ensure efficient investment and the development of effective competition? Please explain your reasoning.**

Much of the eircom investment in NGA will take place in areas already served by the UPC cable network. It may not be possible for an efficient eircom NGA investment to match – on a cost-orientated basis – the (implicit) wholesale access price charged by UPC. This will arise because of the lower investment required to upgrade cable networks for NGA services and the UPC first mover advantage. However for reasons of sustaining competition and building retail and wholesale market share in NGA access, eircom may have to set wholesale prices below fully allocated costs. This feature of the NGA deployment raises a fundamental question as to the role of price regulation in the presence of competing (and asymmetrically-regulated) access networks. In these areas ComReg should limit its scrutiny to ensuring that the eircom wholesale access prices allow efficient access seekers to compete with eircom's retail offerings (and eircom and OAOs alike to compete with UPC's broadband offerings).

57. **Do you believe that all the relevant and appropriate options were considered above regarding the main principles for a margin squeeze test? Please provide reasons for your response.**

57.1 All the relevant options are included in the ComReg discussion. However a number of inappropriate options are also included in the discussion. Principal among these is that ComReg should specify minimum prices for active wholesale products so as to "ensure that entrants faced the correct incentives" to use passive services. A general feature of NGA investments is that the economics for access seekers using passive services are extremely challenging even in countries with much lower population dispersions than Ireland. Thus any artificial incentive to use passive services is likely to be flawed, and one that uses active service price floors is probably an unwarranted interference in the setting of efficient price levels for NGA services.

57.2 Furthermore, eircom does not agree with ComReg's conclusions on several elements of the margin squeeze test methodology, including the following **points:**

(a) The use of an REO/SEO cost base can be supported only if it can be shown that entrants are:

(i) not currently at scale, and are therefore not cost efficient; but

(ii) are likely to achieve scale and thus cost efficiency.

If in fact entrants are not likely to achieve scale, then their entry should not be supported by the regulatory regime, since they will be inefficient and the SEO standard would allow them to remain sub-scale with impunity. If they are already at scale, then they do not need to be supported by regulation. eircom does not believe that the regulatory regime needs to support players that are not currently at scale to be scale efficient. In particular, international competitors such as Vodafone and BT already enjoy economies of scale that eircom, as a much smaller firm, does not.

(b) Consistent with the European Commission's guidelines on Article 102, the cost standard used in a margin squeeze test should not include common costs. This rules out the use of LRAIC+ or ATC, contrary to ComReg's suggestion at paragraph 5.124. eircom disagrees with the apparent position of ComReg that avoidable costs are not a reasonable cost standard. If the concern is over the exclusion of existing players, then an avoidable cost measure may be reasonable. eircom accepts that an AVC standard is not appropriate where fixed costs are large; however ComReg should not confuse network infrastructure (with high fixed costs) and active products or retail activity, where less costs are fixed.

(c) ComReg has discussed the correct level of aggregation for the margin squeeze test. The correct approach includes the requirement that each product pass a margin squeeze test based on the incremental or avoidable costs of the EEO providing that product given that it already offers the other products in its portfolio. In addition, each combination of products should cover their incremental or avoidable costs. Further, it only makes sense to apply margin squeeze tests at the level at which exclusion might take place. So if firms compete to offer a range of products (e.g. different broadband speeds), then the test should be run over the portfolio of products, not over individual products.

(d) At paragraph 5.106 ComReg refers to an EC concern that a margin squeeze test might not be enough on its own because there might be a "significant discrepancy between a cost-orientated price and a price that can be considered as abusive". eircom's understanding is that the EC's concern relates to the possibility that an access price significantly above cost might still pass a margin squeeze test (for instance, if retail competition is weak and so retail prices are high). This concern is not relevant to the Irish NGA context as eircom believes that the retail minus price will be below a cost-based (e.g. LRIC) access price.

(e) The same paragraph also suggests that relying only on a margin squeeze test may not give competitors enough certainty about the access price that they will pay. In the circumstances, this is not a concern. A cost-based access price would not allow competitors, or eircom, to compete with UPC. However, a retail minus access price based on the retail price set by eircom, which will be constrained by UPC's pricing and product offering, will allow access seekers to compete.

58. **Are ex-ante price controls or measures required in order to prevent margin squeeze? If so, what is the appropriate methodology to address margin squeeze and what factors should be considered by ComReg when specifying an imputation test (if this approach is deemed to be necessary)? Please explain your reasoning.**

Please see the response to question 57 above.

59. **Should Eircom be required to maintain existing copper network infrastructure in parallel with NGA network upgrades? If so, then for what period of time? Under what circumstances could a shorter period of parallel operation be appropriate?**

eircom plans to leave the legacy exchange–based infrastructure in place, alongside the NGA network, for the time being. As and when eircom develops a proposal for the removal of any of the legacy infrastructure, it will be necessary for eircom to make best endeavours to secure agreement from OAOs to any proposals developed. eircom accepts that any such proposals will ultimately be subject to securing ComReg's approval.

60. **What forms of fully equivalent access at the points of interconnection (such as exchanges), might justify an advance notice period for decommissioning of less than five years? Please explain your reasoning.**

60.1 There are many reasons why an advance notice period of less than five years would be desirable in the majority of cases. Amongst other things:

(i) space restraints may mean that upgrades to NGA services may be delayed significantly in certain locations;

(ii) the maintenance of a legacy network in parallel with an NGA network will increase eircom's operational and capital costs in supporting two networks (e.g.

additional staff, training, cost of spares, cost of legacy upgrades, vendor support costs). These costs will impact on eircom's finances; and

(iii) a five-year notification could impact on the ability of eircom to upgrade: one operator may not want the upgrade even if all other operators do for their own product evolution. For example, if one OAO chose to maintain legacy services, it could effectively place a strategic block on eircom's infrastructure and developments for other OAOs in certain areas.

61. **In an NGA setting, what are the most appropriate migration paths that need to be put in place and what are the main technical, operational or commercial issues that would need to be addressed? Please explain your reasoning.**

61.1 In technical terms, the evolution of access technology, and the evolution of customer requirements - with the expectation of increased broadband speeds offering multi-play product capabilities at a low cost - will drive the development of new products and services based on NGA. Also, specifically in the context of Ireland, these developments are of strategic importance for international recognition as a country at the leading edge of telecommunications and broadband services, in supporting a national smart economy and economic recovery.

61.2 Technically this will require the provision of FTTX technologies as platforms to support new broadband products and services. From eircom's perspective it is necessary that that they are implemented efficiently and effectively and that they are delivered to a high standard with optimised support arrangements.

61.3 eircom's equipment has to be of high standard of availability and performance (in particular, for reputational reasons given its status as national carrier). This is not always the cheapest solution available. Optimum assurance arrangements must be put in place both from a staffing and network management/infrastructure point of view. There are also costs to providing robust and effective support systems. Ideally the systems should be developed to assist in migration strategies.

61.4 The migration path to new technical platforms requires that eircom:

(i) gives reasonable notice of the migration changes to industry;

(ii) provides suitable wholesale products to Industry that meet Industry needs and facilitates the migration;

(iii) provides systems support to help migration form existing products and services;

(iv) publishes clear pricing on new products and services with migration scenarios covered; and

(v) works with industry to facilitate a successful migration.

61.5 In turn industry must recognise that:

(i) the cost and investment by eircom in the platform, infrastructure, product development and systems support has to be recovered and generate a return; and

(ii) successful migration requires mutual co-operation.

61.6 eircom and Industry must therefore work together in key migration scenarios derived from a position of mutual understanding.

62. **Are commercial arrangements likely to lead to the most effective outcome in ensuring that an efficient and transparent migration process takes place? Please explain your reasoning.**

Commercial arrangements are just one way to help to help the migration process. However, migration cannot be driven by price and commercial arrangement alone. There are issues of obsolescence, integrated solution development, national implementation plans and national strategic imperatives, support costs and deployment plans that all have to be factored in to a migration solution.

63. **How should ComReg ensure that the systems and procedures put in place by Eircom, including operating support systems, are designed so as to facilitate the switching of alternative providers to NGA-based access products? Please explain your reasoning.**

As part of providing new NGA products and services, eircom recognises that it must develop appropriate systems solutions and new processes to facilitate any migrations. Eircom does not consider the involvement of regulation in this sphere is in any way necessary, as it considers this a natural requirement of any migration requirement in any event. ComReg will of course have a monitoring brief, but a light touch would be the best approach.

64. **What would be an appropriate and proportionate regulatory approach for ensuring that information around Eircom's network and its extension plans are made available to WPNIA and WBA access seekers? Please consider issues regarding commercial sensitivity and network integrity when explaining your reasoning.**

64.1 From an eircom perspective, it is critically important that the commercial sensitivity and national strategic sensitivity of the network is not compromised. This is both from a competitive position and from an integrity point of view (e.g. prevention of sabotage or attack on strategic cables and installations). There are also other issues, such as:

(i) confidentiality with eircom's own vendors;

(ii) data protection and confidentiality – such that the details of other OAOs' locations/assets or end customers are also protected; and

(iii) another operator or any individual should not be compromised or put at risk through information provided by eircom (for example, knowledge of a main cable location could help burglars isolate housing estates).

64.2 Given the commercial and strategic sensitivity of the information involved, and the complexity of the scenarios involved and the many potential interpretations of the level of data required, eircom does not consider that an effective regulatory approach can be implemented universally or easily.

64.3 eircom is willing to make appropriate and necessary network information and plans available to operators to support migration strategies and to support their effective implementation in co-operation with other operators on a case by case basis. These would be supplied on the basis of an appropriate NDA and effective controls being demonstrated by the other operators to maintain confidentiality. The level of detail and timing will be agreed between eircom and OAOs

65. **What should be the format and level of detail to be contained in the network information above and how can the strict confidentiality of such information be maintained? Please explain your reasoning.**

Please see the response to question 64.

***

Offering fibre-like speeds over copper – Huawei Solution for VDSL2 Vectoring to leverage existing copper infrastructure.

Product & Solution Dept

Huawei Technologies Co Ltd.

August 2011

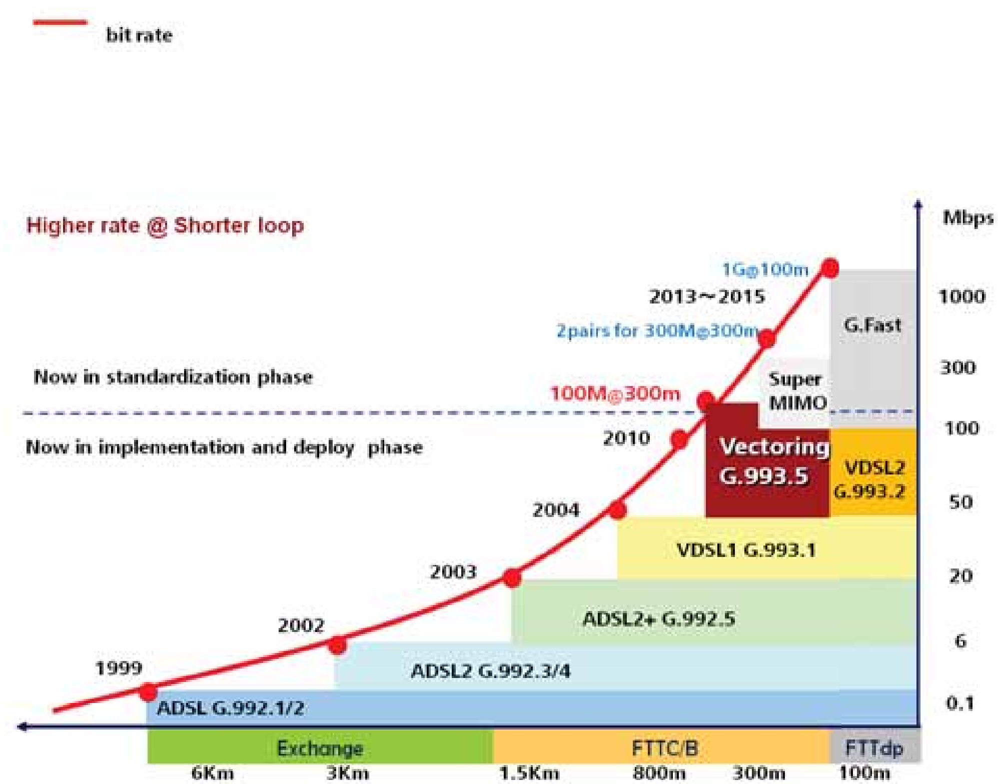
Table of Contents

1 Abstract

In the race to super-fast broadband, the biggest challenge facing operators is the civils cost of deploying fibre to every home. The current speeds of ADSL2+ and VDSL2 are not sufficient for the anticipated future demands. The European Union has mandated that 50% of homes should be able to receive speeds of 100Mbps or more by 2020. In order to address these problems, Huawei proposes vectoring technologies to enhance VDSL2 line speeds to offer fibre-like speeds over existing copper infrastructure. This paper discusses the technologies of vectoring; the real-world results of testing; the next stage, SuperMIMO; and the barriers to be overcome to introduce vectoring into an operator's network.

This paper will show that **vectoring can leverage fibre-like speeds** out of existing copper infrastructure and advises that allowing **Sub-Loop Unbundling restricts the end-user speeds**

2 Copper Access Technology Evolution

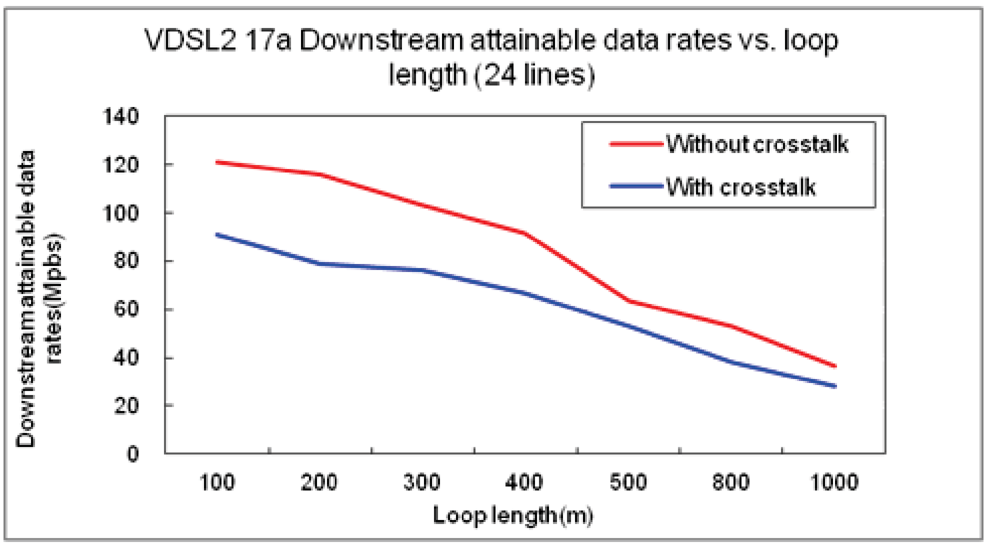


The above diagram shows the evolution of access technologies and their headline speeds, and operating distances.

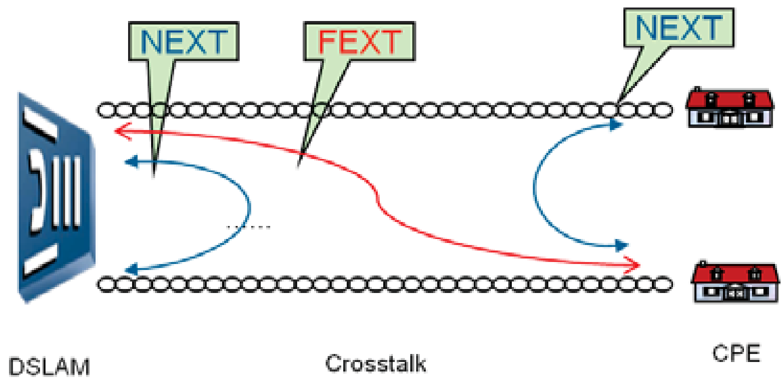
3 What is Vectoring?

3.1 What can Vectoring do?

Crosstalk is the dominant source of noise in VDSL2 and the amount of crosstalk increases with signal frequency. It is especially a problem in the extended VDSL2 bands 12-30 MHz. It is typically 20-30 dB stronger than other noise sources in a VDSL2 system. Crosstalk leads to significant performance losses.



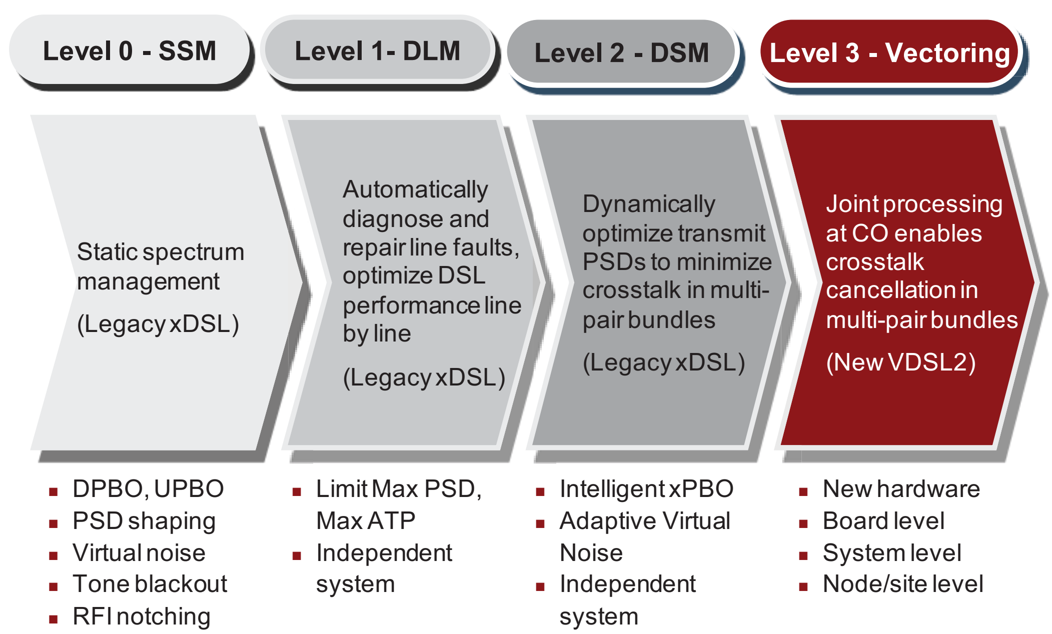
It decreases data rates, service penetration rates and can cause frequent re-initialization of the CPE. One solution to protect against crosstalk, is to use more transmit power, but this leads to higher power consumption and can break national frequency management plans, and cause interference with other systems.



Far end crosstalk (FEXT) is the dominant source of noise in a VDSL2 system

The crosstalk problem can be almost completely eliminated by using vectoring.

The following figure shows the evolution of Spectrum Management techniques, that can be used to combat interference in xDSL systems:

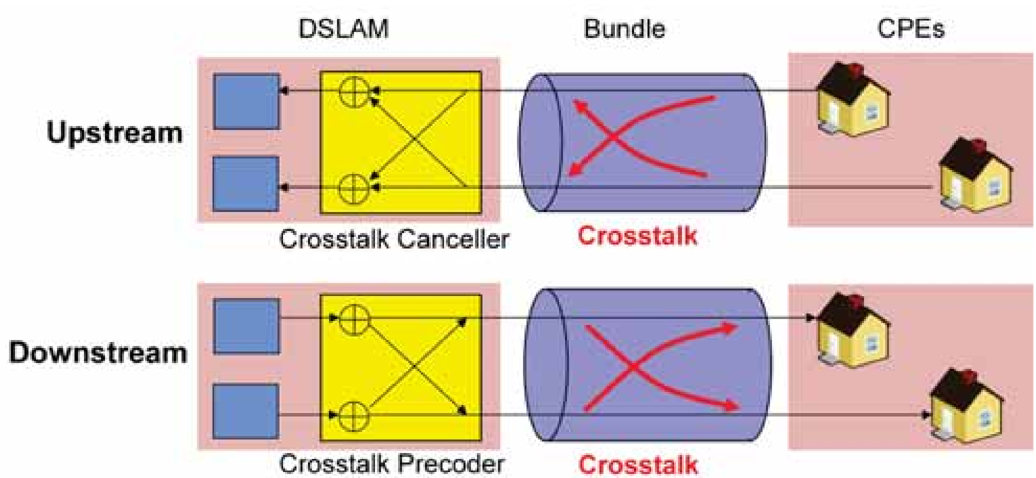


3.2 How does Vectoring work?

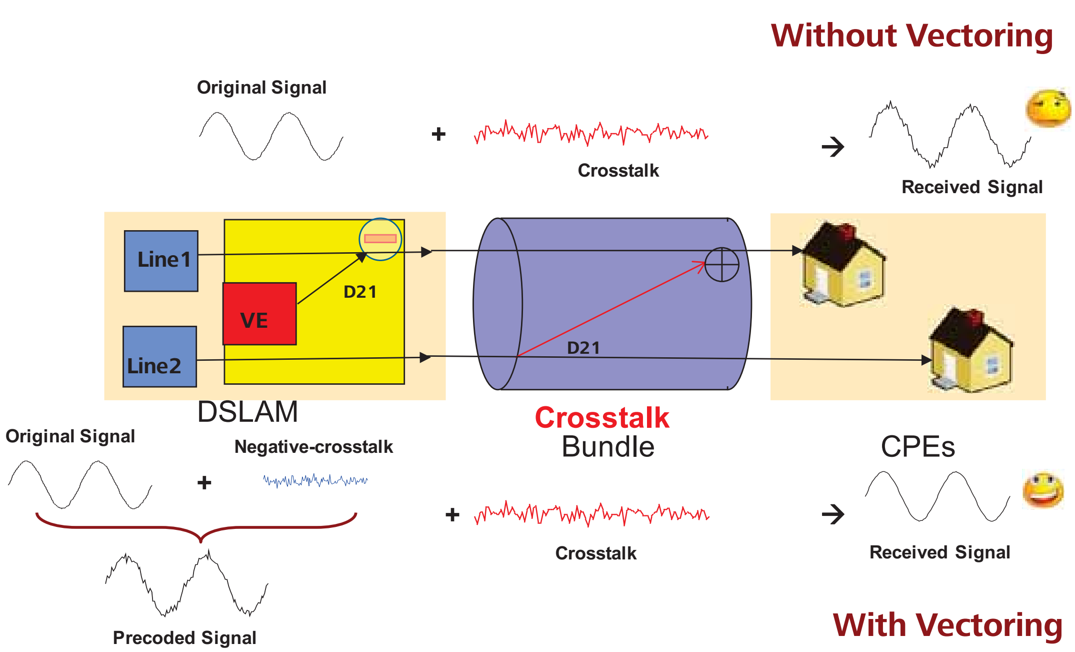
The DSLAM processes the multi-line signals:

- In the upstream, received signals are combined to cancel crosstalk
- In the downstream, transmitted signals are pre-compensated, which aims to eliminate crosstalk during transmission

  This processing is shown in the following figures:

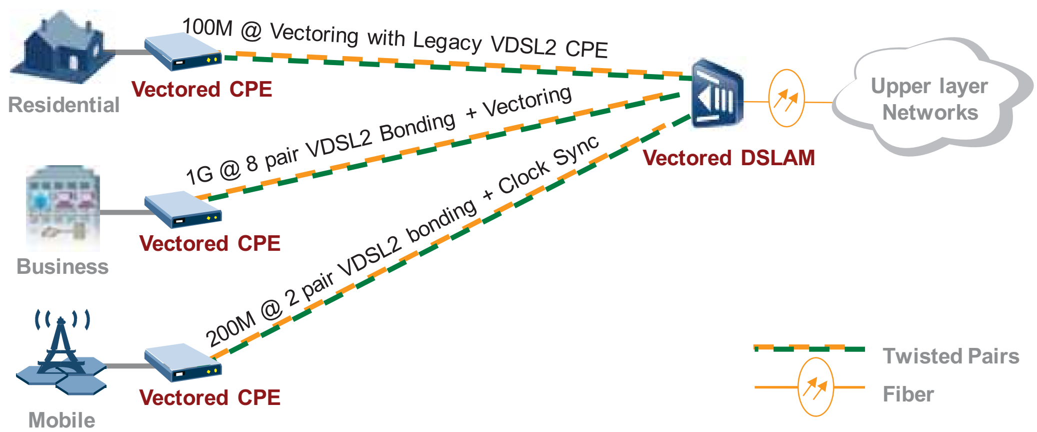


Signal Processing in Upstream and Downstream signals



Downstream example of pre-coding to eliminate crosstalk

3.3 Vectoring Applications



The above figure shows three example applications where vectoring can be used to offer differing services. For residential subscribers, 100Mbps is possible with vectoring, and up to 1GBps is possible using a combination of bonding and vectoring.

3.4 Vectoring Standardisation Status

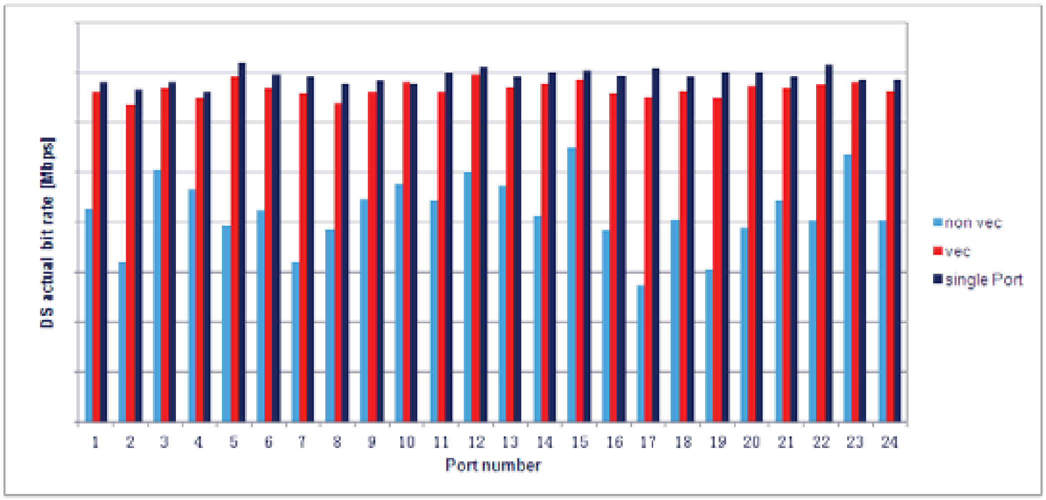
The ITU-T developed the G.993.5 (G.Vector) standard to define VTU requirements for FEXT cancellation, the first version has been released in May 2010. Huawei has actively contributed to the development of this standard with contributions on various topics including:

- Speeding up the convergence of crosstalk pre-coder training
- Reducing feedback overhead during crosstalk pre-coder initialization
- Crosstalk channel identification on non-vectored (legacy) DSL lines
- Handling disorderly leaving of lines from a vectored group

4 Vectoring Successful Test Cases

4.1 European Incumbent Operator A

Huawei and Operator A made a test of vectoring in Operator A’s lab. The following figure shows the test results from vectoring 24 pairs on an isolated cable bundle:



500m, 0.4mm cable, INP=2, B8-11

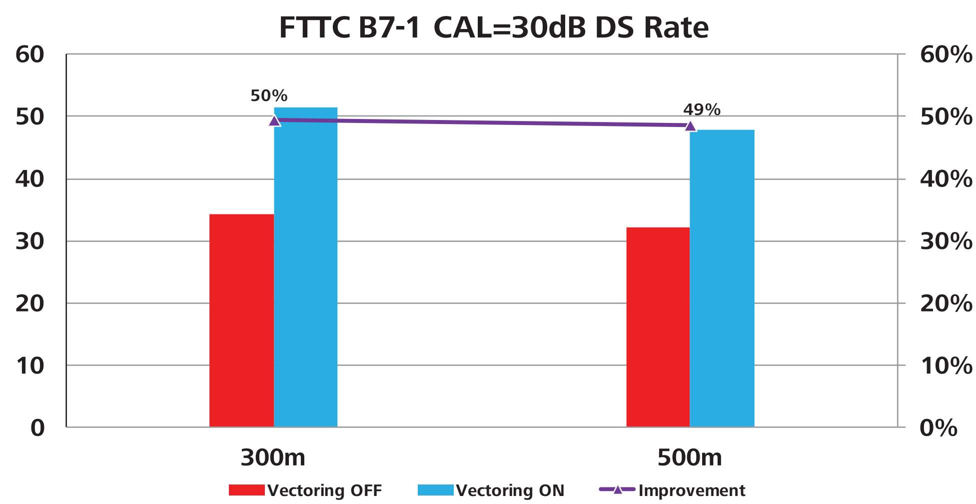
Highlights of the testing were as follows:

- The average downstream rate improves by 63%
- The minimum downstream rate improves by 131%
- Vectored rates are close to single line performance (up to 96%)

4.2 European Incumbent Operator B

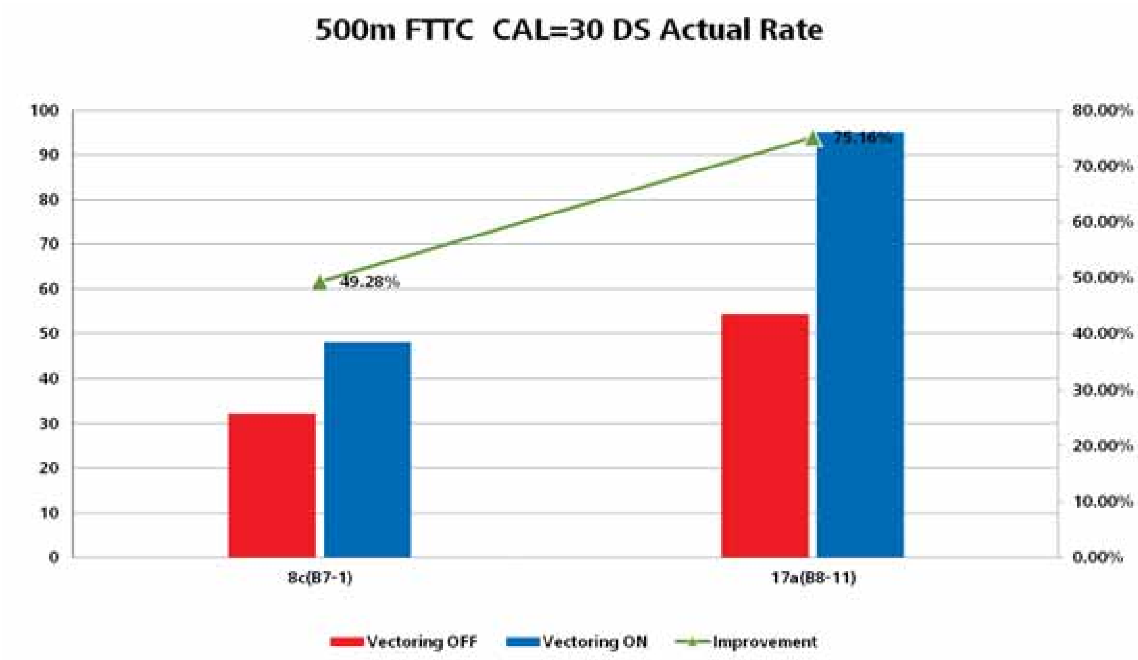
Operator B was interested in the gains vectoring could offer, and how results differed with band-plans 8c and 17ADE. Tests were performed by Huawei in the Operator's lab environment.

In the first test, two line lengths were selected, and the affect of vectoring was examined, using the VDSL2 8c profile:



The downstream performance shows average increases of around 50% with vectoring.

For the next test, the line length was fixed at 500m, and the affects of vectoring were considered against lines using band-plans 8c and 17ADE:

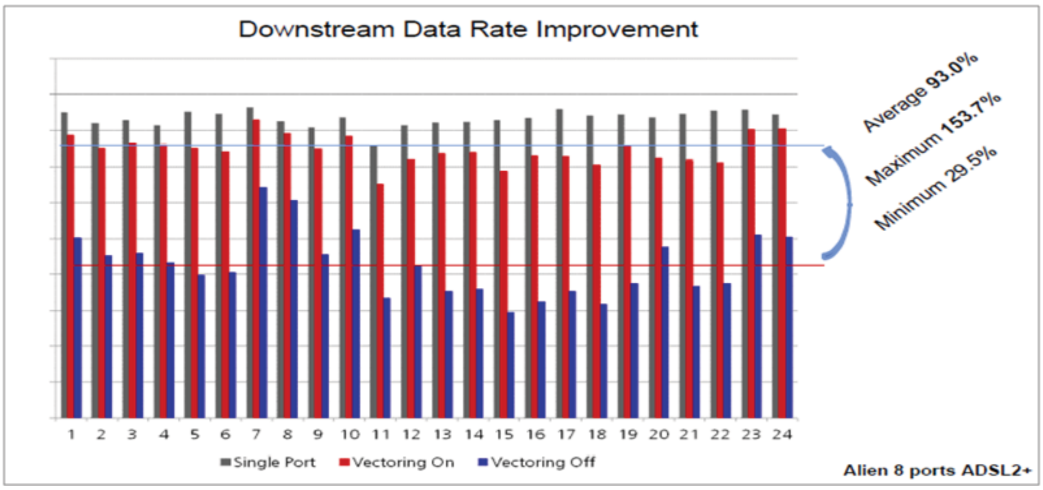


An average 75% increase in downstream line rate was observed when using profile 17ADE, which show greater improvements as the higher frequencies are used. In the upstream direction, vectoring was shown to increase the average rate by around 65%.

This operator has started a limited field trial of vectoring in the past month, and results are expected later in the year.

4.3 European Incumbent Operator C

Operator C wanted to test the affect of non-vectored talkers (aliens) present in the same bundle as the vectored VDSL2. In this test setup, 8 ADSL2+ lines were present in the same bundle as the 24 vectored VDSL2 lines:



553m (220m + 333m), 0.4mm, INP=2, B8-11

Highlights of the testing were as follows:

- Negligible performance impact if ADSL2+ aliens are coming from the CO when the VDSL2 is in the street cabinet (Less than 1% performance drop)
- Slight performance impact if ADSL2+ alien DSLAM and vectored VDSL2 DSLAM are co-located. (Around 4% performance drop)

5 SuperMIMO – the next level

5.1 Overview

Super MIMO is the ultimate multi-pair DSL technology. It allows signals to be sent over both traditional channels and virtual channels, leading to a significant increase in data-rate from around **50% to 100%**.

Super MIMO creates N-1 virtual pairs out of N copper pairs in an optimal way, thus it could maximize the potential of copper resource for operators and significantly improve performance for broadband access customers and other commercial users. Super MIMO is a technique which combines channel expansion and crosstalk cancellation, improving the multi-pair capacity by optimal channel expansion.

However, channel expansion leads to significant crosstalk which is sometimes larger than that between the normal twisted pairs. So SuperMIMO has to overcome a more serious crosstalk problem than VDSL2.

Therefore, proper crosstalk cancellation functionality must be included in the SuperMIMO system.

5.2 Common Mode (CM)

Common Mode is also known as Phantom Mode. Channels 1 and 2 both have an independent common signal. CM uses the two signals to carry differential information, which means it creates a new differential channel based on two common signals. It expands N pairs to 2N-1 channels;

5.3 Alternative Mode (AM)

AM uses the two differential signals together to carry differential information, which means it creates a new alternative channel based the differential of the two signals. It expands N pairs to 2N-1 channels;

5.4 Mixed Mode (CM+AM)

Mixed mode uses a combination of CM and AM:

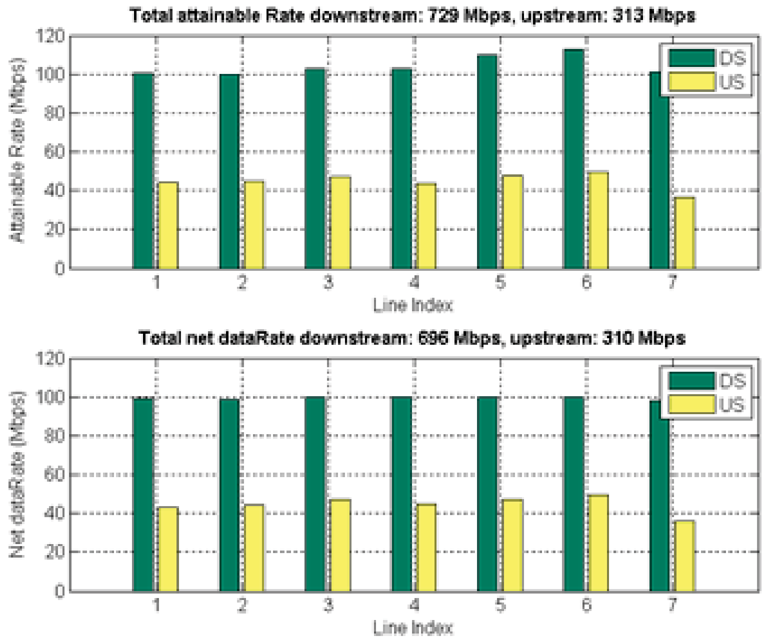
Huawei's SuperMIMO solution supports Common Mode, Alternative Mode or Mixed Mode.

5.5 Test Results

The SuperMIMO test setup was as follows:

- 4pairs SuperMIMO
- VDSL2 Profile 17a, B8-11,
- 0.5mm, 400m cable (CAT5)

The results of the test are shown in the following figure:



The key points to highlight from the test are:

- Total net data rate downstream: 696Mbps, 75% improvement over single lines without SuperMIMO
- Total net data rate upstream : 310Mbps, 30% improvement over single lines without SuperMIMO

6 Obstacles to Vectoring

6.1 Increased Power Requirement

Vectoring requires a higher power requirement per line. This is estimated at around 10W per line card. Fortunately as the VDSL2 chipsets have become more mature, the port density per chip has increased, and hence the power per port is falling. Requiring additional power for vectoring will not have a massive impact on overall power consumption, as VDSL2 required power approaches 1W per port.

Conclusion: Not a major obstacle to vectoring

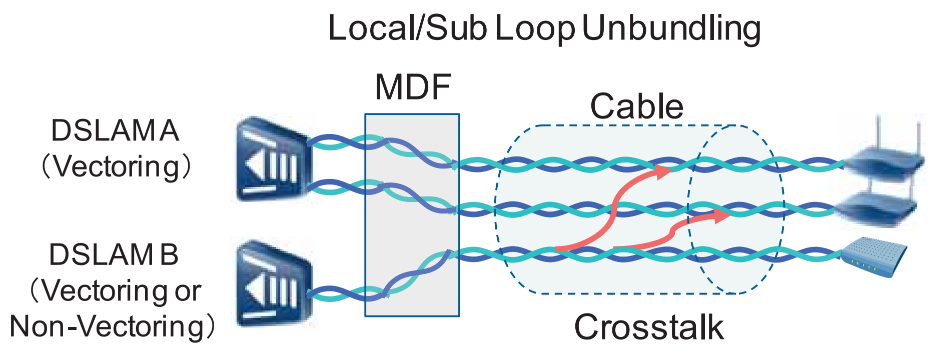
6.2 CPE

In order to support vectoring, the VDSL2 CPE needs to be either fully compliant with the G.vector standards, or "vectoring friendly" such that it can join a vectoring group and does not affect the performance of the vectored lines in that group. If non-compliant or non-friendly VDSL2 CPEs are present, they will limit the performance of other vectored lines in the same cable bundle. Some vendor's CPE can be firmware upgraded to be G.vector compliant, whilst some vendor's CPE can be firmware upgraded to be vectoring friendly, although they may not experience the full vectoring gain.

Conclusion: Ensure all VDSL2 CPE are G.vector compliant or friendly through firmware update *– this is more likely if one operator is in control of the distribution to subscribers of the VDSL2 CPE.*

6.3 Unbundling

In the unbundled scenario, different operators share the same bundle with different equipment types, and different xDSL technologies. It's very difficult for cross system vectoring especially from different equipment vendors. In the case of unbundled lines, the performance improvement from vectoring will be limited and un-controllable. The next figure shows that crosstalk from DSLAM B's lines will have an adverse effect on the lines from DSLAM A:

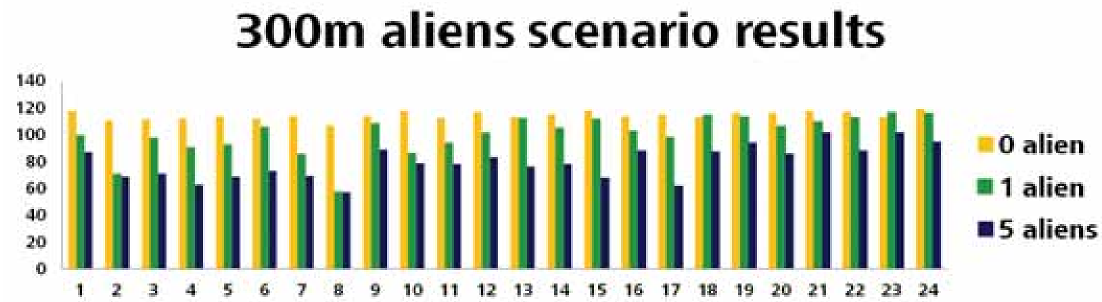


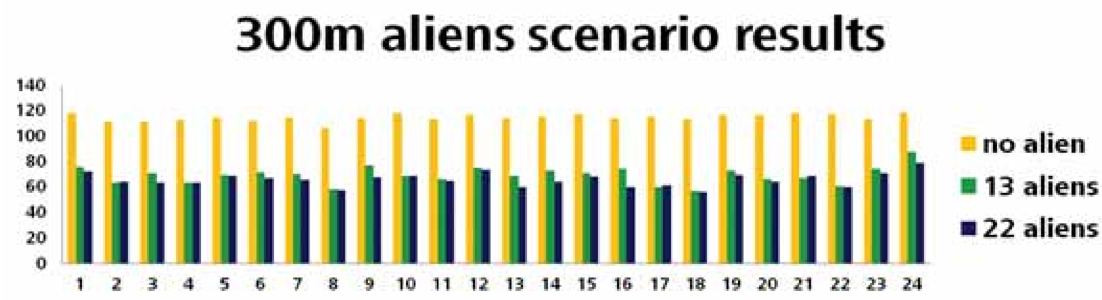
For a 24 pair cable bundle, the vectoring-capable DSLAM A will suffer the un-controlled crosstalk from DSLAM B as aliens. The more lines that are connected to DSLAM B, the higher the impact on the lines of DSLAM A.

In a previous section it was shown that ADSL2+ aliens have a very small affect on vectoring. In the next section, the affects of VDSL2 aliens are examined.

6.3.1 Investigation into the impact of aliens on Vectoring

In this section, the affect of another operator's VDSL2 lines (aliens) is considered, as the number of aliens is varied:





As shown in the above figure, with no other VDSL talkers (aliens) it is seen that the 24 subscribers each receive a service in excess of 100Mbps. When 22 aliens are present in the bundle the average speed is around 50Mbps. This means that comparing the situation of no unbundling with the unbundling scenario, vectoring can give a 100% line rate improvement.

Conclusion: Allowing unbundling of VDSL2 places a severe restriction on the achievable line rates.

7 Beyond VDSL2 – FTTdp

Fibre to the distribution point (FTTdp) is still in the early stages of development, as a possible way to increase end-user line speeds whilst still using the existing copper entering the subscriber's property. It is typically planned as a solution to the last 100m.

Features of FTTdp are:

- Faster speeds, closer to end users
- Ultra high speed DSL (UDSL) - Up to at least 500Mbps DS+US
- Reverse power feed to DSLAM from subscribers

Since the intention is to remotely power the mini-DSLAM from the subscriber end, it is clear that all lines at the dp need to be connected to the same mini-DSLAM.

Conclusion: if FTTdp is to be considered as a future technology then unbundling the lines from the dp to subscriber premises would not be feasible.

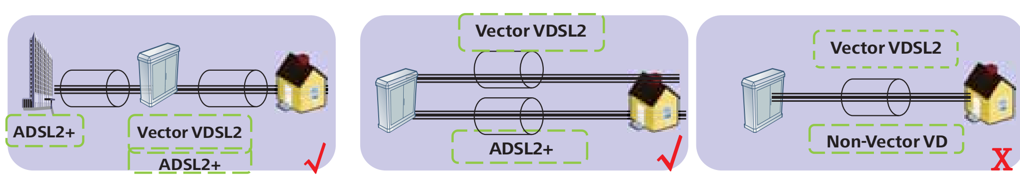
8 Conclusions & Recommendations

8.1 Performance Improvement

- Without aliens (i.e. **without sub-loop unbundling**), up to **96%** of the crosstalk-free performance can be achieved.
- If loop length is less than 800m (0.4mm), the vectoring performance is obvious and the data rate can be improved more than **50%.**
- **SuperMIMO** depends on Vectoring and can offer **speeds of around 700Mbps** over 4 copper pairs

8.2 The Impact of Aliens

- **Negligible** performance impact if ADSL2+ aliens are coming from the CO side
- **Slight** performance impact if ADSL2+ alien DSLAM and vectored VDSL2 DSLAM are co-located in the Street Cabinet
- VDSL2 aliens (coming from sub-loop unbundling) have a **severe** impact on the vectored performance: Alien lines can cause some vectoring lines to retrain.



8.3 Recommendations

- ➢ **Vectoring can leverage fibre-like speeds out of existing copper infrastructure**
- ➢ **Allowing Sub-Loop Unbundling for VDSL2 restricts the average end-user speeds**
- ➢ **Node level vectoring for the entire cable bundle, controlled by a single operator, in a FTTC site is the best solution**

About Huawei

Huawei is a leading global information and communications technology (ICT) solutions provider. Through our dedication to customer-centric innovation and strong partnerships, we have established end-to-end advantages in telecom networks, devices and cloud computing. We are committed to creating maximum value for telecom operators, enterprises and consumers by providing competitive solutions and services. Our products and solutions have been deployed in over 140 countries, serving more than one third of the world's population.

Huawei's vision is to enrich life through communication. By leveraging our experience and expertise in the ICT sector, we help bridge the digital divide by providing opportunities to enjoy broadband services, regardless of geographic location. Contributing to the sustainable development of the society, economy, and the environment, Huawei creates green solutions that enable customers to reduce power consumption, carbon emissions and resource costs.

Huawei DSLAMs are connected to 34% of the world's broadband lines, ranking as the number one vendor in the xDSL market. Huawei is the biggest contributor to DSL standards, and has won over 50% of global FTTx projects.

Advice regarding SLU in context of VDSL2 vectoring

Jan Verlinden, Alcatel-Lucent DSL expert

Aug 22nd, 2011

Alcatel·Lucent

Agenda

- Context : Importance of VDSL2 / Vectoring in Europe
- Technology :
  - Crosstalk as main limitation of VDSL2
  - Vectoring mechanism to cancel crosstalk & requirements
  - Results from Vectoring
- Deployment :
  - Where to apply vectoring
  - How to deal with SLU
- Conclusions

Alcatel·Lucent

Towards ubiquitous very high-speed broadband

Context

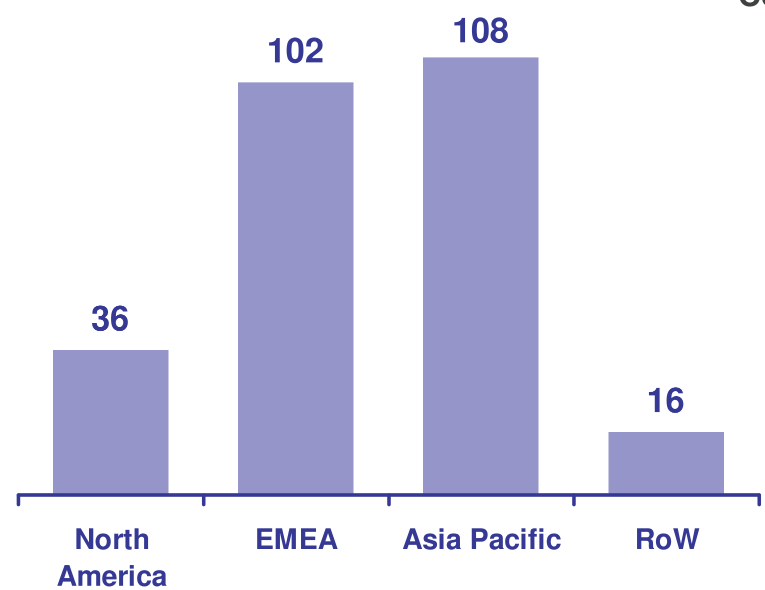
The Challenge

EC Digital Agenda

- broadband connectivity to all by 2013
- **30 Mbps** to all subscribers by 2020
- **100 Mbps** to 50% by 2020

FCC's National Broadband Plan (USA)

- **100 Mbps to 100 Mio** households by 2020



The Opportunity

DSL subscribers (millions), Dell'Oro 2Q10

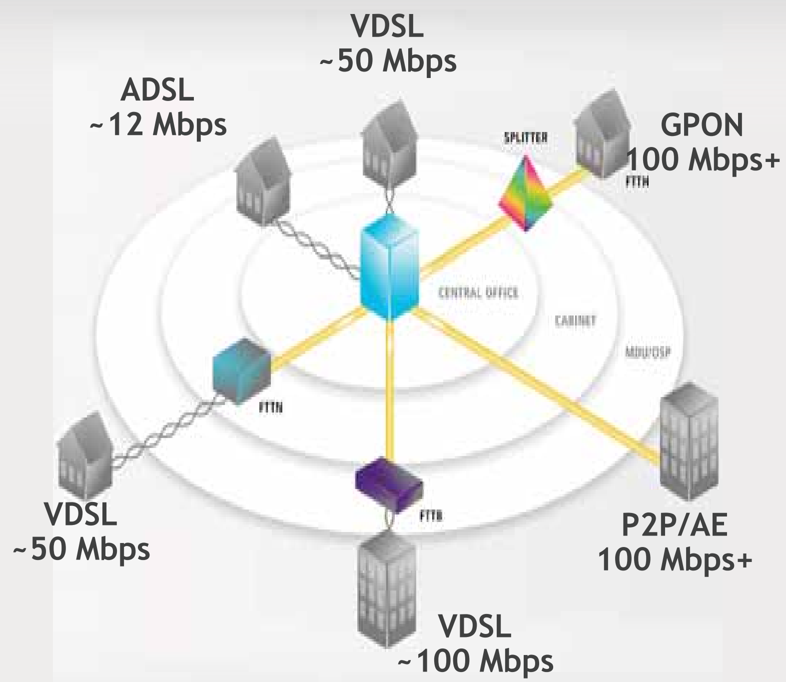
- **100M+** households in EMEA on DSL broadband
- **250M+** households worldwide

FTTx + VDSL2 is the fastest path to universal coverage in the most cost-effective way, at the most economical pace

Alcatel·Lucent

Solving the bandwidth equation

Context

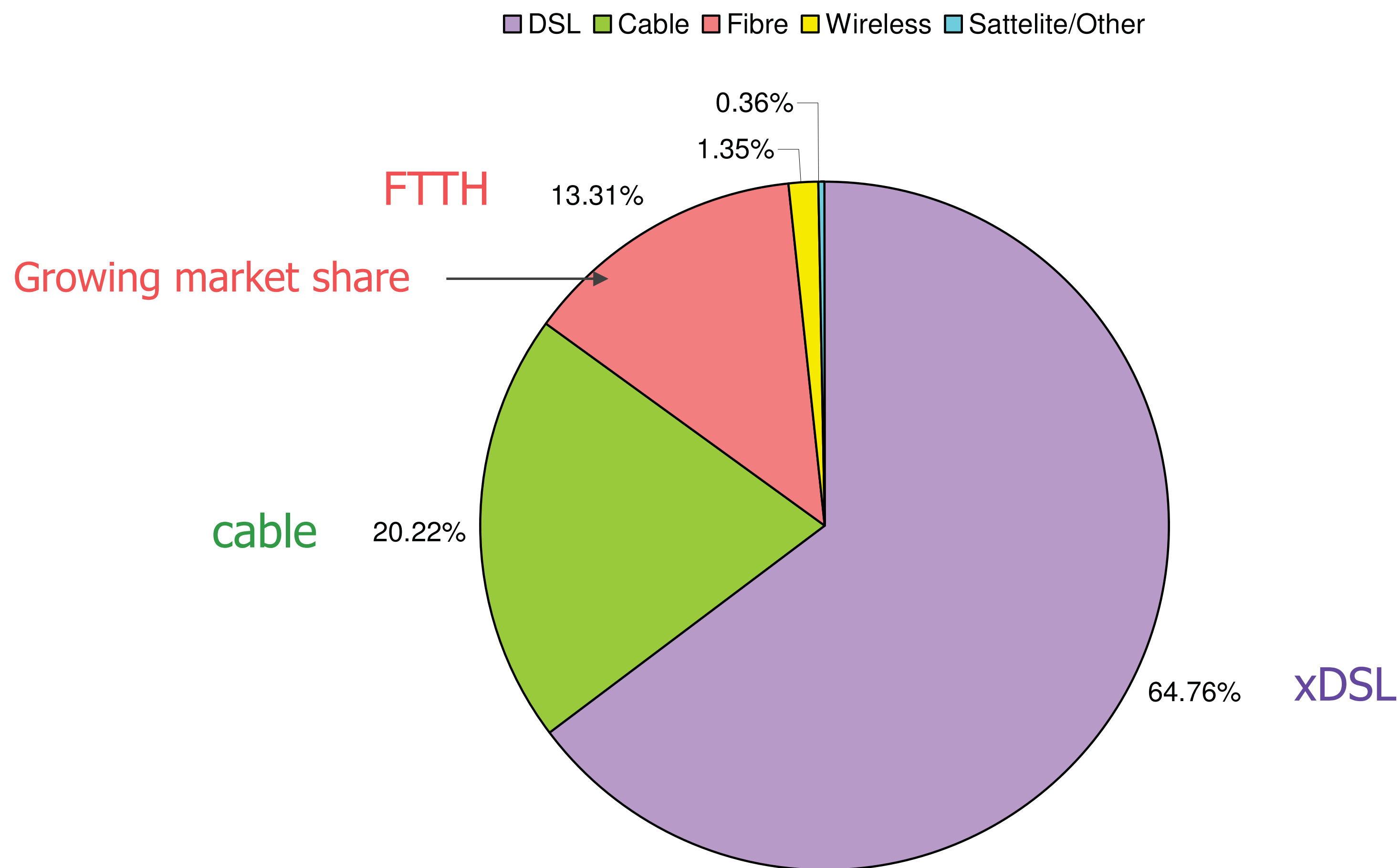


FTTH is the end game; FTTx to bridge the gap with FTTH
Key drivers: CAPEX and time-to-market

Broadband market share by technology worldwide

2Q2010

Context



Source: Point Topic

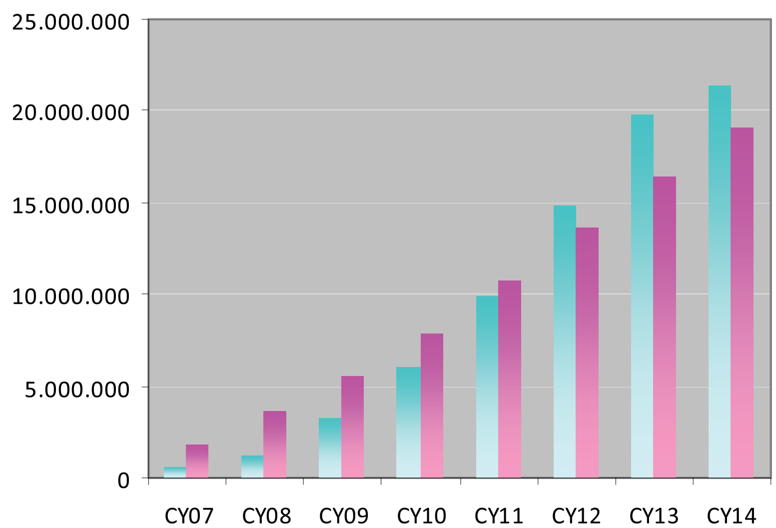
2 out of 3 broadband customers are connected over xDSL

VDSL2 shows strong growth in EMEA and NAR

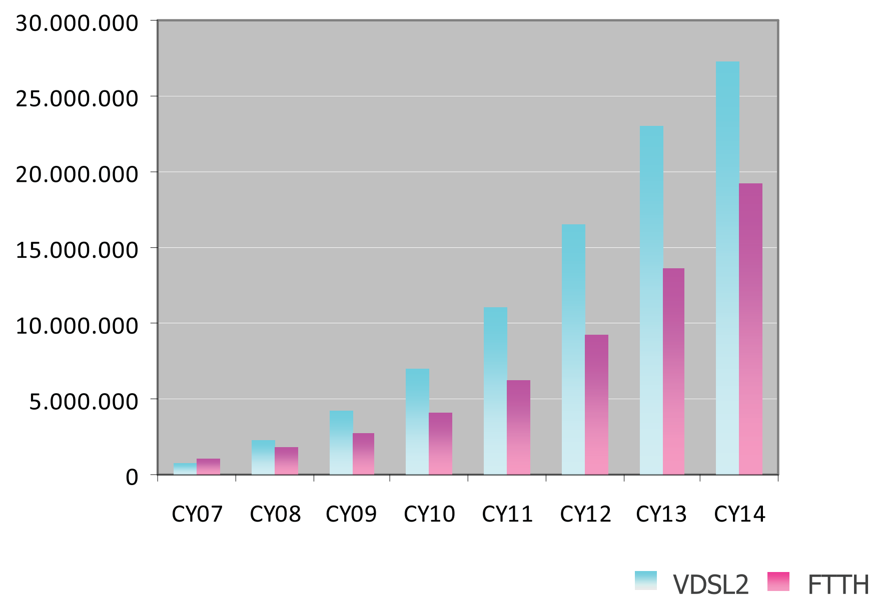
Context

Drivers: time to market, competition, CAPEX, infrastructure, regulations

FTTx subscribers in NAR



FTTx subscribers in EMEA



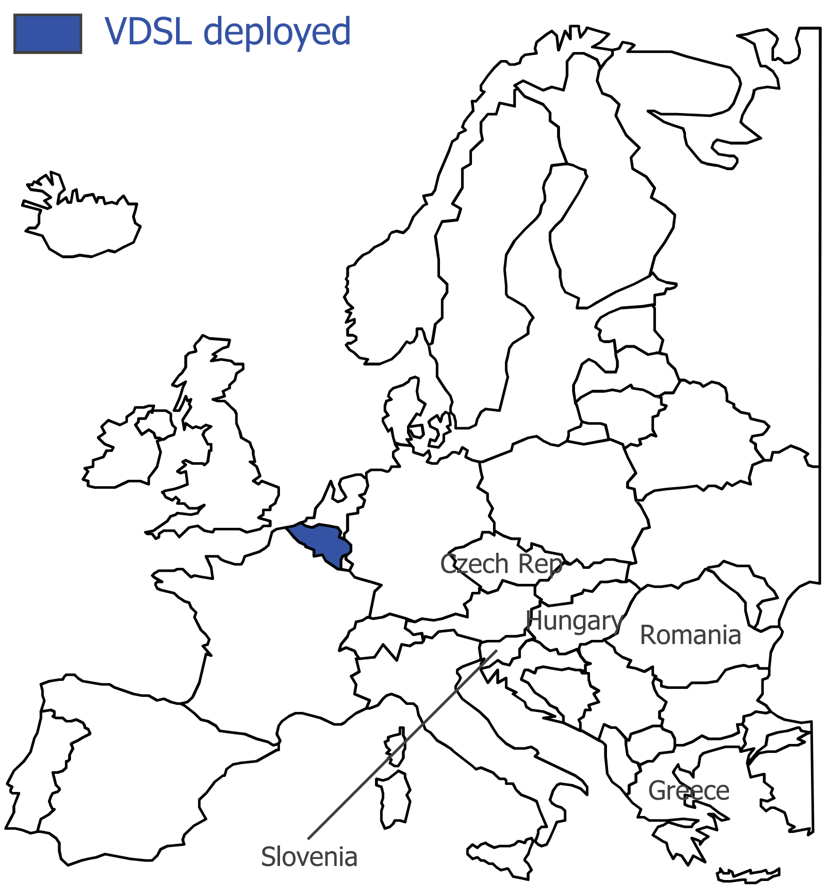
Source: Infonetics Research, Sep 2010

In EMEA market, VDSL2 grows faster than FTTH
Take maximum from your existing network and prepare for the next wave

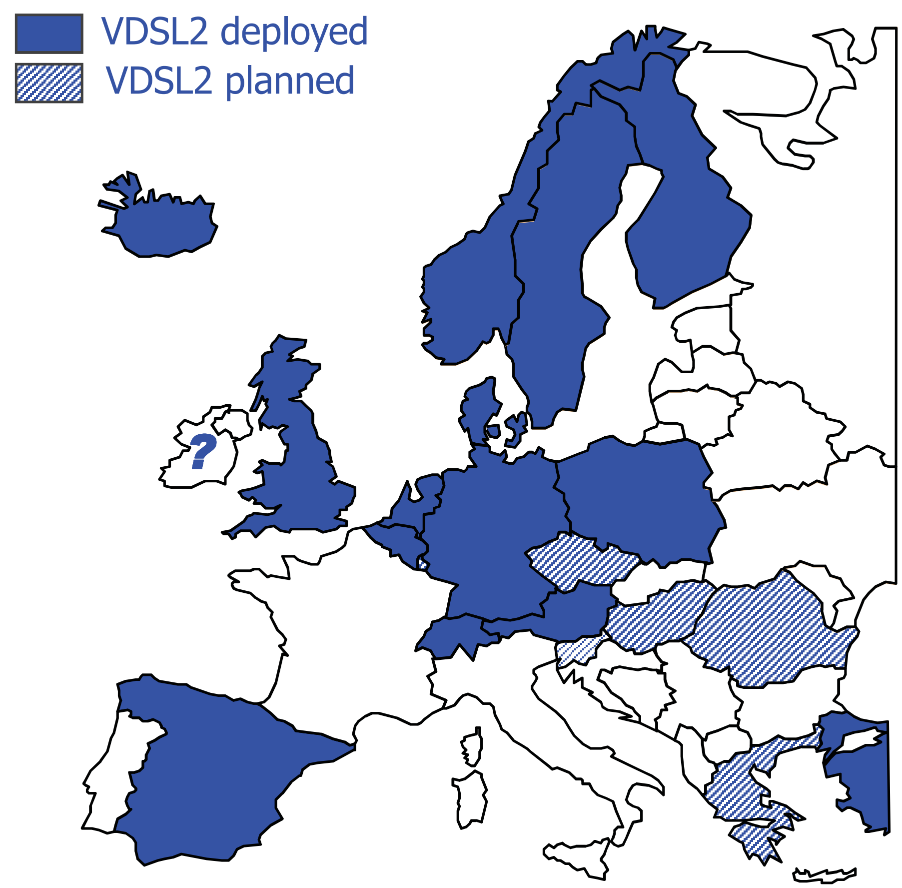
VDSL2 take-up in Europe

Context

VDSL deployment in 2004



VDSL2 deployment in 2011



Belgacom was first to deploy VDSL in 2004
VDSL2 deployment is spreading across (Western) Europe – more to come

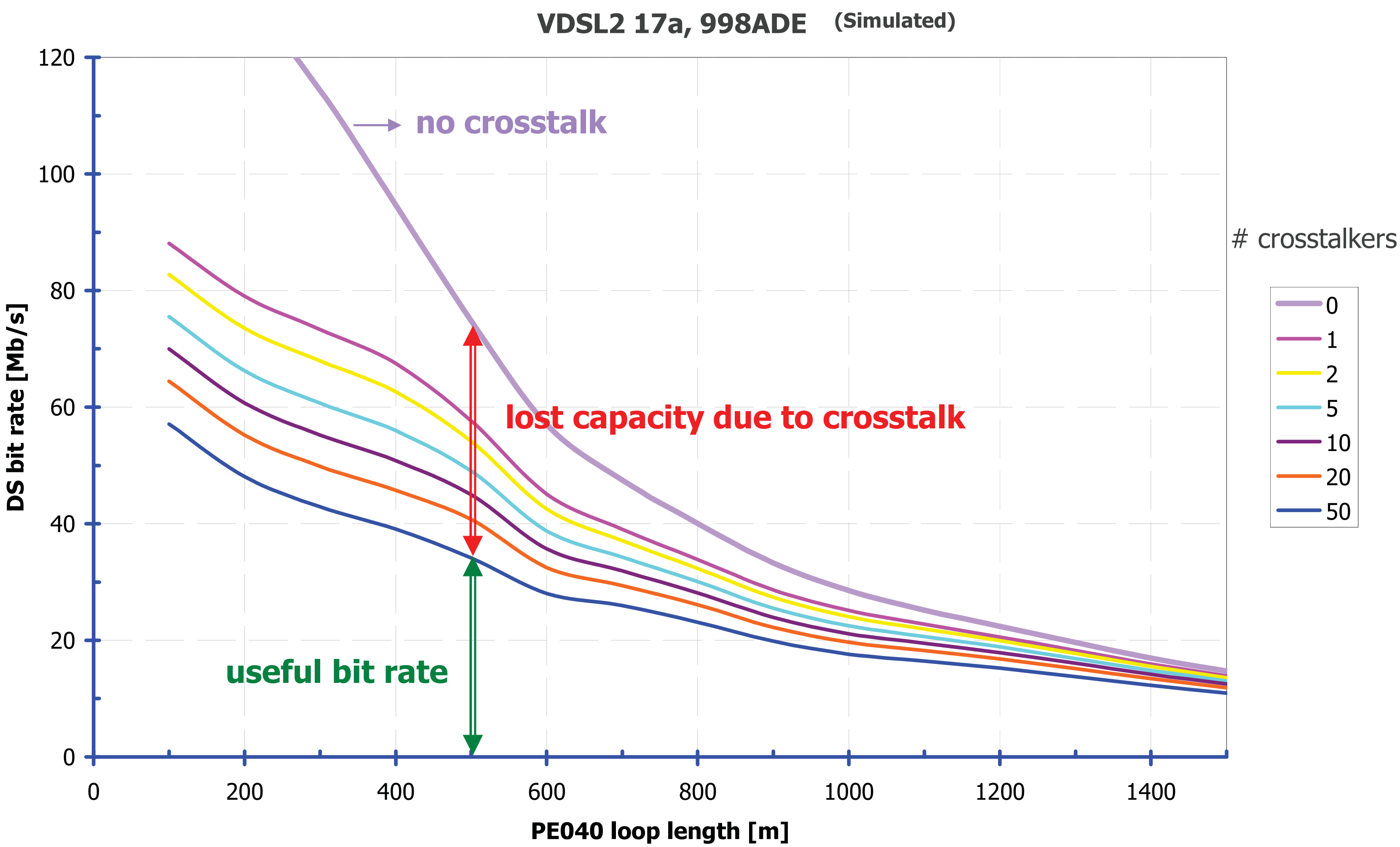
Conclusion on Context

Context

- xDSL
  - Main broadband technology today
  - Keeps on growing : faster growth of VDSL2 than FTTH
- VDSL2 is important to meet the EU Digital Agenda
  - Cost effective
  - Fast time to market
- Many countries in EU are deploying or planning deployment of VDSL2
  - (i.e. VDSL2 is seen by other countries as a future-safe investment)

VDSL2 bit rate with increasing penetration

Technology



Crosstalk limits the achievable bit rates over VDSL2

VDSL2 Vectoring - Cancelling crosstalk

Technology

Crosstalk is dominant disturber for VDSL2

Vectoring cancels self-crosstalk

- Measure crosstalk from each line into all other lines in cable (binder)
- Cancel the noise with an anti-phase signal (similar to noise-cancellation head-phone)

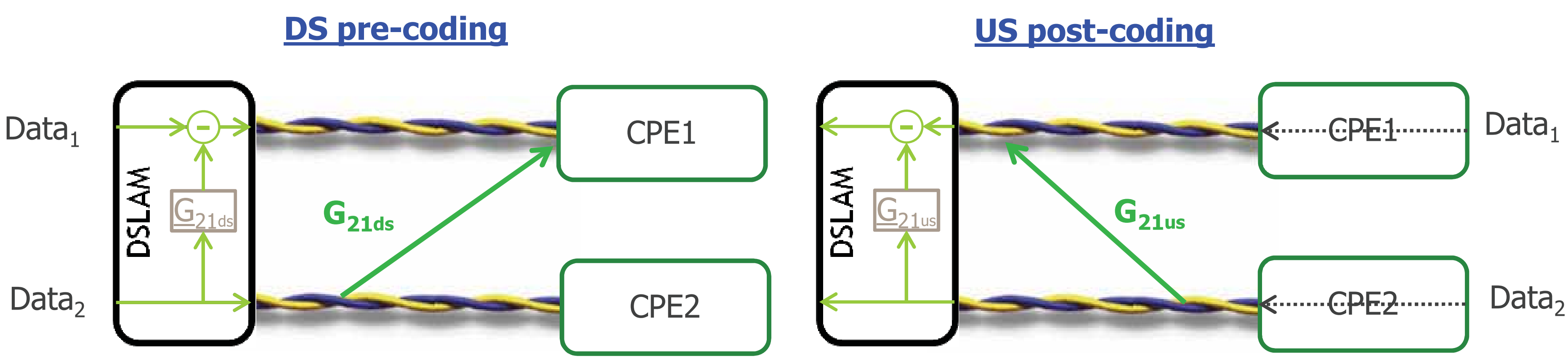
Vectoring cancels noise - potential gain up to 100% bit rate increase

VDSL2 Vectoring

The main principle

Technology

- Crosstalk cancelling by injecting an 'anti-signal' on each line
  - Requires full control over all VDSL2 lines
  - Requires a crosstalk estimating mechanism to derive the crosstalk coefficients
    - Mechanism specified in ITU-T G.993.5 (G.vector) standard for DSLAM/CPE interoperability



VDSL2 Vectoring

The main principle – implications for SLU

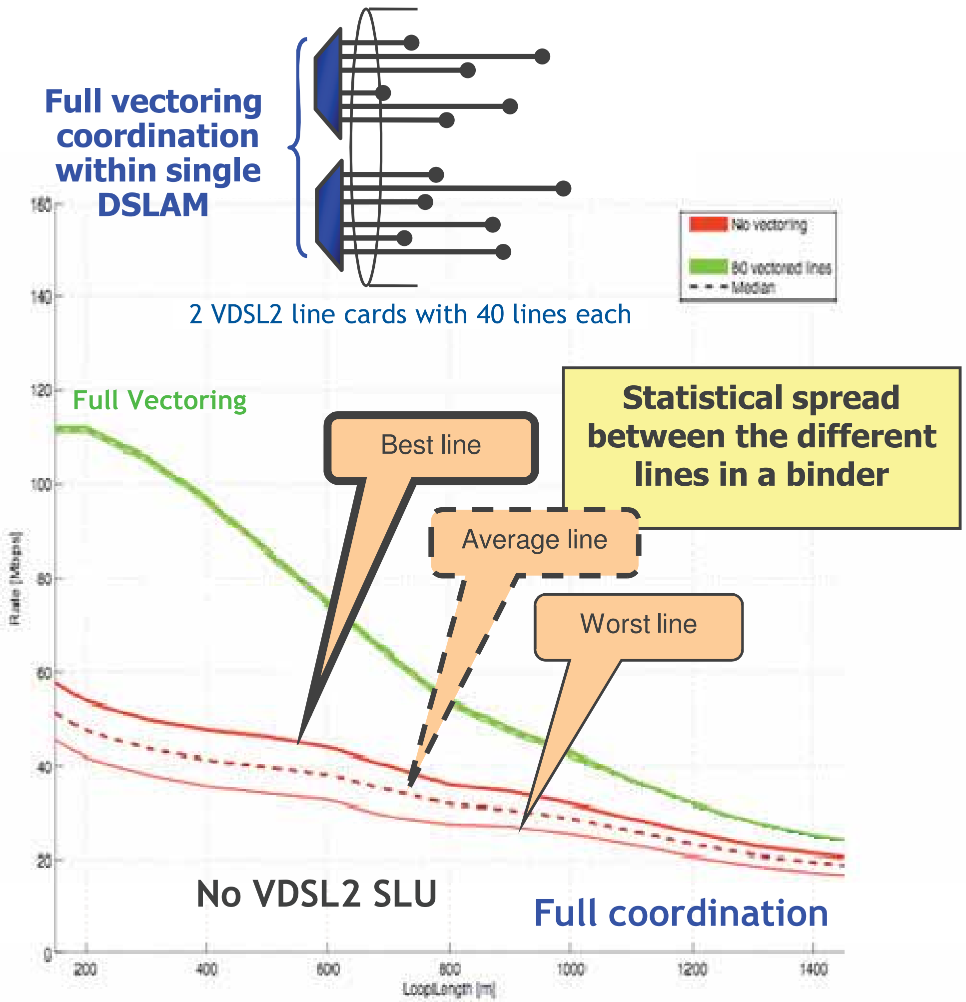

Technology

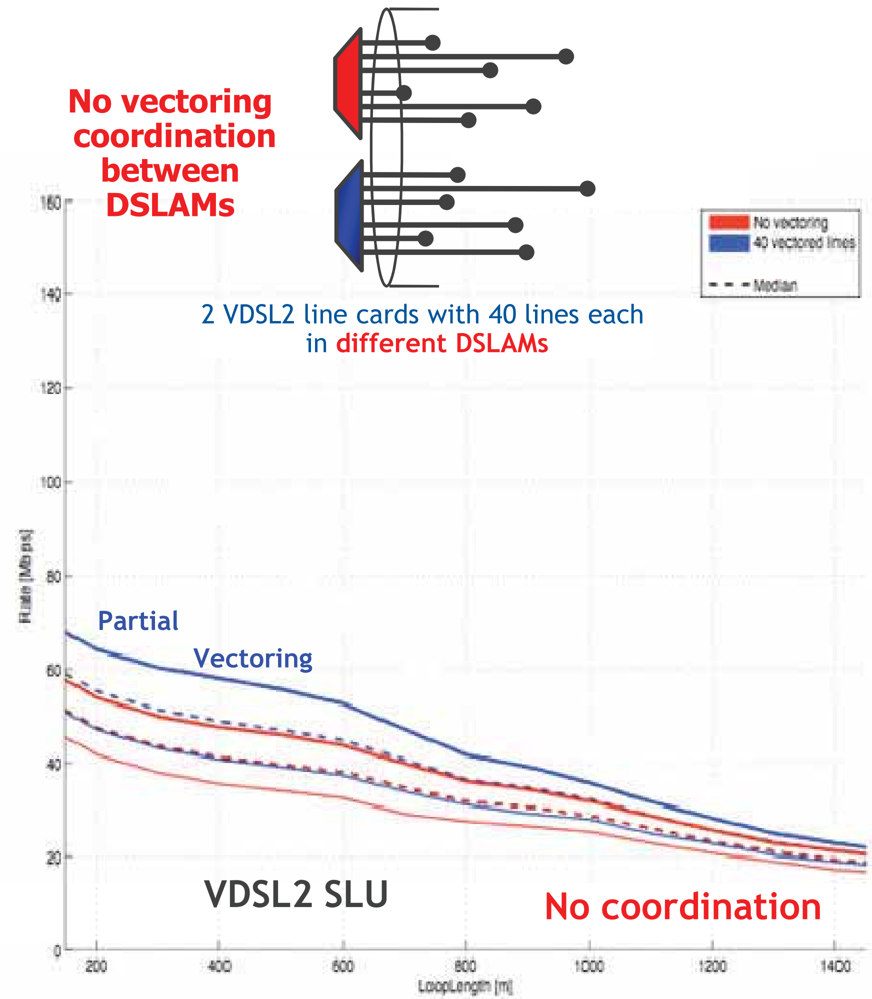
- Full control over all the VDSL2 lines
  - Without full control, there is a strong reduction of vectoring bit rates (see next slide)

- Crosstalk estimating mechanism to derive the crosstalk coefficients
  - All CPEs in a certain neighbourhood need
    - At least "G.vector friendliness" compliance (to allow other lines to do vectoring)
    - By preference "G.vector" compliance (to benefit themselves from vectoring)
  - All CPEs that are not "G.vector friendly" or "G.vector" compliant will behave as today's VDSL2 crosstalkers
    - Strong reduction of vectoring bit rates

Vectoring in Unbundled environment

Simulation example: 80 VDSL2 lines in 300-pair binder





Technology

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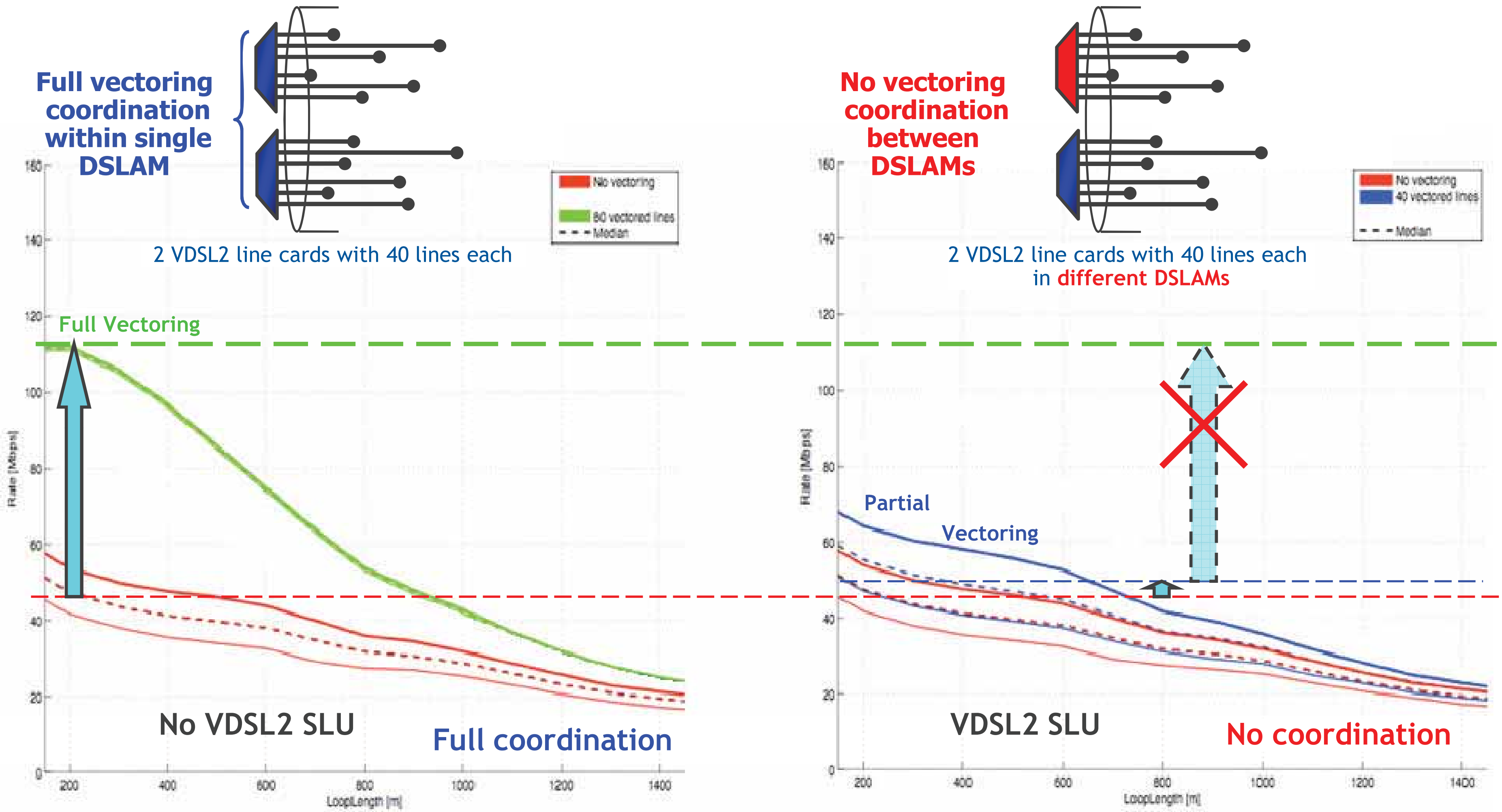
Vectoring in Unbundled environment

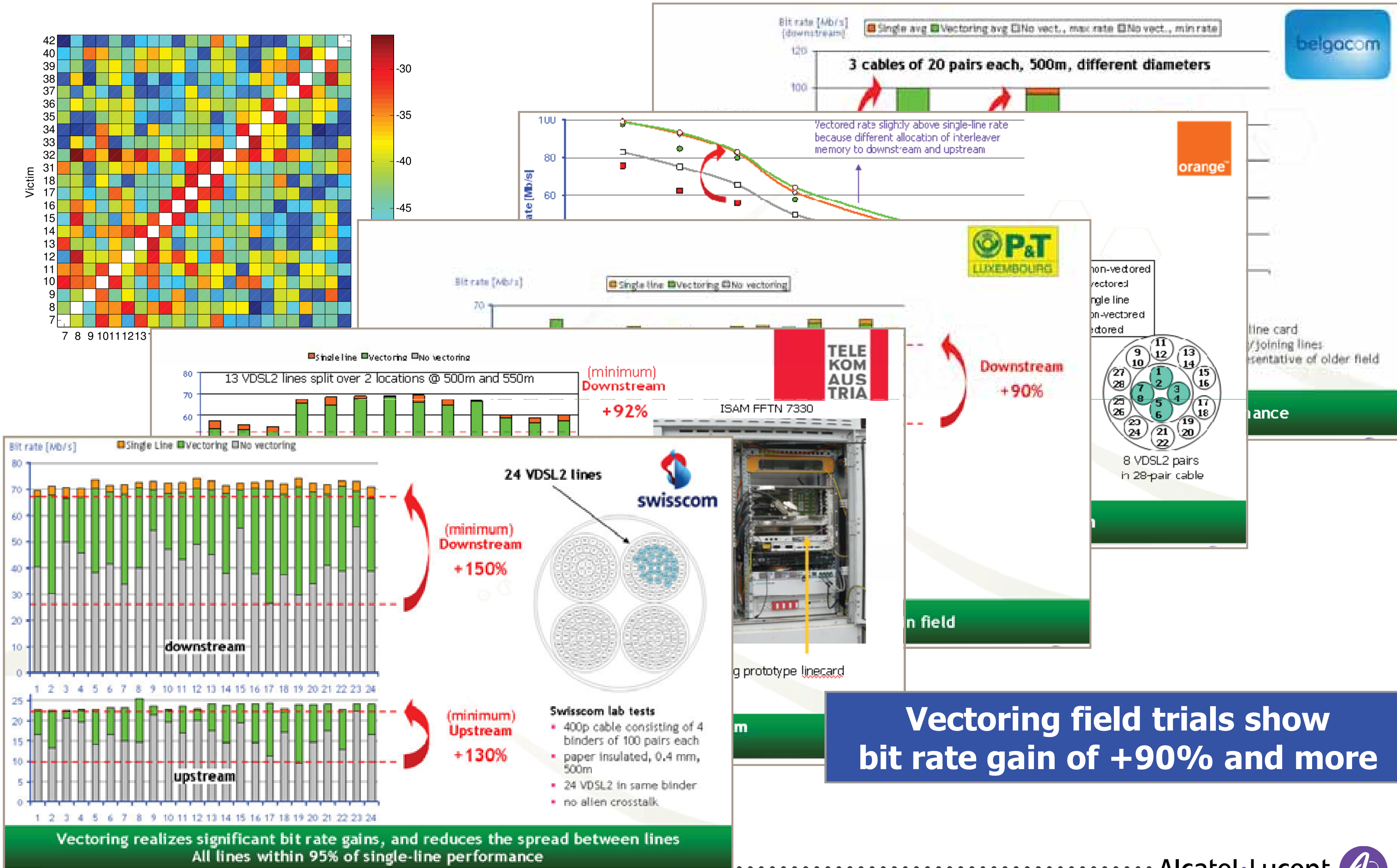
Simulation example: 80 VDSL2 lines in 300-pair binder



Vectoring gain is drastically reduced if no control over all VDSL2 lines in binder

Vectoring customer lab & field results

Technology



Vectoring field trials show bit rate gain of +90% and more

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Conclusion on Technology

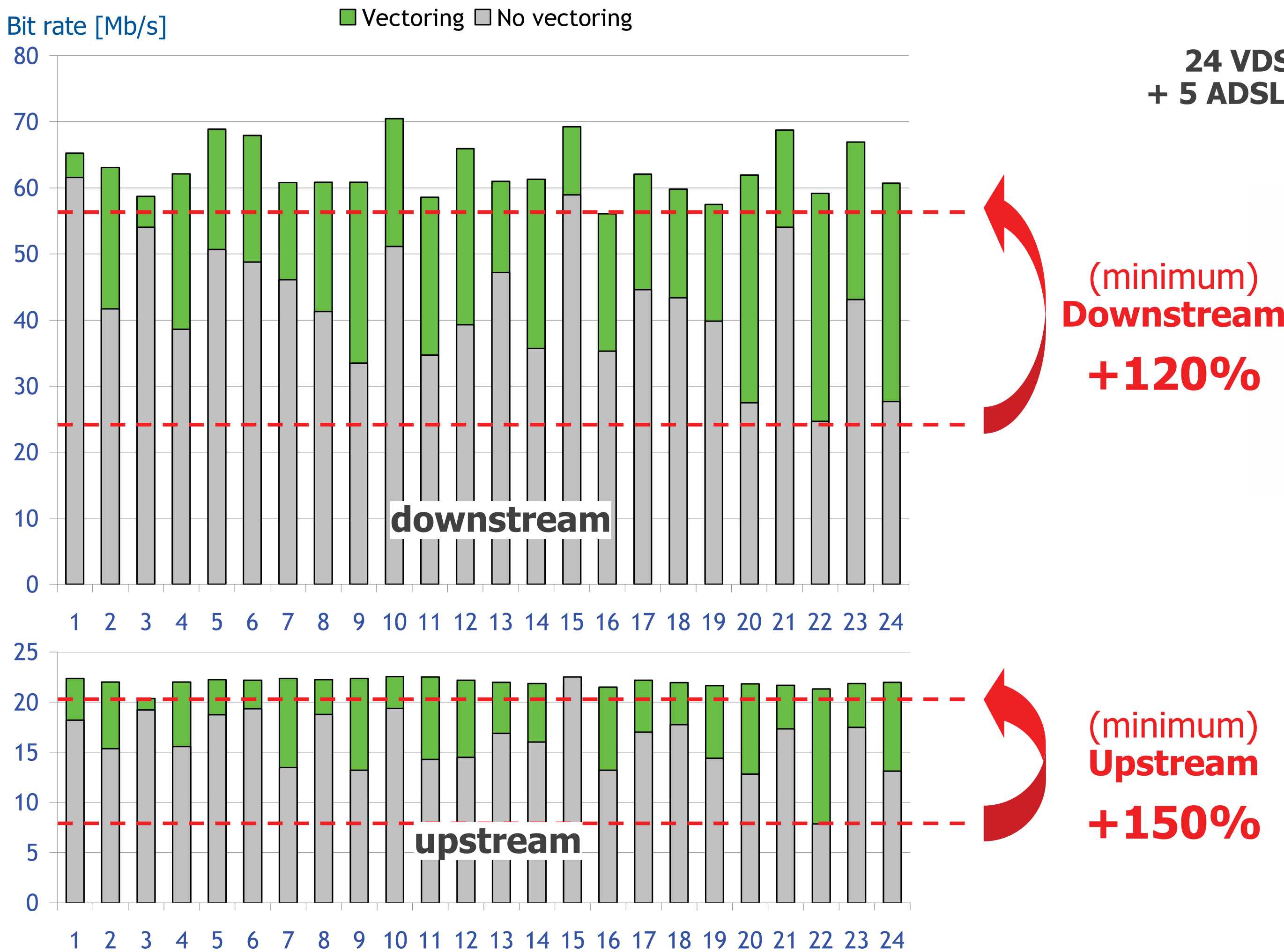
Technology

- Crosstalk
  - Main limitation of VDSL2
    - 10% crosstalker can reduce bit rates by more than 50%
  - Vectoring allows to cancel crosstalk
- Requirements for vectoring
  - Full control: all VDSL2 lines under control of 1 DSLAM
  - All CPEs in a binder: G.vector friendly or full G.vector compliant
- Benefit from vectoring
  - Bit rate gains of +90% and more, demonstrated both in lab & field
- Vectoring & SLU (of VDSL2)
  - SLU strongly reduces the benefit of vectoring

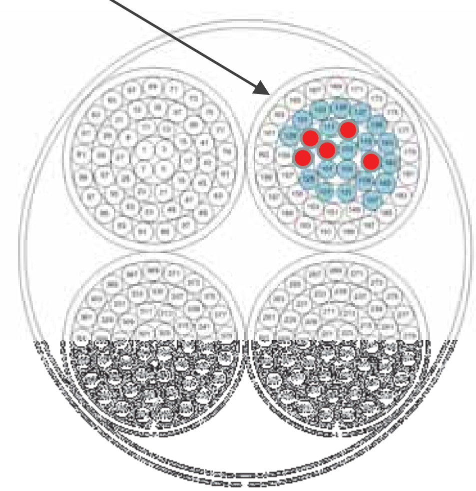
Vectoring in presence of CO-based ADSLx

Swisscom lab

Deployment



24 VDSL2 lines
+ 5 ADSL2plus lines



Swisscom lab tests

- 400p cable consisting of 4 binders of 100 pairs each
- 0.4 mm, 500m
- 24 VDSL2 in same binder
- 5 ADSL2plus lines sharing same quad as VDSL2 line

Even in an unbundled ADSLx environment, Vectoring still realizes significant gains

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Vectoring

Applicability depending on Deployment scenario & Regulatory environment

Regulatory environment		Deployment scenario: CO deployment	Deployment scenario: FTTN / FTTC / FTTB
	No LLU (no physical loop unbundling)	**Technical challenges for application of Vectoring** • Large number of lines; grooming considered unfeasible • Computational effort may be prohibitive • Bundle integrity often not guaranteed • Rewiring to connect all binder lines to same LT and/or DSLAM considered difficult • Small vectoring gain on long lines	**Vectoring applicable** • Typically limited number of lines • Computations feasible • Control over all lines • With VDSL2 wholesale offers, all service providers will benefit from vectoring gains
	LLU (physical loop unbundling)	**Vectoring not applicable** • Same challenges as above (no LLU) • No control over unbundled lines	**Strongly reduced Vectoring gains** • No control over unbundled lines • Vectoring gains could be minimal **no SLU in practice**

- Notes
  - VDSL2 wholesale (bitstream access) is compatible with vectoring
  - VDSL2 vectoring gain is slightly reduced in presence of uncontrolled (and LLU) ADSLx

Vectoring: main application in remote nodes, with no SLU
Wholesale bit stream access is compatible with vectoring

SLU evolutions in other countries in Europe

Deployment

- Netherlands
  - Business case for SLU (http://www.opta.nl/nl/download/publicatie/?id=2120)
    - Conducted by "Analysys" on request of OPTA, the Dutch regulator
    - Conclusion: "However, our analysis also indicates that even with … **there may still not exist an attractive business case for SLU deployment to reach the mass market**."
- Belgium
  - No longer an obligation for Belgacom to offer SLU
    - Subject to actual deployment of vectoring in Belgium within reasonable time period
    - Possibility to re-introduce SLU should technological evolutions solve the incompatibility between vectoring and VDSL2 SLU.
  - http://circa.europa.eu/Public/irc/infso/ecctf/library?l=/belgiquebelgi/registerednotifications/be20111227/be-2011-1227-1228/_EN_1.0_&a=d
- Austria
  - Proposals towards "Virtual unbundling in NGA areas"
    - Layer 2 bitstream offer based on ethernet technology
    - NGA = next generation access, for example VDSL2 roll-out from a cabinet
    - No need for physical unbundling in such areas : all lines under control of 1 operator
    - Single operator could be either ILEC or CLEC – same rules for either of them
  - Idea presented at TNO Seminar 2011
    - Similar slideset at : http://www.slideshare.net/qrt123/ensuring-effective-regulation-of-nga-networks-in-austria

Conclusion on Deployment

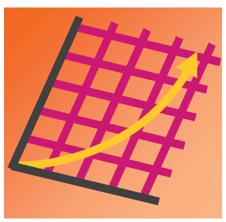

Deployment

- Unbundling
  - Of ADSLx : still possible
  - Of VDSL2 : strong reduction of vectoring bit rates
- Main applicability for vectoring
  - Cabinet deployment
  - Without SLU (single DSLAM for VDSL2)
- Regulation in EU
  - Many regulators are looking at stopping the requirement for SLU
    - From cabinets
    - For new technologies (VDSL2 & vectoring)

Overall Conclusion

DSL is a critical part of operators’ FTTx strategy

- Short & Medium term complement, until fiber is ubiquitous
- Fastest way to provide universal coverage for very high speed broadband
- Fast deployment is critical in markets with cable competition



Technology to boosts rates becoming available

- Large bit rate gains from VDSL2 vectoring possible
- First VDSL2 Vectoring field results confirm this potential in real life

Vectoring is not compatible with VDSL2 SLU

- VDSL2 SLU severely reduces Vectoring gains
- VDSL2 WBA (bitstream access) is compatible with Vectoring; all users benefit
- As fiber moves closer to end-user, physical loop unbundling becomes less practical

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ANNEX 1.1

eircom - Vectoring Technology

ANNEX 1.1 – eircom summary of Vectoring Technology Characteristics

Pitfalls of sub-loop unbundling for Broadband Service Providers

Vectoring technology (standardised in ITU-T G.993.5 April 2010) is available now from VDSL2 chip manufacturers. DSLAM vendors are proposing to commercially provide the functionality at DSLAM node scale from late 2012.

Chip manufacturers claim that vectoring will increase broadband speeds by up to 100% if node scale vectoring is deployed (this implies SLU is not possible). Furthermore, chip manufacturers claim that vectoring can only bring marginal speed improvements if line card vectoring is used. Marginal speed improvements would not justify the additional investment in vectoring technology by operators. Some operators have lab trialled early versions of vectoring systems and report significant performance improvements.

There are a number of pitfalls to SLU for the broadband service provider which will negatively impact on future broadband speeds and service providers' capability to compete with cable. SLU will rule out the use of future and imminent VDSL2 technology developments, specifically VDSL2 vectoring developments. SLU will also complicate VDSL2 cabinet planning requiring bespoke design, increased costs and delays in deployment.

VDSL2 to increase broadband speeds

Very high speed digital subscriber line (VDSL) technology will deliver very high broadband speeds over short copper loops. VDSL2 has to be deployed over short copper loops because of the high frequencies used and the transmission properties of twisted pair cable.

Over longer loop lengths, (>1Km) the bit rates delivered by VDSL2 modems drop off much more sharply than the bit rates delivered by ADSL2+. VDSL2 is thus deployed in cabinets remote from the exchange to decrease the average customer loop length.

Electrical Noise reduces delivered DSL speeds

After distance, the principal factor that limits the speeds achieved by DSL systems is electrical noise. Crosstalk is a significant source of noise in the multi-pair copper cables used for DSL. FEXT (Far End Crosstalk) is the coupling between two or more transmitting pairs as the signal propagates from the transmit end of the pair to the receive end – see Figure 1 and Figure 2 below. If the blue VDSL2 signal shown in Figure 2 below is present in pair 2, then an attenuated replica of this signal (shown in pink) is induced as noise into pair 1. In a multi-pair cable, FEXT would be induced in all the pairs in the cable. This is commonly referred to as "Self FEXT" where the DSLAM itself is responsible for generating the FEXT and this differs from alien FEXT coming from systems other than the DSLAM.

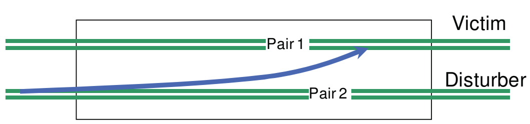

Figure 1 – Far end Cross talk (FEXT)

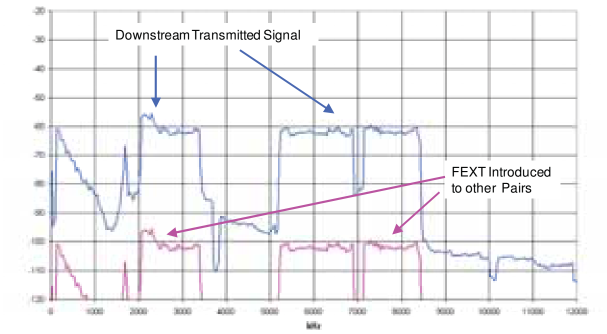

Figure 2 – Far end Cross talk (FEXT) signal induced into other pairs.

Vectoring

The industry has moved to eliminate the effect of this Self FEXT by introducing an active noise cancellation system known as vectoring.

ITU-T Recommendation G.993.5 defines vectoring as "… a transmission method that employs the coordination of line signals for reduction of crosstalk levels and improvement of performance."

The title of G.993.5 - " Self-FEXT cancellation (vectoring) for use with VDSL2 transceivers" declares that the standard applies to SELF – FEXT only.

The vectoring engine or processor needs to manage the signal in all pairs in the multi-pair cable in order for vectoring to be effective. The following extracts from the ITU recommendation highlight the importance of the processor managing all the pairs.

> "The techniques described in this Recommendation provide means of reducing self-FEXT generated by the transceivers in a multi-pair cable or cable binder. Self-FEXT cancellation techniques are particularly beneficial with short cable lengths (< 1 km) and limited near-end crosstalk (NEXT), background noise, and FEXT from systems which are not a part of the vectored group (alien noise).
>
> Another significant factor is the degree to which the self-FEXT cancelling system has access to the disturbing pairs of the cable. Maximum gains are achieved when the self-FEXT cancelling system has access to <u>all of the pairs</u> of a cable carrying broadband signals.
>
> For multi-binder cables, significant gains are possible when the self-FEXT cancelling system has access to <u>all of the pairs</u> of the binder group(s) in which it is deployed and has the ability to cancel at least the majority of dominant self-FEXT disturbers within the binder.."
>
> [Extracts are from the Scope of ITU-T G.993.5]

Vectoring technology is being integrated by vendors into their platforms. Early systems have been demonstrated by vendors and lab tested by some operators.

Figure 3 below illustrates from a functional point of view a "Vectoring Control Entity" and a "FEXT cancellation Pre-coder" working in tandem on all lines in the vectoring group to cancel the effects of

FEXT. The outputs of each individual line encoder is used to pre-compensate for the FEXT that will be induced on the copper lines. Put simply, an individual line specific anti-phase noise signal, which takes into account the noise from all the working VDSL2 lines is added to each line to cancel out the effects of the noise that will be experienced on the line, so that the received signals at the Customer Premises Equipment ("CPE") are free of crosstalk.

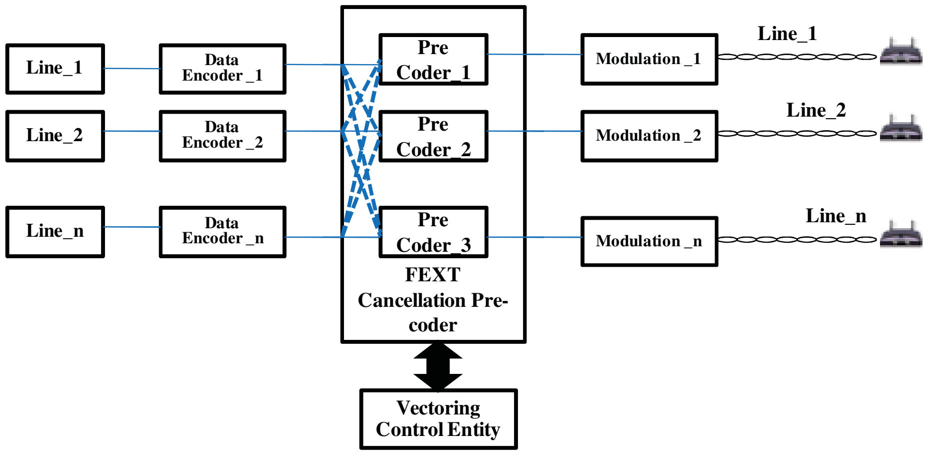

Figure 3 Vectored group – All lines controlled by a single vectoring control entity to cancel Self FEXT

Sub-loop unbundling precludes the use of vectoring and associated speed improvements

As stated above, vectoring has been developed by vendors and lab tested by some operators, and it has been shown to be an effective way to almost eliminate the effects of Self FEXT and to greatly increase VDSL2 bitrates.

eircom has not trialled vectoring technology in the laboratory yet but we have reviewed the research results from chip manufacturer Ikanos, shown below. Results from country to country will differ according to the band plans (8MHz, 12MHz, 17MHz, 30MHz etc.) trialled in the individual country and it can be expected that chip manufacturers will publish results for the most favourable band plan options (30MHz). eircom has explored vectoring with its vendors, including Huawei and Alcatel-Lucent, confirming that the technical incompatibility of VDSL SLU and vectoring solutions is real (see Annexes 1.2 and 1.3).

Ikanos research results

The slide below, taken from an Ikanos presentation, illustrates a doubling of speeds for copper loop lengths of up to 500m with improvements tapering off for longer loop lengths. The base speed of 40Mbps at 500m is consistent with the eircom VDSL2 lab and trial results. A jump to ~100Mbps at 500m with vectoring seems high for an Irish context and more likely than not applies to a 30MHz band plan, however, that said, node scale vectoring would bring substantial speed increases and the Irish band plan may well move to 30MHz over time.

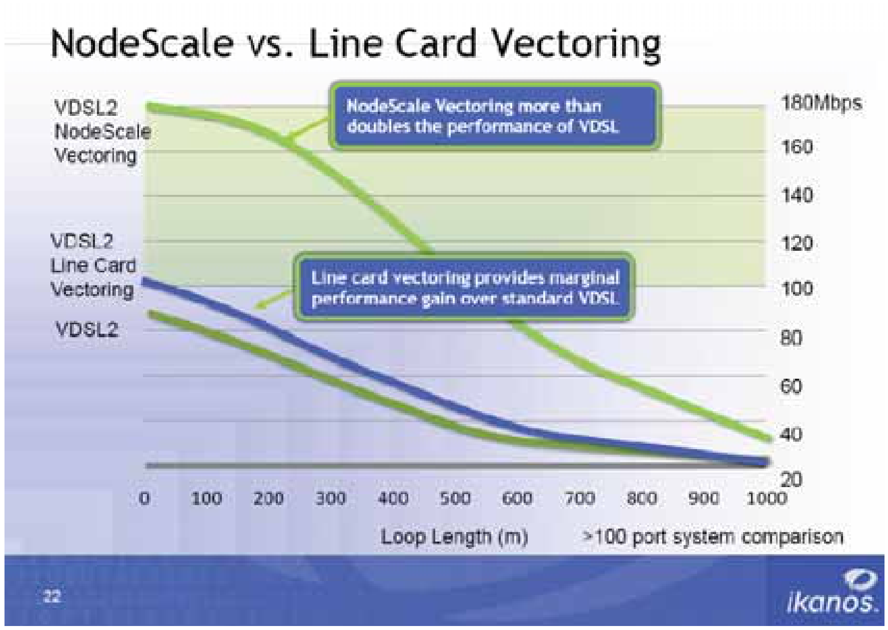

Figure 5 - Chip manufacturer Ikanos claims 100% increase in performance with node scale vectoring

Plan and design of cabinets becomes complicated with sub-loop unbundling

Moving the electronics out of the exchange and into street cabinets decreases the average customer loop lengths, allowing for increased broadband speeds. The new cabinet can be co-located with the copper cross connection point and is designed to house the VDSL2 active equipment along with cross connection blocks, power and cooling equipment.

A requirement to accommodate equipment for multiple operators will have a bearing on the design of the cabinet deployed, leading to bespoke designs that are more expensive than a cabinet designed for a single operator. Our suppliers have not experienced to date a requirement from any operator to design and build a cabinet solution to support multiple operators' equipment. Were eircom required to pre-fund additional space and facilities to provide for the possibility of OAOs seeking SLU, this would place an unreasonable economic and time burden on eircom that would significantly damage the business case

Conclusion

The key to exploiting vectoring is that the vectoring engine has control over all the pairs in the sub loop. If more than one operator is providing service on the same multi-pair cable it will be impossible for either vectoring engine in either DSLAM to pre cancel the effects of crosstalk on the subscriber loops.

There will be significant benefit in deploying vectoring, with increases of up to 100% in downstream broadband speeds being indicated by equipment manufacturers. A single DSLAM should be used in a FTTC deployment to exploit the benefits of vectoring to maximise broadband speeds that can be achieved by all operators using eircom's network.

The speculative provision space and facilities for several operators would also place damage the business case for NGA through unreasonable economic and time burdens.

Virtual Unbundled Access ("**VUA**") is a viable and efficient alternative to sub-loop unbundling. With VUA, all operators will be able to enjoy the benefits of vectoring and all operators will be able to compete with Broadband speeds that are comparable to the speeds cable operators provide.

If OAOs unbundle the subloop, then their own and all customers would be limited to reduced speeds defined by eircom's estimates for VDSL2 performance. The benefits of vectoring would be lost to all customers. Thus, in the case of VDSL2 deployment, SLU would have a negative impact on the whole industry, whether availing of Bitstream or VUA, as well as SLU operators themselves.

ADSL	Asymmetric Digital Subscriber Line
DSLAM	DSL Access Multiplexer
FEXT	Far end crosstalk
MPoP	Metropolitan Point of Presence
OAOs	Other Authorised operators
VDSL2	Very high speed digital subscriber line 2
VLLU	Virtual Leased Line Unbundling

References

ITU-T G.993.5: Self-FEXT cancellation (vectoring) for use with VDSL2 transceivers

2 Next-Gen Networks: Enabling 100 Mbps & Beyond

Kevin Fisher VP, Advanced DSL Technology, Ikanos

http://www.telecoms.com/21618/very-fast-vdsl-vectoring-and-virtual-unbundling-the-next-superfast-broadband-compromise/

eircom Group

Response to ComReg Doc. 11/40

Preliminary Consultation on

Next Generation Access (NGA) Remedies in Wholesale Regulated Markets

Wholesale Physical Network Infrastructure Access (WPNIA) and Wholesale Broadband Access (WBA) Remedies in an NGA Environment

24th August 2011

DOCUMENT CONTROL

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Document Owner	eircom Group
Last updated	24/08/2011
Status	Final

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TABLE OF CONTENTS

1. Introduction

eircom Limited and Meteor Mobile Communications Limited (jointly referred to herein as "eircom") welcome the opportunity to respond to ComReg's Preliminary Consultation Document 11/40 of 26th May 2011, "Next Generation Access (NGA) Remedies in Wholesale Regulated Markets - Wholesale Physical Network Infrastructure Access (WPNIA) and Wholesale Broadband Access (WBA) Remedies in an NGA Environment" ("Consultation Document").

eircom has announced its intention to deploy a Next Generation Access network that will make ultra-fast broadband available to the majority of households and businesses in Ireland.[1] This is a complex undertaking involving a range of interdependent issues relating to network architecture, IT systems and processes as well as commercial, financial, and organisational considerations. The complexities are compounded by the comparatively small size of the Irish marketplace and the country's challenging demographics. Developing a commercially viable plan is all the more difficult given the economic uncertainties facing Ireland, which now must be assessed within the context of the evolving Eurozone crisis.

Due to these complexities, workstreams relating to some aspects of the plan have yet to be finalised even though considerable progress has been made towards completion of a comprehensive NGA plan. Nonetheless, in order to provide a foundation for eircom's responses to the questions posed by the Consultation Document within the timetable established by ComReg,[2] eircom sets out in Sections 2-4 below an overview of the current plan and eircom's basic working assumptions for achieving a viable NGA deployment in those areas where the planned roll-out is commercially feasible. Sections 1-4 of this document are referred to below and in the annexes as eircom's "Preliminary Response." eircom's answers to the specific questions posed by the Consultation Document are set forth in Annex 2.

eircom intends to provide a detailed briefing for Other Authorised Operators ("OAOs") on key aspects of its NGA plan at a meeting that is expected to take place during the week commencing 12th September 2011. Over the past few months, eircom has had interchanges with ComReg about the basic elements of its plan and also has made a concerted effort to obtain the views of OAOs on their anticipated NGA requirements through the Fibre Pilot. This has been accomplished in industry group meetings and one-on-one discussions. The views of the OAOs are important to eircom because OAO take-up of wholesale NGA offerings will be crucial to the long-term success of eircom's NGA investment and the ability of all fixed-network operators to compete on the basis of quality and price against cable broadband and high-speed mobile broadband offerings. eircom expects that the September briefing will be the first of several detailed information exchanges with OAOs leading up to NGA launch.

As soon as possible following the September meeting with OAOs, eircom intends to supplement its preliminary response to the Consultation Document with the expert statement of Dr. Mike Walker of the economics consultancy, Charles River Associates, which will rely on many of the inputs that will be disclosed during the OAO briefing session.

1 eircom Announces Over €100M Investment in Phase 1 of Planned Fibre Rollout, Press Release Thursday 28th July 2011

2 The original deadline for comments, 11 July 2011, was extended by ComReg to 24 August 2011.

We note that some of the specific questions posed by the Consultation Document appear to presuppose an NGA network architecture and product suite that will not be viable in Ireland in the near to medium term, if ever. As acknowledged in the Consultation Document, the prevailing economic conditions create demand uncertainty at every level of the value chain as well as severe financing challenges for all industry players, not least eircom. Our answers to the consultation questions necessarily take these economic realities into account, and our Preliminary Response focuses on eircom's actual plan as currently envisaged, instead of attempting to address hypothetical NGA options that are not realistic or feasible in Ireland today.

In developing its NGA plan, eircom has had to factor in an important constraint: the well established and intensifying competition from high-speed cable broadband that is present in virtually all areas where NGA is expected to be commercially viable. As indicated in Annex 2 (Responses to Questions 1 & 27), ultra-fast broadband services are already being offered successfully by eircom's cable competitor in bundles featuring core pay-television programming and telephony, at the incremental cost of the broadband component. The aggressive retail prices set by UPC for its cable broadband offerings will have a significant "compression" effect on the retail and, consequently, the wholesale pricing of eircom's NGA offerings. These prices will also impact eircom's ability to recover cost-based prices for ultra-fast broadband, including a weighted average cost of capital reflecting eircom's considerable NGA investment risk. The uncertainties created by UPC's evolving cable broadband strategy add to the already substantial risks to eircom of deploying NGA in Ireland.

eircom recognises that ComReg must take utmost consideration of the European Commission's NGA Recommendations ("Recommendations") in deciding on the regulatory measures that should apply to NGA. However, eircom notes that the Recommendations were published in September 2010 following consultations earlier that year, well before the Eurozone crisis could have been foreseen. Moreover, the Recommendations appear to have been developed with a focus on countries that are much larger than Ireland and enjoy far more favourable demographics for the roll-out of NGA.

As ComReg is aware, National Regulatory Authorities ("NRAs") in several other influential EU Member States have found justification to deviate from certain of the Recommendations on the basis that to do otherwise would be neither reasonable nor proportionate in the specific national circumstances, taking account of the state of the technology, the economy and consumer demand.[3] eircom trusts that ComReg will assess eircom's NGA Plan and any applicable remedies with a view to encouraging eircom to invest in NGA while balancing the need for reasonable and proportionate competitive safeguards tailored to the Irish demographic and economic situation and evolving economic conditions in Europe.

2. Overview of eircom's plan for the deployment of Next Generation Access

If Ireland is to come close to meeting the EU's ambitious Digital Agenda targets for ultra-fast broadband, the regulatory scheme selected by ComReg should promote eircom's investment in an NGA plan that is suited to Ireland's circumstances, can generate the best value for money, and allows for the widest possible NGA coverage in Commercially Viable Areas ("CVAs"), as described below. A regulatory framework that accomplishes these objectives will work to the benefit of OAOs as well as eircom, all of which must develop

[3] *See*, for example section 3.2 of the Preliminary Response.

retail offerings that can compete with the prices, features and speeds offered by cable broadband. eircom's NGA plan has been designed to achieve these goals.

2.1 NGA Deployment in Commercially Viable Areas – Network Architecture

In Ireland, Fibre to the Cabinet ("FTTC") – that is, a hybrid fibre-copper solution – will be the optimum means of providing ultra-fast broadband in CVAs. eircom has reached this conclusion after assessing the technical, commercial and financial implications of the proposed NGA roll-out. These considerations include eircom's assessment of the costs of deploying various network architectures and the level of consumer demand for high-speed applications over broadband in the next three to five years. eircom also has taken the following factors into consideration:

(1) technologies are now available (e.g. modification of access network frequency band, vectoring, bonding and phantom technologies) that can deliver speeds of 80 Mbps and 100 Mbps using this hybrid approach that will maximize broadband speeds for all users of eircom's network;

(2) FTTC can be deployed more quickly and efficiently than Fibre to the Home ("FTTH") ; and

(3) deployment of FTTC is significantly less expensive than FTTH and so will enable eircom to cover a greater footprint on a commercially viable basis with the funds available.

eircom expects FTTC to be the primary mechanism for delivering NGA. In only about ten percent of cases is there any reasonable expectation that the deployment of FTTH will be a more cost-effective solution. This will be the case in some areas of very high population density where existing copper pairs are directly connected to the customer's premises rather than through street cabinets. However, there simply is not a viable business case for FTTH in most of the CVAs.

Any deployment of FTTH must be consistent with future deployments. In the Irish context, GPON architecture will offer the most cost- effective solution. In those limited locations where FTTH is feasible, it would be disproportionate to require eircom to install multiple fibres to the building. This would add substantially to the cost of deploying FTTH, with little prospect for eircom to recover the sunk investment. Virtual unbundling can deliver much the same competitive and customer benefits at a substantially lower cost. In any event, the expectation is that there will be limited demand from OAOs for a cost-based multi-fibre solution. Imposing such a remedy would act as a major deterrent to FTTH roll-out. As discussed below, however, eircom would be willing to offer FTTH unbundling if OAOs were to request this option and if the requesting OAO were willing to commit up-front to a reasonable risk-share arrangement.

The FTTC architecture that eircom has decided to deploy in most CVAs is described in greater detail in Section 3 below.

2.2 Commercially Viable and Non-viable Areas

eircom will deploy FTTC, and to a limited extent, GPON FTTH, in CVAs. As a starting point, eircom's criteria for selecting CVAs will be based on an assessment of the competitive and commercial imperatives, expected demand for ultra-fast broadband, and the roll-out costs of making services and applications available at higher speeds, including IPTV. eircom is in the process of developing the proposed list of exchanges that will qualify as CVAs and intends to publish the proposed list in conjunction with the upcoming meeting to brief OAOs on the NGA roll-out plan. However, generally speaking, the CVAs are contiguous with those more densely populated areas in which Local Loop Unbundling ("LLU") and cable broadband are currently available.

Other solutions are being explored for the delivery of ultra-fast broadband in non-CVAs, and eircom expects to play a leading role in developing plans for high-cost areas in cooperation with OAOs, the Government and other stakeholders. It is anticipated that there will effectively be two categories of non-CVAs: one group of areas (generally, smaller towns) that can be served by fixed-line infrastructure, and a second category in very low density areas, outside of towns, that would be served by wireless solutions.

In non-CVAs, some form of government support will be required to enable the roll-out of NGA solutions, as is the case in most other countries, subject to applicable EU State Aid rules. eircom hopes to play a pivotal role in the deployment of NGA solutions in rural areas, together with other interested operators. eircom intends to actively pursue a co-investment model with OAOs, utilising a mix of technologies in non-CVAs.

2.3 Virtually Unbundled Access

eircom plans to provide Virtually Unbundled Access ("VUA") to OAOs over both FTTC and FTTH configurations, similar to the Virtual Unbundled Local Access ("VULA") service offered by BT in the UK. eircom's VUA offerings will enable OAOs to provide differentiated services at the retail level, as if physical unbundling were being provided. In addition, the pricing of the VUA products can be structured to replicate LLU-type economics, with significant up-front investments and lower recurring costs.

The virtual unbundling approach gives OAOs substantial flexibility in utilising their own core network, with eircom maintaining management of the access network and providing wholesale products and services in line with the capability of its NGA platform. This facilitates the optimisation of network assets and investment to achieve higher speeds (*e.g.* by using VDSL2 vectoring) and a better co-ordinated path to upgrades to newer technologies (e.g. GPON to WDM-PON).

OAOs and eircom Retail will be able to avail of future technological upgrades on an equal footing, by contrast with the limitations that are inherent in a "multi-tier" approach, which is neither technically nor economically sustainable in Ireland. The VUA product offered in the NGA pilot implements a virtual unbundling approach - the same approach that BT has decided to follow in the UK, with the support of Ofcom, and the same approach that is increasingly being adopted across the EU, for example in The Netherlands and Belgium.

VUA is optimal in the Irish context for a variety of reasons:

(1) VUA offers the best potential to maximize broadband speeds for all users of eircom's network because it enables deployment of new technologies (e.g. vectoring, , etc.);

(2) VUA is vastly more cost-effective than actual unbundling (as discussed below);

(3) an appropriate VUA pricing structure can pass the benefits of LLU economics on to OAOs; and

(4) as a feature of the VUA offering, eircom will provide Ethernet backhaul services to OAOs.

eircom's proposed VUA offering is described in greater detail in Section 4 below.

2.4 Unbundling and Sub-Loop Unbundling should not be mandated by Regulation

FTTH Unbundling

Physical unbundling of FTTH in the limited CVAs where FTTH is an option is unlikely to be commercially feasible for either eircom or OAOs, primarily because this solution can only be offered cost-effectively in very small pockets or niche areas.

It is very likely that there will be little, if any, demand for FTTH unbundling given the:

- uncertainty around customer take-up rates;
- uncertainty around customers' willingness to pay more for very fast broadband;
- presence of an established strong cable competitor in the very fast broadband space;
- poor economies of scale associated with a small eircom FTTH rollout; and
- availability of a VUA product which will allow effective downstream competition (see further below).

However, should OAOs request FTTH unbundling, eircom will attempt to accommodate their requests, provided they are willing to commit to compensation arrangements that will appropriately limit eircom's risk (including but not limited to up-front payments and/or minimum volume commitments). Any requests for FTTH unbundling in this context are likely to involve location-specific unbundling costs and so should be left to commercial negotiation, with intervention by ComReg only in cases where the parties cannot reach a mutual agreement within a reasonable period of time.

Sub loop Unbundling

Unbundling cannot be offered in a FTTC environment and still allow eircom to deliver broadband speeds that will meet the Digital Agenda targets set by the EU. More specifically, it will not be feasible - technically or commercially - for eircom to provide street-based co-location or Sub-Loop Unbundling ("SLU") in conjunction with FTTC deployments. This is because:

(1) SLU is incompatible with the deployment of new technologies (e.g. vectoringor phantoming) that offer the potential to achieve higher broadband speeds for all users of eircom's network;

(2) SLU would seriously impede eircom's (and, likewise, OAOs') ability to compete effectively with cable broadband because of the speed limitations SLU deployments would impose by effectively precluding VDSL technology improvements that will deliver ultra-fast broadband speeds; and

(3) it would be costly and risky for eircom to build spare capacity in street cabinets to cater for uncertain demand by OAOs, which might at some point in the future seek to co-locate VDSL equipment, and it would substantially increase eircom's investment requirements and business risk. Any increased cost could lead to a reduction in NGA rollout

(4) It would be operationally inefficient. See Section 3 below.

From a technical perspective, the introduction of SLU would impede eircom's ability to provide ultra-fast broadband at the wholesale or retail levels. eircom plans to deliver ultra-fast broadband over FTTC by deploying VDSL solutions, such as vectoring, that will enable copper lines to reach download speeds of up to 100Mbps. The substantial benefits of vectoring are discussed in Section 4.3 below.

It has become clear, however, that in order to implement vectoring, only one operator can operate a VDSL node in a cabinet due to the need to implement node level noise cancellation to achieve the uplift in performance. This cannot be achieved where VDSL equipment operated by multiple operators is present in or adjacent to a cabinet, due to the crosstalk that would occur.

A detailed discussion of the technical problems related to SLU is set forth in Annex 1, including an overview of the problems prepared internally by eircom (Annex 1.1) and documentation provided by two potential vendors - Alcatel-Lucent (Annex 1.2) and Huawei (Annex 1.3).Apart from the technological impediments, the economics of SLU are unsustainable in the Irish context. This is due in part to the lack of sufficient population density in most CVAs but also to the fact that the competing cable broadband platform is already serving a substantial portion of the addressable market.

To utilise SLU in a FTTC deployment, an OAO's commercial assessment (like eircom's) would have to take into account a number of costs that would be covered by a relatively small number of customers, including:

- cost of rental of space within the street cabinet; or cost to deploy an active cabinet;
- investment in VDSL equipment to be installed in the cabinet;
- cost to backhaul traffic from multiple cabinets;
- operating costs for repair and maintenance of their equipment in the cabinet and back-haul; and
- capex and opex costs for each cabinet.

Given the fact that UPC has secured a substantial share of the market, it will be challenging even for eircom to cover the costs of installing VDSL equipment in CVAs. In a multi-operator environment, the economics would become unsustainable for eircom and OAOs alike under these circumstances.

eircom recognises that under the WPNIA regulations applicable to current generation access, it has an obligation to make SLU available to OAOs upon request. However, to date, no OAO has seriously pursued SLU in Ireland. The viability of SLU as an option for current generation services has become more complex in light of NGA developments. The current SLU obligation will therefore need to be re-examined in light of its potential impact on eircom's ability to deliver ultra-fast broadband over FTTC.

For example, eircom is currently considering a preliminary inquiry from one OAO concerning the development of processes for the provision and repair of SLU in relation to current generation services. This may ultimately lead to a request for the provision of SLU. eircom's understanding is that the OAOs' intention would be to use SLU as an infill to serve customers with VDSL services where eircom may elect not to roll out FTTC in the medium to long term.

If an OAO were to install VDSL equipment in or adjacent to a street cabinet and deploy vectoring, it would then effectively preclude eircom from providing VUA to other OAOs. Since the OAO would presumably not be subject to a finding of SMP, this would mean that it would not have an obligation to provide wholesale access to eircom Retail or to other operators. This could permanently prevent eircom's retail customers and customers of other network operators from being able to avail of NGA services from such cabinets in the future. Such an outcome would not be good for consumers and would be incompatible with the EU Digital Agenda.

To accommodate the legitimate interests of OAOs in serving customers outside the immediately planned CVAs, eircom recognises that it will need to give OAOs a strong assurance that the NGA network will be extended to individual cabinets identified by them as being required to meet their customers' needs. This could potentially be accomplished by agreeing a set of commercial criteria that would apply when determining which cabinets to include in the NGA roll-out. eircom is committed to work with ComReg and OAOs to find a reasonable solution to these peripheral issues. In the meantime, however, it is imperative for ComReg to consider the technical, economic and competitive issues surrounding any implementation of SLU with current generation access, in light of the major technical and economic impediments it would create for eircom's ability to deliver ultra-fast broadband in Ireland.

In summary, if SLU were to be required by regulation for Next Generation Access , the business case for FTTC would become fraught with risk and ultra-fast broadband would become technically unfeasible in Ireland (and we note that similar issues for the deployment of NGA would arise if eircom were required under existing rules to act on any new requests for sub-loop unbundling of current generation access). For these reasons, it would be disproportionate and counterproductive for ComReg to mandate SLU in connection with FTTC or to continue to mandate SLU for current generation services going forward.

2.5 Passive Infrastructure Access, including Duct Access

eircom will provide access to passive duct infrastructure on a first-come, first-served basis where there is space available. The terms and conditions, including the pricing, will necessarily be situation-specific depending on the particular circumstances. The terms and conditions should be left to commercial negotiation between the parties, subject to intervention by ComReg if the parties cannot reach a mutual agreement within a reasonable period of time. This is discussed further in Annex 2 (responses to Questions 4-8).

2.6 Pricing of NGA Products

The regulatory paradigm for the pricing of wholesale services should be applied to NGA in a way that reflects the reality of cable competition and self-provision in Ireland's more densely populated areas, either through a redefinition of the relevant geographic markets to cover CVA and non-CVAs, or through the application of geographically differentiated remedies. This is discussed in greater detail in Annex 2 (Response to Question 27) and will also be considered in greater detail by Dr. Mike Walker in his forthcoming expert statement.

In summary, within CVAs:

(1) ComReg should acknowledge that a de facto ceiling on retail prices will effectively be set by UPC, which prices its retail broadband offerings as part of a larger bundle including its core pay TV services;

(2) The maximum wholesale charge for eircom's VUA product should therefore be set using a retail-minus approach; however, in setting the retail "delta," ComReg should give greater weight than does the Consultation Document to the comparatively greater efficiencies from which eircom's well-established multinational competitors in Ireland benefit, as illustrated by Vodafone's recent announcements that it plans to: (1) relocate its marketing and sponsorship teams to the UK as part of a move to consolidate its group commercial function, and (2) outsource its Irish call centres to Egypt and India;[4]

(3) NGA wholesale prices should be set by reference to eircom's legacy wholesale prices for LLU, which should remain at their current level.[5] The relative prices between LLU and NGA are as important as the absolute prices for eircoms's NGA offerings, since OAOs must be given reasonable incentives to opt for or migrate to NGA in order to obtain improved service quality, features and functionality. This is important in order for eircom to achieve sufficiently high levels of utilisation of access lines and associated volumes of traffic over its NGA network to justify the NGA investment; and

(4) The structure of VUA prices should be similar to that for LLU so that OAOs can take advantage of LLU-type economics.

Price Controls for NGA

We note that ComReg has posed a number of questions concerning NGA price controls in several discrete sections of the Consultation Document. For the sake of convenience and clarity, we provide in this section, an integrated response to these pricing questions, which include the following:

1. Question 9, which asks about the form of a price control for civil engineering infrastructure.
2. Question 15, which asks about the form of a price control for terminating segments.
3. Question 24, which asks about the form of a price control for unbundled access to the fibre loop.
4. Question 34, which asks about the form of a price control for copper sub-loop.
5. Question 46, which asks about the form of a price control for WBA access.

In each case, the same list of four options is presented:

a) Cost model: cost plus.
b) Cost model: retail minus.
c) Cost-oriented benchmark.
d) Allow for commercial negotiation.

Little consideration appears to have been given to the need for internal consistency in choosing approaches for the various wholesale levels that are the focus of the pricing questions. However, Section 5.44 of the

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4 *See*, The Irish Times - Vodafone to relocate marketing to London [Tuesday, August 16, 2011] noting "the recent creation of the "group commercial function".

5 For similar reasons, there should be no mandated reductions in the price of Line Retail for PSTN voice services over the next several years. UPC and OAOs can and do offer Voice Over Broadband services on an incremental cost basis, which will place substantial price pressure on traditional telephony products.

Consultation Document outlines five potential approaches for determining costs for purposes of setting cost-oriented prices for NGA. These are as follows:

i. The combination of historic costs, TD and FDC methodologies commonly called Historic Cost Accounting ("HCA").
ii. The combination of current costs, TD and FDC methodologies commonly called Current Cost Accounting ("CCA").
iii. The combination of current costs, TD and FL-LRAIC methodologies commonly called TD LRAIC ("TD LRAIC").
iv. The combination of current costs, BU and FL-LRAIC methodologies commonly called Bottom-Up LRAIC ("BU LRAIC").
v. A combination of the current BU-LRAIC modelling approach used to determine the cost of the copper local loop while using a DCF modelling approach to determine the cost of fibre.

It is not clear why ComReg considers that the approach (essentially "BU-LRIC"), which was used in Decision D1/10 to set the prices of unbundled local loops ("ULMP") and sub-loops, needs to be substantially changed. There may well need to be a substantial update to the parameters of that model (e.g. for volume forecasts, cost levels, tilts etc.). However, the basic approach was adopted only 18 months ago and fully anticipated the use of sub-loops for VDSL/FTTC when considering sub-loop costing and pricing (assuming that the provision of SLU would be technically and commercially viable).

We are aware of various proposals[6] that seek to apply a different costing approach to each of duct, copper, fibre and active equipment, where the only logic seems to be to assign the lowest cost for each passive element, and the highest possible cost for the active elements. A major concern raised by these approaches is that they are frozen in time, and make very broad assumptions: e.g. that duct will be maintained, but not extended; that copper will be rapidly replaced[7], that fibre will be a regulated asset forever, because there is no alternative[8], and that active product demand is predictable[9]. This approach is inherently flawed and is incompatible with the principles of regulatory certainty and predictability, proportionality and reasonableness. ComReg should instead adopt an approach that leads to longer term predictability and consistency while allowing flexibility in responding to market developments.

ComReg should take an end-to-end view of the need for price controls, and should consider the dynamics (as suggested in Question 50) not only of eircom's migration of wholesale products from legacy to NGA, but of access seekers' migration options as well. ComReg should carefully consider margin squeeze issues (Questions 56-58), but should resist the temptation to impose excessive "economic space" at multiple

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6 E.g. Frontier Economics: Access Network costing: A report prepared for Vodafone.

7 With DSM-3, copper lifetime may be substantially extended.

8 The existence of wireless and cable alternatives in the very areas where fibre might exist, may provide sufficient competition in the future: so price regulation that denies the ability to recover costs until that future period will ultimately deter investment.

9 Free options for migration can require incumbents to build excess active capacity, priced as if it will last for a 5 year life, to serve access seekers who plan to migrate to passive products as soon as possible.

points in the value chain, which will effectively impose a "regulatory price squeeze" on eircom that will make NGA non-viable.

As already observed, ComReg should recognise that price structure can be as important as price level, and that both need careful consideration at each layer. At present, price structures for true unbundling are complex[10], whereas price structures at the retail level are relatively simple[11]. If we consider a value chain ranging from infrastructure access to retail, it might include several levels not explicitly considered in the Consultation Document:

a. Infrastructure access (e.g. duct).
b. Unbundled sub-loops (copper or fibre).
c. Virtual unbundling (near-passive products).
d. Active bitstream –with handover at cabinet, MDF, regional or national.
e. "white label" wholesale broadband services.
f. Retail service.

The relative price levels for these various layers are important, but the price structure must also vary as an access seeker moves up the "ladder of investment" from layer e to layer a. Complex structures with many elements, and a large fixed, upfront component are appropriate at Layer a or b; however, a simple per-customer, per-month charge is appropriate at Layer f. Complexity, and the proportion of costs that are sunk, might reduce gradually when moving from the lowest layers to the retail level.

Thus, white label charges may be almost "retail-like", while bitstream would be multi-part (port, backhaul and perhaps site elements). Virtual unbundling could have more upfront fixed costs, and would involve greater complexity.

The Need for Flexibility

The demand for NGA products is uncertain, and there will be a period in which retail and wholesale prices need to be tested so that all operators – eircom Retail, new access seekers and incumbent NGA providers such as UPC – can identify which price levers and price levels are likely to support a sustainable business.

During this period, eircom will need to be able to adjust its retail and wholesale prices rapidly. A form of price control at any layer that is too rigid will reduce flexibility and damage competition to the detriment of consumers.

Therefore, a rigid price control involving a single directed price for an extended time period (such as the existing control for current generation sub-loop prices[12] set by Decision D1/10, which applies until

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10 LLU prices and costs to access seekers have elements such as surveys, collocation, backhaul, jumpering, DSLAM purchase and installation, such that costs vary with the network, the number of sites unbundled, the location of sites, number of customers, churn etc..

11 Retail users typically get free connection and equipment, and pay a single fixed rental price unless some generous usage limits are exceeded.

12 While the sub-loop rental price is in theory a maximum price, it cannot be easily changed without prior ComReg approval, and only in response to revisions to the cost model: so in effect it is a ratchet.

November 2012) should only apply - if at all - at the lowest infrastructure layers. Greater flexibility is required to allow retail and the intermediate wholesale prices to be adjusted as market conditions change. A form of retail minus pricing, or cost floors and ceilings, which allow considerable leeway, should be used. Provision should be made for promotions and rebates at the wholesale layers as required, while ensuring that true economic margin squeeze is avoided. This form of price flexibility was very useful in the early days of broadband adoption, and NGA migration will be severely impeded if it is not available over the next few years.

Cost allocations are not prices

One fundamental issue that arises in the context of NGA is that a cost model cannot, and should not, be used directly as a pricing model. That approach leads to a series of difficulties, distortions and inefficiencies. In order for the cost model to produce economically justified prices, a number of additional steps must be taken, so as to ensure that the price, while reflective of costs, also gives appropriate signals in terms of efficient investment (supply) and use of the network (demand). As explained in eircom's submission to ComReg Doc. 10/56, pricing at the average cost does not necessarily achieve the most efficient outcome. Pricing might require an understanding of cost, but it also requires an understanding of demand, whose variations may well be independent of underlying network costs. As explained in previous submissions, average total cost is not the appropriate cost standard for setting a price floor, which should be based on the incremental cost.

In particular, before arriving at prices on the basis of costs, due consideration must be given to the structure of the costs (and not only the levels) and, in particular, to the use of gradients. Gradients arise where the cost is averaged over elements that are allowed or required to have different prices. This is relevant to the treatment of both backhaul costs and per-port costs, for example. The implications of these issues will be considered further in the expert statement that is being prepared by Dr. Walker and will be submitted as a supplement to eircom's response.

2.7 Wholesale NGA Services to be Provided on an Equivalency of Inputs Basis

eircom will deliver its wholesale NGA products to OAOs on an Equivalency of Inputs ("EOI") basis. eircom will implement a single interface and the same processes for OAOs and eircom Retail for accessing NGA-related Operational Support Systems ("OSS") to carry out order entry, provisioning, repair, and similar functions. eircom is also in the process of enhancing Key Performance Indicators ("KPIs") and Service Level Agreements ("SLAs") in relation to its wholesale offerings, and these improvements will be built into the NGA product implementation process. eircom is also implementing enhanced internal safeguards to reinforce the delivery of information symmetry as between eircom Retail and OAOs.

eircom expects to be able to provide a significant briefing to OAOs at the early stage of NGA roll-out as part of the Fibre Pilot that is already underway, as well as in specific NGA briefings for OAOs, including the one planned for the week of 12th September. Consequently, we believe that OAOs will gain information in parallel with eircom's own learnings. In this context, and in regard to the lead time between eircom's provision of detailed product and pricing information and the roll-out of eircom's retail NGA-based products that will be necessary to ensure that OAOs are not disadvantaged, eircom submits that three to four months should be sufficient in the case of NGA products. In fact, it is important to keep in mind that as part of the Wholesale Reform initiative, eircom's retail operations will also need time to adapt to the use of a single interface along with new systems and processes.

In order to ensure that there is as little delay as possible in delivering ultra-fast broadband to Irish consumers, ComReg should carefully consider the minimum lead time, necessary to ensure a reasonable amount of preparation time for efficient OAOs and eircom Retail between delivery of the basic preparatory inputs by eircom Wholesale (e.g) the date on which eircom delivers the final detailed product and pricing information to OAOs, and the date of eircom's launch of wholesale NGA services) and the earliest permitted retail launch date for eircom Retail.

Wholesale Reform is discussed in greater detail in Annex 2 (response to Questions 4-7).

2.8 Provisioning of Legacy Access

eircom intends to leave the legacy exchange-based copper network in place for the foreseeable future, alongside the NGA network. eircom recognises that it will be necessary to make best endeavours to secure agreement from OAOs to any proposals that may be developed to decommission exchange-based copper installations, and accepts that such proposals will ultimately be subject to securing agreement with ComReg. If the incentives are right, however, then it should not take five years for OAOs in Ireland that already have LLU in place to migrate to NGA. Moreover, the commercial, competitive and economic imperatives for OAOs will be to move as quickly as possible from traditional wholesale services or from LLU to NGA services to compete against high-speed cable broadband offers.

2.9 Rules for the Pricing of Retail Bundles

The regulatory paradigm in Ireland must be recalibrated to reflect the reality of cable competition and LLU-based competition in more densely populated areas that are commercially viable - either through a redefinition of the relevant geographic markets to include CVA and non-CVAs, or the application of geographically differentiated remedies recognising the very different market dynamics in these areas.

In CVAs, the pricing of retail bundles based on NGA should not be subject to ex ante tariff review. In light of competition from UPC bundles and OAO abilities to replicate eircom's fixed-line offerings using LLU today or eircom's virtually unbundled product in the future, the application of competition law principles ex post is sufficient.

If, however, ComReg concludes that an ex ante test is necessary and proportionate, the following principles should apply to eircom's NGA products:

(1) the ability to price mixed regulated/unregulated bundles at the retail level based on a margin test that relies on pricing of the unregulated elements on an incremental avoidable cost basis;

(2) margin tests to look at the overall bundled service or bundle portfolios, rather than each individual bundle;

(3) margin tests to be based on an "Equivalently Efficient Operator" test;

(4) margin tests for NGA and copper-based products in CVAs to be assessed against LLU or NGA wholesale products (i.e., based on LLU or NGA products being reasonably available in such areas, not on LLU take-up);

(5) margin tests to be based on eircom's forward-looking retail costs, rather than its historic retail costs;

(6) margin tests to look at eircom's avoidable cost, rather than total cost; and

(7) if eircom offers bundles using VoB instead of PSTN voice, and/or if eircom's wholesale services are priced on the basis of costs rather than retail-minus, ex ante regulation of eircom's retail bundles should be withdrawn.

In eircom's view, there should be no triggers relating to LLU take-up but, rather, availability of LLU or NGA products based on replicability and improved KPIs to be provided by eircom through the Wholesale Reform process.

3. eircom's Proposed Fibre Deployment

eircom's initial NGA deployment will include a mix of urban exchange areas and a selection of provincial cities and towns over the first 12 months of the programme. The goal is to cover over 100,000 lines and premises in the initial phase. The second phase will provide further coverage in urban areas and extend to medium sized suburban and provincial towns. In total, the programme is expected to take four years and when complete it will cover over one million premises around Ireland. The exchanges targeted will be characterised by high DSL based broadband penetration and more dense population areas.

The deployment will primarily use FTTC technology, with fibre to a node co-located within a current cabinet and distribution to each premise over current eircom copper network. Over the course of the programme, eircom plans to deploy improved VDSL technologies, such as vectoring, to deliver up to 100 Mbps to a significant number of customers served from the FTTC infrastructure. Vectoring will be commercially available from eircom's preferred suppliers in 2012 and is dependent on certain technical conditions that require planning and agreement now. The exchanges targeted typically have average number of lines of 180 per cabinet with an average D-side loop length of 550 metres and 75% of D-side loops less than 750 metres.

In the overall targeted deployment area, a proportion of lines will be direct fed, i.e. they do not have a copper cross connect cabinet (the proportion of premises which are direct fed is smaller as many direct fed buildings house multi-line business customers). In some cases, these lines will not be suitable for engineering or economic reasons to connect via a cabinet. It is anticipated that premises currently served from direct MDF-fed copper in some of the targeted exchanges, which cannot be served using an FTTC solution, will be connected to NGA services using FTTH GPON architecture. It is expected that the FTTH solution will be deployed to a small percentage of lines in a subset of the targeted exchanges, with a number of direct-fed copper lines within a short distance from the exchange. The FTTH architecture will deploy optical splitters between the MDF (exchange) and the building receiving Fibre NGA service. The location of these will be determined in detailed design for each location.

3.1 Efficient Investment

eircom does not intend to invest in 'in-cabinet co-location' facilities for access seekers in NGA fibre cabinets. Evidence from other much larger markets strongly indicates that SLU is uneconomic. There is no evidence of demand or commitment to this requirement to justify the significant investment required. As discussed above, it is questionable whether SLU can ever be economically viable in the Irish context of low population density with very few dense MDU dwellings. eircom's proposed investment in NGA to cover approximately one million premises relies upon the assumption that the network deployment will be achieved in an efficient and expeditious roll-out. This can only be achieved through the application of a so-called ‘off the shelf’ solution that enables the repetitive deployment of cost-effective active VDSL cabinets, avoiding speculative investment in network capacity or special solutions for cabinet and facilities design.

BT also defined this efficiency requirement as central to its proposed NGA investment as evidenced in its recent (April 2011) Openreach SLU Internal Reference Offer available at:

http://www.openreach.co.uk/orpg/home/products/llu/subloopunbundling/subloopunbundling/downloads/slu_iro_v1b.pdf

In BT’s words:

> *“Openreach have . . . been consistently clear in public and with stakeholders that its investment in NGA is contingent on an integrated and efficient operational model and that there is no commercial or operational scope to build inefficient internal hand-offs into the production process. Ofcom have previously consulted on this matter and recognised the importance of operational efficiency in both FTTC and FTTP Undertakings variations granted in 2009 and 2010.”*

Ofcom statements acknowledging these issues are referenced at:

http://stakeholders.ofcom.org.uk/consultations/fttc/statement/

http://stakeholders.ofcom.org.uk/binaries/telecoms/policy/bt/fttp.pdf

3.2 Technology Considerations

Also of significant importance is the fact that SLU limits the capability of the copper D-side asset and precludes its potential to compete effectively with cable. Working with its suppliers, eircom has determined that VDSL technological advances, such as vectoring (see Section 4.3 below), can enable copper lines to reach download speeds of up to 100Mbps. These developments are expected to be available commercially within the next 12 months with additional advancements, such as phantom lines, planned in the coming years to further increase speeds. As discussed in detail in Annex 1, to implement vectoring, only one operator can operate a VDSL node in a cabinet or location, as control of the D-side pairs via a single VDSL node is required to implement the required noise cancellation to achieve the uplift in performance.

A 2008 study commissioned by ComReg from Analysys Mason illustrated how challenging the business case for access seekers unbundling eircom sub-loops actually is. The “optimistic scenario” required to show positive returns in that study was based on a number of unrealistic projections – principally around ARPU uplifts, broadband penetration, and cabinet sizes. A survey of cabinet sizes and potential VDSL penetration in the presence of competing DOCSIS offerings shows that the “optimistic scenario” has a limited basis in reality for most of the eircom access network where VDSL will be deployed.

Several NRAs have decided against mandating SLU or cabinet co-location in connection with the deployment of FTTC in their countries, in order to avoid compromising the incumbent’s ability to utilise vectoring technologies to deliver ultra-fast broadband speeds over hybrid fibre-copper NGA. For example, the Dutch regulator, OPTA, has recently issued a draft direction removing an obligation to provide SLU and replacing it with a virtual unbundling obligation.[13] Similar approaches have been taken in Belgium[14], Austria[15], and Switzerland.

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[13] Marktanalyse Ontbundelde toegang - Ontwerpbesluit – (23 June 2011) OPTA/AM/2011/201353.

The European Commission has also recognized the technical and economic issues surrounding SLU in the context of FTTC. It recently issued comments concurring with the decision of the Belgian regulator to withdraw the SLU obligation imposed on Belgacom insofar as it has "been upgrading its VDSL technology and achieving higher speeds through vectoring, a technology which is rendered ineffective by SLU". The EU Commission commented that "there appears to be sufficient evidence to sustain that it is neither justified nor proportional to impose such remedy, since there is currently a lack of demand for SLU products and the imposition of such remedy could hamper the NGA investment strategy of Belgacom and thus run counter to the need to promote and ensure sustainable investment in the development of high-speed networks."[16] There is thus a growing consensus among NRAs that SLU is neither commercially nor technically feasible, particularly in smaller countries.

Ensuring that a glidepath for achieving ever higher speeds over FTTC in the future is paramount to eircom's investment decision and is a precondition for ensuring that competitive ultra-fast broadband services can be deployed in CVAs across Ireland in the medium to long-term. This approach is Ireland's best and perhaps only option for developing an NGA network that can offer products that are truly competitive with cable with open access to all operators via appropriate VUA and bitstream products.

Another set of technical issues surrounding withdrawal of the legacy exchange-based copper network will also need to be dealt with. In the initial phase of NGA roll-out, eircom will provide voice services via the current PSTN platform using the current E-side copper to combine voice at the cabinet with the VDSL service. This is a technology and platform limitation that eircom intends to transition away from as soon as possible. It is eircom's intention to migrate to a VoIP solution for NGA-served customers, which will require neither E-side copper nor a PSTN exchange port. eircom recognises that, as proposals are developed in the future for the withdrawal of exchange-based copper infrastructure, these proposals will need to be discussed with OAOs and with ComReg, and would be subject to current obligations pending any variations approved by ComReg.

4. Features and Advantages of Virtual Unbundled Access

4.1 Introduction

The fibre unbundled access (FUA) product proposed by eircom for the forthcoming Industry Fibre Pilot[17] involves virtual unbundling, much like BT's VULA product offering in the UK. eircom's VUA product is designed to give operators maximum flexibility in the design and development of their own Next Generation products and services, with minimal investment required by them to install their own access network components and solutions. It makes the full capability of the access network medium, either FTTC or FTTH, available to the operator to utilise in whatever fashion they wish. The product delivers a Layer 2

14 Case BE/2011/1227.

15 Case AT/2010/1084.

16 Case BE/2011/1227 at page 11.

17 The Pilot is planned to commence on 26th September 2011 in Wexford and areas of South Dublin.

connection between the customer location and handover to the operator at maximum bandwidth possible and allows the operator to implement whatever protocols it wishes over that connection.

The key benefits of eircom's proposed VUA offering are:

- It provides the full capability of the access network to the operator without the requirement for the operator to make significant investment in its own infrastructure.
- It enables a single cost efficient access network to be constructed without the requirement for excess capacity being built to support SLU.
- It enables capacity enhancing technologies, such as vectoring, to be deployed in this network to maximize the potential bandwidths available to customers.
- It enables operators to utilise their own core networks and existing co-location facilities. Thus they can minimize their dependence on regulated inputs to the enduring bottleneck of the access infrastructure.
- It eliminates the requirement for intervention in the access network in order to migrate end customers between operators. This produces the twin benefit of reducing migration lead times and costs. Migration between VUA operators can be fully automated with extremely low migration charges.

As already noted, the VUA product is similar to BT's GEA product (Generic Ethernet Access product) provided in the UK. In fact, the product was requested by BT Ireland and copied to and discussed at the Fibre Industry Leadership Group, which is the industry forum established to oversee the development and operation of the commercial pilot. There was a consensus that VUA is the preferred approach as SLU is not economic in the Irish market.

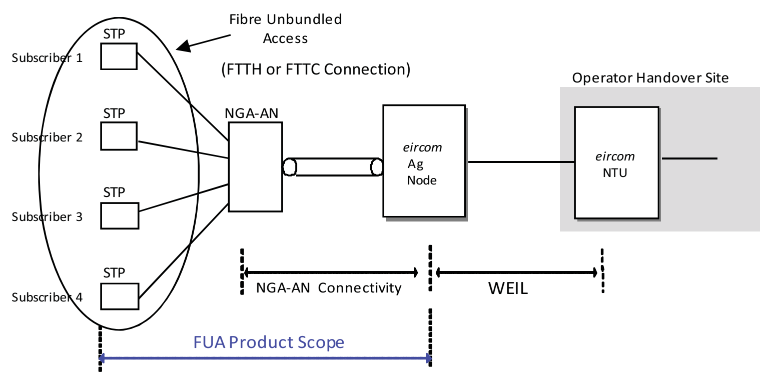
VUA allows operators to provide ultra-fast broadband connections to their customers using eircom's access network. OAOs can use eircom's NGA platform on an "open access" basis to connect to an end customer, and that customer's traffic is handed over to the operator at the local exchange, without being transported through eircom's core network. This allows operators to maximise the potential of their own network infrastructure assets.

VUA is a pragmatic product that facilitates the accelerated roll-out of high-speed broadband in Ireland, while at the same time giving OAOs the same degree of flexibility to differentiate their services as they would obtain from a physical unbundling solution. Operators will have full control over authentication and management of Class of Service ("COS"). They will also be able to use their own multicast solutions. This gives flexibility and control to operators to develop their own next generation multi-play products and services, without the need for a major investment in access network platform solutions. Operators will also have the flexibility to migrate easily between active and VUA solutions, and switching between operators will be simplified, without the need for physical jumpering in cabinets.

4.2 Product Description

VUA provides an enhanced broadband access service, between the Service Termination Point ("STP") at an end-user premises and a Wholesale Ethernet Interconnect Link ("WEIL") at an operator's nominated Point of Handover ("POH"), within the local exchange area. There are various options for the WEIL including In-Building Handover, in Span handover ("ISH") and Customer Sited Handover.

It is intended to support a mix of time sensitive and high volume applications including voice, general entertainment (including Broadcast TV), and high speed internet. The product is designed to use both copper and fibre as the physical access methodology. The product supports traffic-based COS. The product will also support the operator's multicast capability.



VUA terminates on a STP on the end-customer's premises. This STP will vary, depending on the access mechanism used. Where Services are delivered over fibre (using FTTH technology) the STP will be an interface on an Optical Network Terminal ("ONT"). Where Services are delivered over copper, the STP will be a Copper Network Terminating Unit (using FTTC Technology with a copper connection to a cabinet DSLAM). The STP connects to a Next Generation Access, Access Node ("NGA-AN"), at the local exchange. The WEIL is connected directly to the controlling NGN Aggregation Node.

4.3 Technological Benefits

VDSL2 Vectoring is Possible

Vectoring is a modern approach to minimize noise interference on VDSL2 connections.

For FTTC, VDSL2 vectoring works across multiple pairs and is based on the concept of "noise cancellation". VDSL2 vectoring calculates the interference between all pairs in a cable binder (set of pairs), based on the actual signals, and will use this information to generate a noise cancellation signal on each pair, effectively removing all crosstalk. The net gain can be up to 100%.

Vectoring is very suitable to an FTTC platform solution using VDSL2. The key requirement is that all lines are under full control of a single operator, meaning that there can be no sub-local loop unbundling. If the lines belong to multiple operators and are terminated on different equipment, then there is no way to collect all the signal and crosstalk data.

Technology Upgrade Benefits

Because FTTH and FTTC connections are provided by a single provider all operators and their end customers can benefit from platform enhancements and upgrades, e.g. vectoring and phantoming . Additionally, their products, services and customers are not left behind as others upgrade.

ANNEX 1.1

eircom - Vectoring Technology

See attached file “eircom Group response to preliminary consult on NGA Remedies Annex 1.1.pdf”

ANNEX 1.2

ALU – Advice regarding SLU in context of VDSL2 Vectoring

See attached file “eircom Group response to preliminary consult on NGA Remedies Annex 1.2.pdf”

ANNEX 1.3

Huawei Vectoring Solution - Fibre Speeds from Copper

See attached file "eircom Group response to preliminary consult on NGA Remedies Annex 1.3.pdf"

ANNEX 2

Response to ComReg Consultation Questions (1-65)

See attached file “eircom Group response to preliminary consult on NGA Remedies Annex 2.pdf”

COMMENTS ON COMREG'S "PRELIMINARY CONSULTATION ON NEXT GENERATION ACCESS (NGA) REMEDIES IN WHOLESALE REGULATED MARKETS"

Dr. Mike Walker

19th October 2011

Prepared for	Prepared by
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1. Introduction

1. I have been asked by eircom to provide an expert statement on three issues that arise out of ComReg's consultation on Next Generation Access ("NGA").[1] These issues are:

    - the extent to which there are varying degrees of competition in different geographic areas in Ireland and implications for the application of geographically differentiated remedies to eircom's wholesale NGA offerings;
    - the correct approach to applying various aspects of margin squeeze analysis in the circumstances that I understand exist in Ireland (including the choice of an EEO or REO/SEO standard; the correct definition of cost; the approach to aggregation; the sufficiency of retail-minus regulation; and application at different levels of the value chain); and
    - the appropriate relationship between the pricing of exchange-based copper LLU and NGA services in the relevant circumstances.

2. I am a Vice President at CRA, an economic consultancy established in Boston, USA, in 1965. I started CRA's European Competition Policy team in 2000. We now have European offices in London, Brussels, Barcelona and Paris with about 40 economists working across Europe on issues related to the economics of regulation and competition policy. I have been working on economic issues related to regulation and competition policy since 1991. I have a D.Phil. in Economics from Oxford University. I am the co-author of The Economics of EC Competition Law (3rd ed.) and a number of published articles. I am the Visiting Professor of Competition Economics at Loughborough University in the UK, a Visiting Fellow at King's College, London, and the Course Director of the Diploma/Masters in Economics for Competition Law at King's College, London. It is reasonable to consider me an expert on the economics of competition law and regulatory policy.

3. In addition, I have considerable experience of economic issues related to telecommunications. I have represented telecommunications firms before the European Commission, the UK Competition Commission, Ofcom, the English High Court and the Irish High Court. In addition I have provided regulatory and competition policy support to telecommunications firms in South Africa, Germany, Austria and the Czech Republic.

4. I confirm that I have made clear which facts referred to in this report are from within my own knowledge and which are not. I confirm that I believe that those within my own

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[1] "Preliminary Consultation of Next Generation Access (NGA) Remedies in Wholesale Regulated Markets" (26 May 2011).

knowledge are true. The opinions which I express represent my true professional opinions on the matters to which they refer.

5. Before moving on, I should make one definitional point clear. When I refer to "LLU" in this statement, I mean entirely copper-based LLU. When I refer to fibre or NGA, I mean fibre roll-out of the kind in which eircom is engaged, which involves primarily fibre to the cabinet ("FTTC") and a copper segment from the cabinet to the customer premises.

2. Are geographically distinct remedies required?

6. In assessing the need for, and the type of, regulatory remedies to apply to the wholesale NGA services that I understand eircom is planning to roll out, ComReg should carefully consider the full conditions of competition in which eircom's NGA wholesale services and associated retail products will operate. I consider this issue below. I first present my understanding of the relevant facts and the implications of these facts for competition. I then discuss whether this means that geographically distinct remedies are required.

7. As a general principle, any regulatory assessment should take into account geographic differences in competitive conditions. This has been recognised by the European Commission in its NGA Recommendation, which states:

> *"NRAs should examine differences in conditions of competition in different geographical areas in order to determine whether the definition of sub-national geographic markets or the imposition of differentiated remedies are warranted. Where divergences in the conditions of competition are stable and substantial, NRAs should define sub-national geographic markets in accordance with Recommendation 2007/879/EC. In other cases, NRAs should monitor whether the deployment of NGA networks and the subsequent evolution of competitive conditions within a geographically defined market warrant the imposition of differentiated remedies."*[2]

8. ComReg has previously found that the WPNIA and WBA markets are national in scope.[3] However, I understand that eircom's NGA roll-out will be limited to those areas where it is potentially commercially viable. This raises the question of whether there will be distinct geographic areas in which the conditions of competition vary and, if so, whether this means that access remedies also need to vary geographically. Whatever market definition is adopted by ComReg in respect of eircom's NGA offerings, its regulatory

2 "Recommendation on regulated access to Next Generation Access Networks (NGA)", European Commission, 20th September 2010, paragraph 9.

3 See for example the ComReg Market Reviews of the WPNIA and WBA markets (document 10/39, paragraphs 1.18-1.20 and document 11/49, paragraph 1.29).

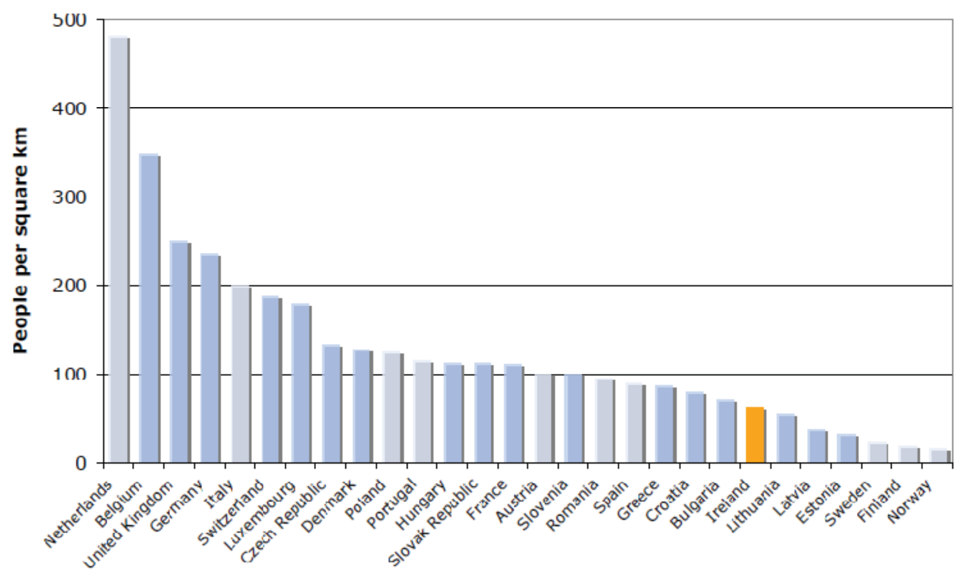
approach should take account of differences between geographic areas when assessing market power and the conditions of competition in different areas. Any significant differences may affect the degree and type of regulation that is appropriate under the circumstances (for exchange-based copper access as well as for NGA).

2.1. The circumstances of competition in Ireland

9. Ireland's population is more dispersed than that of most other European countries. According to the 2009 "Next Generation Broadband" report prepared by the Irish Department of Communications, Energy and Natural Resources (DCENR), less than 10% of people live in apartments and around 40% live in rural areas in Ireland. Only the Scandinavian and Baltic countries have lower population densities in Europe. This is shown in Figure 1.

Figure 1: Population density by country

(World Development Indicators, 2007)



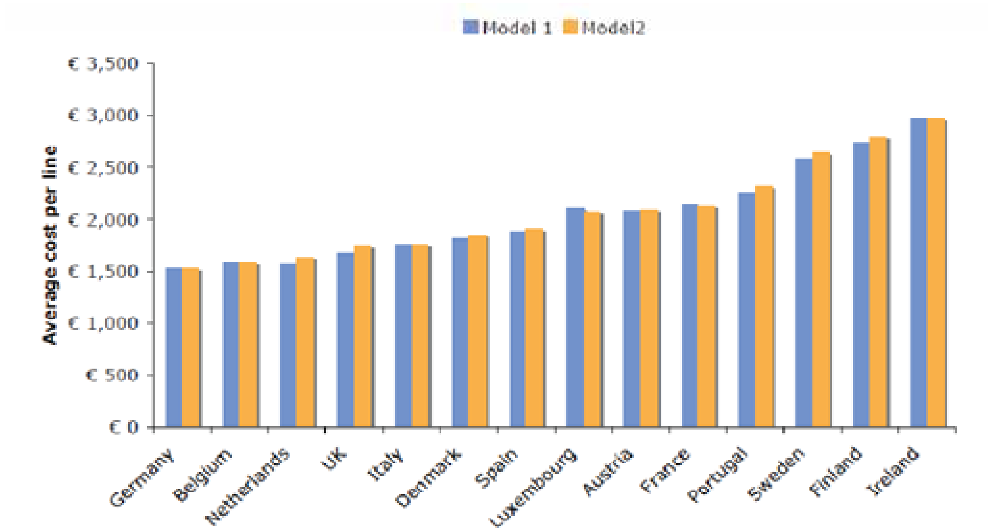
10. As recognised by the DCENR, this factor "impacts on the economics of broadband infrastructure."[4] This position is also reflected in the August 2008 work by DotEcon and

4 "Next Generation Broadband: Gateway to a Knowledge Ireland", Department of Communications, Energy and Natural Resources, 2009, section 5.2.

Network Strategies (for eircom), which found that, largely due to "the unique population dispersion in Ireland", fixed network costs are greater than in other EU15 countries.[5] This is shown in Figure 2.

Figure 2: Predicted average cost per line across Europe

(DotEcon analysis)



Note: Model 1 and Model 2 results are based on slightly different econometric specifications of the cost model. Model 2 uses more disaggregated data on the road network in each country.

11. One result of this is that copper-based LLU is not viable in a significant proportion of Ireland. I understand that this is generally the case where there are fewer than 2,500 lines at the exchange, and that this is the situation with around 40% of the lines in Ireland.[6] In these areas, broadband at the wholesale level can currently only be offered as a bitstream product over copper (or potentially via wireless broadband). Crucially, I understand that it is unlikely that fibre-based NGA will be commercially viable in these areas.[7]

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5 "Network Access Cost in Ireland: Modelling equivalent costs in European countries", DotEcon and Network Strategies, 28th August 2008, page vii.

6 See Oxera draft report of 15 June 2011 entitled "Conceptual framework for the assessment of eircom's bundles", referring to analysis carried out by TERA.

7 See slide 7 of "eircom's Plan for the Deployment of Next Generation Access", 20 September 2011, for a discussion of the scope of potential roll out.

12. eircom has informed me that in most of the areas where NGA will be rolled out, both copper-based LLU and cable broadband are likely to be present. Thus, I expect that in those areas where eircom plans to roll-out NGA, it will usually face competition from operators providing services using unbundled copper and from cable operator UPC, which provides ultra-fast broadband services over its upgraded DOCSIS 3.0 network.[8] UPC's network passes 687,500 homes,[9] which represents almost 42% of households (based on a total number of households of 1,646,200[10]), and it is seeking to increase the footprint of its network. In July 2011, UPC announced almost €80 million of "further investment in its Fibre Power network to extend the reach of its digital TV, phone and ultra-fast broadband services to communities across its footprint in Ireland."[11] I also note ComReg's statement in its WBA Market Review:

> *"According to information supplied by UPC to ComReg, the number of broadband enabled homes by 2012 is expected to increase and the full realisation of UPC's plans will bring its potential national broadband coverage up to around 44% based on an estimate of 720,000 homes passed."*[12]

13. I note that 720,000 homes passed by UPC would be 80% of eircom's four-year target to roll out NGA in areas that will pass 900,000 homes.[13]

14. UPC has 224,800 internet subscribers in Ireland (around 33% of its coverage), and a total of 531,100 customer relationships overall.[14] As stated in eircom's response to the NGA Consultation (Q27), UPC has around 40% of the fixed-line broadband retail market within its footprint, which surpasses eircom's 38% share in that same area.

15. There may be some areas where NGA will not be not rolled out but where copper-based LLU is viable. In these areas, broadband could be offered either via LLU, via a bitstream

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8 I note that LLU viability does not necessarily mean that access will have been sought, and so the absence of LLU does not mean it can be assumed to not be viable.

9 Source: UPC Holding operating data, 30th June 2011, available here: http://www.lgi.com/PDF/UPC_Holding_BV_Q2_2011_Final.pdf.

10 As used by ComReg in its WBA Market Review: see page 52 of "Market Review: Wholesale Broadband Access (Market 5)", Response to Consultation and Decision, Commission for Communications Regulation, Document No. 11/49, 8th July 2011.

11 See press release available at: http://www.upc.ie/pdf/UPC%20creates%2050%20new%20jobs.pdf.

12 "Market Review: Wholesale Broadband Access (Market 5)", Response to Consultation and Decision, Commission for Communications Regulation, Document No. 11/49, 8th July 2011.

13 See slide 2 of "eircom's Plan for the Deployment of Next Generation Access", 20 September 2011, for a discussion of the scope of potential roll out.

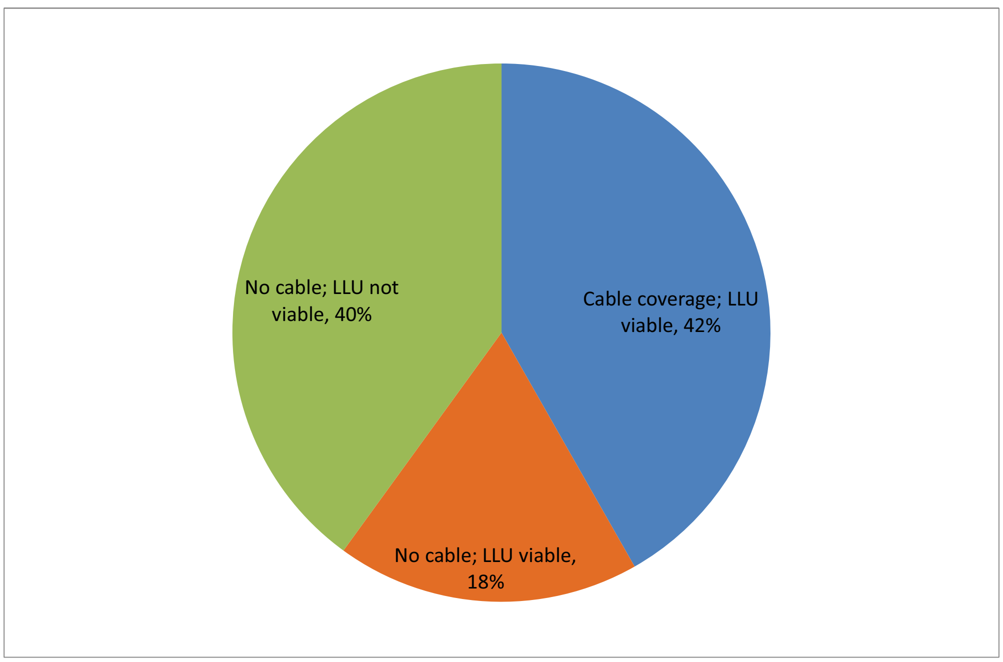
14 Source: UPC Holding operating data, 30th June 2011, available here: http://www.lgi.com/PDF/UPC_Holding_BV_Q2_2011_Final.pdf. Internet subscribers do not include customers receiving services from dial-up connections.

product or via wireless broadband. Some of these areas may also be covered by cable. However, eircom has informed me that in practice, there will be very few areas of this type: virtually all areas where LLU is viable will see NGA rolled out and most will also be passed by UPC.

16. It is therefore likely that in Ireland, there will effectively be two different geographic areas in competitive terms: (1) areas where eircom will roll out fibre, in which cable will usually be present, LLU will be viable and bitstream will be available; and (2) areas where broadband is only available over exchange-based copper via a bitstream product. The Type 1 areas will account for about 60% of lines, and the Type 2 areas for the remaining 40% of lines.

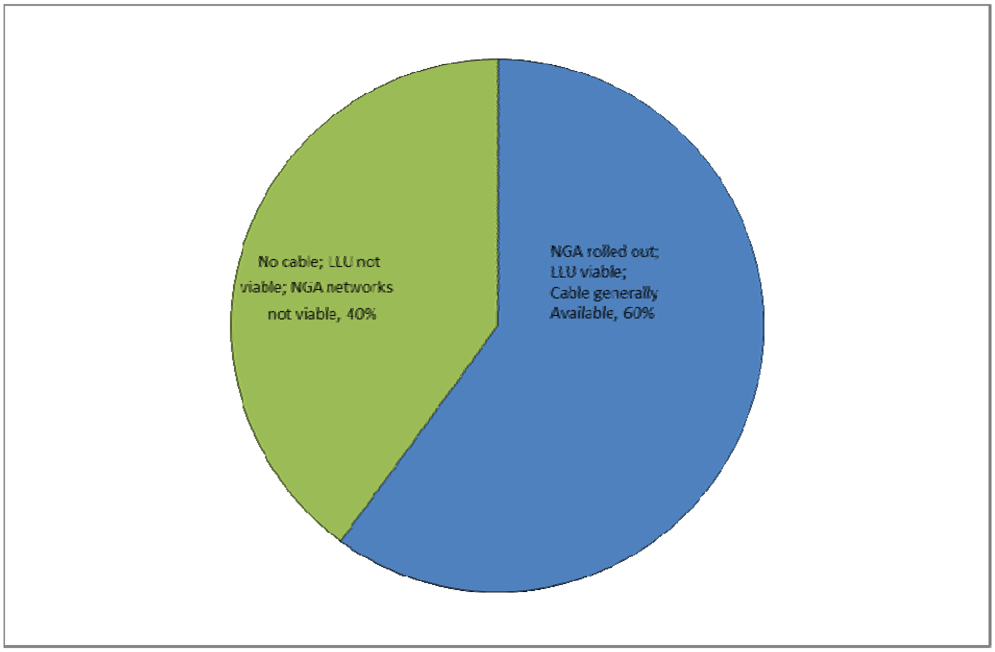
17. The diagrams below show the current and medium term (four year) availability of broadband services over different networks. It is assumed that in all areas copper-based bitstream access is available to access seekers.

Figure 3: Current geographic differences in broadband availability; by number of households/lines



Sources: TERA, UPC, eircom. The coverage of cable is based on number of households covered whilst the LLU viability figure is based on the number of lines. I have assumed one line per household.

Figure 4: Medium term geographic differences in broadband availability; by number of lines



Source: TERA, eircom.

18. At first sight, the fact that there will be two different types of areas in which the conditions of competition vary significantly might be thought to suggest that there will be a need for geographically distinct remedies. However, an important implication of the analysis above is that, based on eircom's announced plans and assumptions that can be drawn from Ireland's challenging demographics, there will be no need for ComReg to articulate any formal geographically differentiated remedies to regulate wholesale prices for eircom's NGA services. This is because NGA will be deployed in the Type 1 areas, where cable, and copper-based LLU are also commercially viable and have already been deployed as well. As a consequence, the competitive constraints faced by NGA will not vary across the country: where fibre is rolled-out, cable will usually be in place and copper-based LLU will either be in use or available. Non-discrimination requirements mean that in those few areas where either cable or LLU are not present, eircom will still price on the basis of the competitive constraints imposed by cable and LLU.

2.2. The need for an access remedy for NGA

19. The retail pricing of UPC's cable broadband services can be expected to constrain eircom's retail pricing.[15] Given that eircom expects to face substantial retail competition from ultrafast cable broadband in almost all areas where it plans to roll out its NGA network, it is far from clear that eircom will have significant market power at the wholesale level. The indirect constraint from cable at the retail level may be strong enough to ensure that eircom does not have market power that it can exploit to raise prices at the wholesale level.[16] The potential for the deployment of high-speed mobile broadband based on LTE in the next few years will provide additional platform competition.

20. A key issue is the question of whether, in the absence of a regulated price for wholesale NGA services, eircom would have an incentive to seek to exclude third party access seekers. In general, when the downstream market (i.e. retail market) is competitive, there is no incentive even for a monopolist with market power to exclude efficient downstream rivals. This is because the profit maximising behaviour for the monopolist is to earn its rent through its wholesale price and then have its product efficiently distributed at the retail level.[17] As discussed below in section 3.1, eircom's wholesale customers would appear to enjoy substantial efficiencies at the retail level that are not available to eircom, as a result of their affiliation with very large and centralised regional marketing and product development operations. In light of the strong competition that eircom is already experiencing from cable broadband, neither eircom nor its wholesale customers will be in a position to price their ultrafast broadband services above UPC's retail prices. In order to maximise the amount of traffic utilising the NGA network as opposed to cable, eircom should have strong incentives to cater to efficient distributors of its wholesale NGA products in order to earn extra wholesale revenue.

21. An alternative way of thinking about this issue is to use a "vertical arithmetic" approach. The standard economic logic for exclusion in a vertical chain is that by excluding rivals, a firm can "steal" their sales and also increase the retail price of the product. This is illustrated below in Figure 5 and Figure 6. Figure 5 shows the situation in which an integrated firm supplies third parties with an input and then competes with them at the retail level. The integrated firm earns a wholesale and retail margin on its own sales

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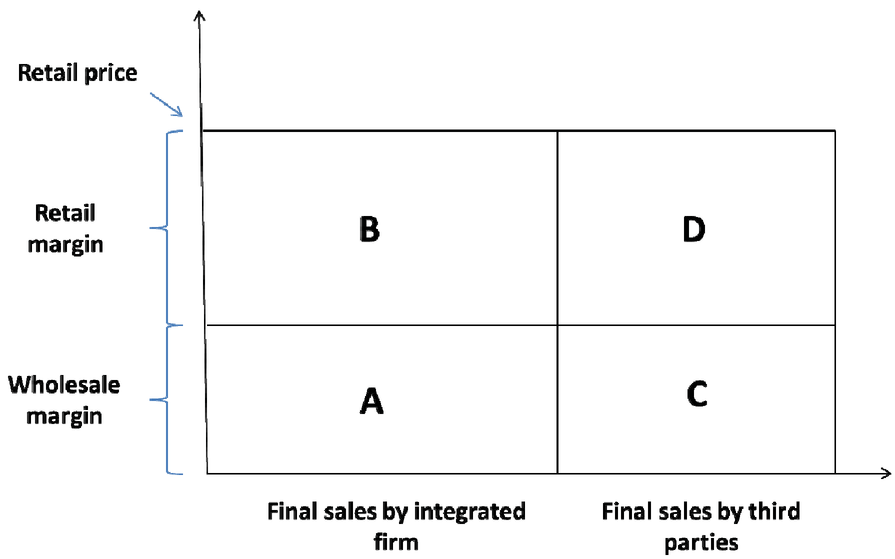
15 See, for instance, slide 29 of "eircom's Plan for the Deployment of Next Generation Access", 20 September 2011.

16 This is consistent with the European Commission's Staff Working Document accompanying the "Recommendation on regulated access to Next Generation Access Networks" of 20 September 2010. This states that "since cable networks are (or easily could be) upgraded to EuroDOCSIS 3.0, they need to be included in any realistic assessment of NGA coverage." (page 10).

17 This is a version of the Chicago critique. See Motta (2004) or Bishop and Walker (2009).

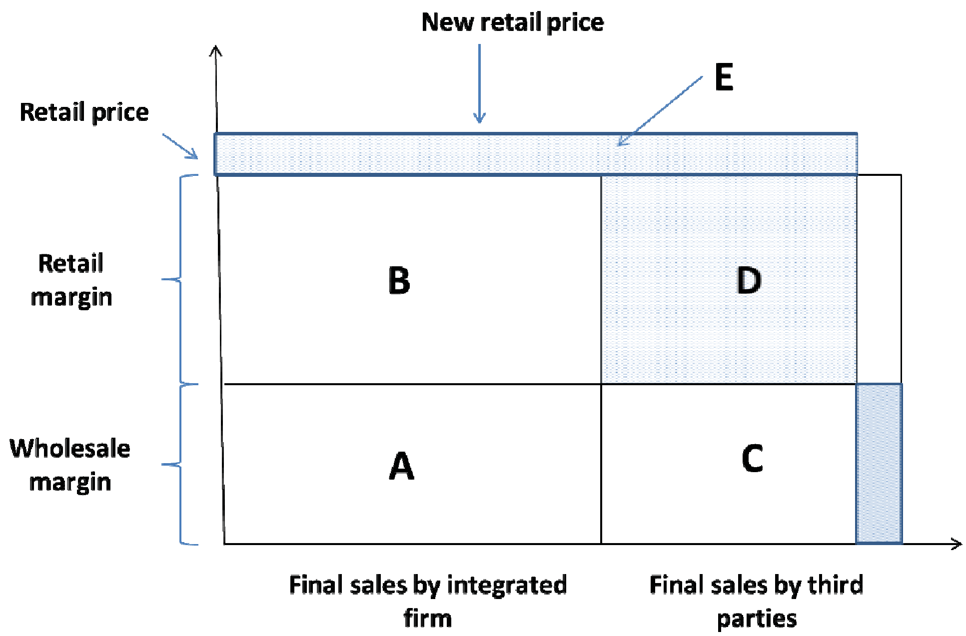
(Areas A and B) and a wholesale margin on the sales of its competitors (Area C). Its wholesale customers/competitors earn a retail margin on their sales (Area D).

Figure 5: Standard vertical arithmetic



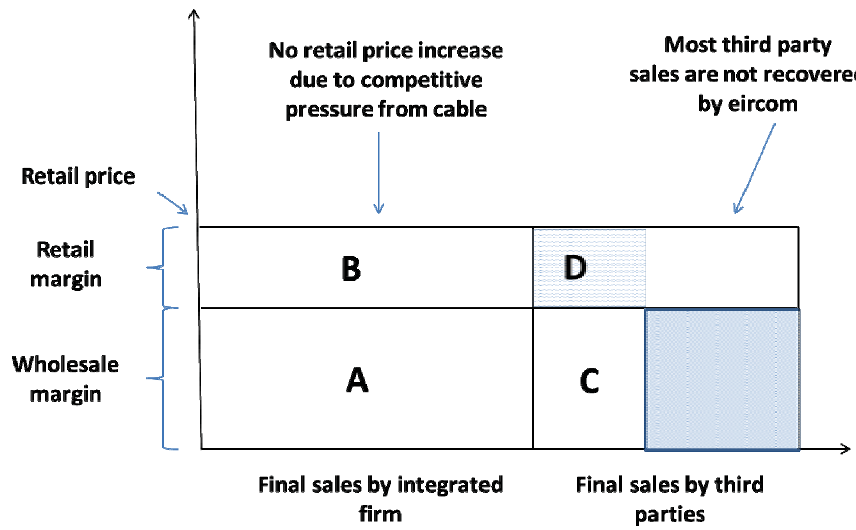
22. Figure 6 shows what happens if the integrated firm stops selling at the wholesale level to its competitors. There are three effects. First, the integrated firm now earns the retail margin that the third party firms previously earned. Second, it is able to increase the retail price. Third, there will be some loss of overall sales due to the higher price. The first two effects are positive for the integrated firm and increase its profit. This is shown by the lighter shaded areas D and E in Figure 6 (though note that area D is now smaller than before). The third effect is negative and is shown by the darker shaded part of Area C, which is wholesale margin that is no longer earned. In Figure 6 it looks clear that exclusion is a profitable strategy for the integrated firm.

Figure 6: Vertical arithmetic of incentives not to offer wholesale access



23. However, this is not the situation that I understand eircom faces. First, it faces a binding retail price constraint from cable broadband, so it could not profitably raise the retail price even if it were to exclude third party wholesale customers from using its NGA network. Second, eircom believes that allowing third party access will significantly increase the demand for NGA-based retail products because some of its competitors may be better placed to win business from some customer groups than is eircom (for example, because they have more efficient or effective marketing organisations or because they are able to bundle their services with products that eircom is not in a position to offer - such as television services including premium content). Third, I understand from eircom that retail margins (over and above retail costs) are relatively small given the strength of retail competition. The result is that the actual scenario is likely to look more like Figure 7 than Figure 4 for eircom, because the loss from excluding its rivals would be significantly greater than the gain.

Figure 7: Vertical arithmetic of situation facing eircom



24. The implication is that eircom is unlikely to have an incentive to exclude third party access seekers and, indeed, would be rational to embrace them as customers in order to maximise the use of, and returns on, its NGA investment. This suggests that any regulatory remedy should be light touch, and that *ex ante* price controls for eircom's wholesale NGA products would not be necessary or proportionate.

2.3. Implications for price regulation

25. In general, the European Commission's NGA Recommendation favours cost-orientated wholesale pricing for access to NGA networks: however, it notes that other methodologies, such as retail-minus, could be appropriate (at least for wholesale bitstream access), if there are "sufficient competitive constraints on the downstream retail arm of the SMP operator". As already discussed, this would appear to be the case here, and ComReg itself acknowledges that UPC's new consumer products are the first of the "most notable developments" related to NGA.[18] Thus, if any price controls are deemed to be necessary, a retail-minus approach would be justified.

26. In its NGA Consultation document, ComReg identified the following recent retail market trends (emphasis added):

18 See paragraph 1.31 of the Consultation document.

"Recent trends observed in the retail market provide a context for forces driving wholesale demand for network infrastructure access and wholesale broadband access. In recent years, the following trends have been observed:

- *a dramatic increase in internet penetration and usage;*
- *a shift from narrowband to broadband access, to the point where narrowband access may be seen as a legacy product, and a shift in consumer usage from lower to higher broadband speeds;*
- *the development of applications that require faster speeds, such as music and movie downloads, and online gaming;*
- *the development of products which meet these needs, particularly in the shift towards higher broadband speeds and increased download allowances;*
- *substantial increases in the geographic reach and penetration of existing broadband platforms, such as DSL, cable and FWA (albeit with the market share of the latter declining in recent quarters), and limited developments of alternative FTTx operators;*
- *the launch and notable expansion of mobile broadband services;*
- *mobile operators entering the fixed market and, to a lesser extent, the converse;*
- *the development of bundled offerings of voice, data and entertainment."*[19]

27. As discussed above, there is good reason to believe that competition from UPC means that the retail price of NGA will be constrained by the retail price of cable.[20] This conclusion is strengthened to the extent that the cable broadband price within a bundle could be very low if it is priced on the basis of its incremental cost within a pay television bundle. This means that, if any price regulation is appropriate, a retail minus remedy would seem reasonable. This relatively light touch approach would recognise the constraining effect of cable pricing on eircom and would also ensure that third party access seekers could be sure of being able to compete with eircom and with UPC using a wholesale NGA product. This is fully consistent with the European Commission's NGA Recommendation, which recognises (at Recital (37)) that National Regulatory Authorities may employ price control methodologies other than cost-orientation – including a retail-minus approach – "where there are sufficient competitive constraints on the downstream retail arm of the SMP operator."

28. There is also a practical reason for favouring a retail-minus remedy, at least as a transitional measure. LRIC is an average cost per customer measure based on the incremental cost of a lumpy investment. Given that a large proportion of the costs of the

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19 Paragraph 1.27.

20 See eircom's response to Q27 of the Consultation, in which it is stated that: "Retailer market prices are set by the UPC offers".

fibre roll out will be fixed (and sunk), the actual average cost figure will depend heavily on the extent of take-up of the fibre products. I understand from eircom that the take-up rate for ultrafast broadband services at the retail level and for wholesale access is very uncertain, and therefore that reasonable estimates of the level of a LRIC-orientated price cannot be developed at this stage.

29. I understand that as a result, in the early years of eircom's NGA deployment, it may even be that the retail price it can charge for its NGA services will not cover its LRIC (particularly if a risk premium is included).[21] If this were the case, then retail-minus regulation would lead to a wholesale regulated price below a cost-orientated (LRIC) access price during the NGA start-up period.

30. My view is therefore that where NGA is rolled out, if wholesale price controls are deemed to be necessary at all, it should be sufficient to require only that eircom passes a margin squeeze test (as I discuss in section 3 below). This will ensure that third party access seekers can compete successfully but, because of the constraining effect of cable, will not allow eircom to exercise significant market power. A cost-orientated access price might actually make it impossible for third parties to compete with alternative platform providers using eircom's wholesale products. This is because the sum of the access price and the third parties' retail costs might be greater than the retail prices charged by competing platform providers such as cable. The same logic means that it might also be impossible for eircom to compete with cable if eircom had to pass a margin squeeze test on the retail price of fibre broadband and the cost orientated wholesale access price during the start-up period.

31. Before leaving this issue, I should note that the possibility of the retail-minus wholesale price being lower than the LRIC wholesale price does not imply that the retail minus wholesale price is exclusionary in relation to competing platform providers. In particular, there is no question of eircom's NGA pricing leading to the exclusion of its cable competitor. UPC has already incurred the very significant sunk costs of its cable network, and I would expect it to be pricing its broadband offerings on an incremental cost basis on the upgraded cable television network. Far from leading to exclusion, a retail-minus wholesale price will encourage inclusion compared to a higher cost-based wholesale price which would exclude third parties from being able to compete using eircom's fibre products. Moreover, as discussed above, there is considerable uncertainty over what the LRIC price would be. Thus, in addition to the other arguments discussed above, a retail minus approach is sensible from a practical point of view as well, at least as an interim measure.

21 See paragraph 27.5 of Annex 2 of eircom's response to the Consultation Document.

2.4. Conclusions

32. My broad conclusions in this section are as follows:

- There are likely to be two different types of areas between which competitive pressures vary considerably. In one type, NGA, cable and copper-based LLU will all be available in the medium term and will compete with products offered over bitstream.[22] In the second type, wholesale bitstream access (and possibly wireless broadband) will be available, but not NGA, copper-based LLU or cable.
- eircom should have no incentive to seek to exclude access seekers from its fibre platform. Indeed, it should welcome the efficient distribution of its wholesale fibre product to which they will contribute.
- Retail competition in those areas served by cable and copper-based LLU will be strong enough that retail-minus remedies should be adequate to protect competition at the wholesale level, at least during the NGA roll-out period, when LRIC costs and volumes will remain uncertain.

3. Issues relating to applying a margin squeeze test

33. Paragraphs 5.102 to 5.131 and questions 57 and 58 of the Preliminary Consultation deal with margin squeeze issues. ComReg raises a number of different issues in this section, some of which are uncontroversial, and I have not been asked to comment on them all. However, a number of issues discussed in the consultation document raise serious concerns from an economic perspective, which I believe ComReg should reconsider.

34. The specific issues that I discuss in this section are:

- use of the "similarly efficient operator" test;
- the appropriate cost standard to use;
- the correct level of aggregation at which to apply a margin squeeze test;
- the relationship between a cost orientated remedy and a retail minus remedy given the circumstances of NGA roll-out in Ireland; and

22 This is consistent with the European Commission's Staff Working Document on NGA (see footnote 16). This states that "levels of competitive intensity are liable to vary not only between Member States, but also in certain segments and areas of a given national market, with infrastructure-based competition particularly strong in urban and metropolitan areas." (page 9-10).

- the principles governing the levels at which a margin squeeze test should be applied in the vertical value chain.

3.1. Use of the equally efficient operator test

35. The standard dichotomy when evaluating actual or potential exclusion under competition law or regulation is between the application of an equally efficient operator ("EEO") test and a reasonably efficient operator ("REO") test. As ComReg notes in the consultation document,[23] a common way to think about the REO test is that it is based on the downstream costs of an efficient firm that is operating at a smaller scale than the incumbent, whereas the EEO test considers the incumbent's own downstream costs. ComReg favours an alternative to the REO test: the similarly efficient operator ("SEO") test. This relates to the costs incurred by a firm that has the same cost curve as the incumbent, but operates at a lower scale. Conceptually it is similar to the REO test, except that it replaces "efficient costs" with the cost curve of the incumbent, which in theory could be efficient or inefficient. For the purposes of my discussion below, the difference between the SEO and the REO standard is not important. The important distinction is between the EEO standard on the one hand, and an SEO or REO standard on the other.

36. In fact, the only time that the application of an EEO vs. REO/SEO standard matters is when a dominant firm's pricing passes an EEO test but fails a REO/SEO test. If the pricing passes on both approaches, or fails on both approaches, then there is no issue. The only time the difference in approach matters is if the pricing behaviour of the dominant firm fails a REO/SEO test but does not fail an EEO test. If this happens, it means that the dominant firm's costs are lower than those of the competitor firm. Applying the REO/SEO standard would then require that the dominant firm changes its price in order to accommodate a firm that is less efficient. This will lead to productive inefficiency and likely also higher prices to consumers. For this reason, the EEO test is generally used in competition law analysis. In my view, the REO/SEO test should be used only exceptionally even when applying *ex ante* regulatory remedies.

37. This does not mean that an REO/SEO standard can never be justified in applying *ex ante* remedies. There may be occasions where the static welfare loss associated with the REO/SEO standard (i.e. productive inefficiency and likely higher prices) is outweighed by expected dynamic efficiency gains. This would generally occur when a sector is newly opened to competition and the competitor firm is currently not cost efficient but, if given

23 Paragraph 5.114 of the Consultation Document.

competitive headroom, would become efficient in the medium term. The increase in competition that this would engender may outweigh the short-run economic harm. This line of argument implies that there are two necessary conditions that need to hold before the REO/SEO standard should be applied:

- There are competitor firms that are not currently as cost efficient as the incumbent but will become equally or more cost efficient as the incumbent if they are able to survive in the short run and achieve efficient scale in the medium term.
- The increase in the number of efficient firms must have a positive effect on the competitive outcome for consumers in the medium and long term that outweighs the short run costs from higher prices to consumers.

38. The first condition gives rise to an empirical requirement for applying the REO/SEO test: there must be competitors who are not currently at scale but who will likely achieve scale if they are given competitive headroom. If competitors are already at scale, then they do not need to be supported via the REO/SEO standard. If they are not at scale and are not likely to achieve scale, then they should not be supported by the regulatory regime as this would lead to productive inefficiency. Note that this condition does not imply that any sub-scale operator should be protected even if it could reach scale. If there are already enough other firms operating at scale, then it is not necessary and, indeed, productively inefficient, to offer regulatory protection to sub-scale firms.

39. The second condition also gives rise to an empirical requirement: protecting competitors in the short run so that they can become efficient in the medium term must have a positive impact on competitive outcomes.

40. If ComReg wishes to apply a REO/SEO standard to NGA, it needs to show that competitors are not currently at scale but will achieve scale. I have not seen any analysis or evidence from ComReg relating to this issue for either legacy or NGA products.

41. When thinking about the firms that may use wholesale access to eircom's NGA network, it is important to consider the comparative scale of the likely access seekers at the retail level. The standard situation when considering issues relating to access to an incumbent's network is that the firm requiring access is smaller than the incumbent. That is not the situation in Ireland. The most likely NGA seekers are Vodafone, 02, Sky and BT. All of these companies are part of multinational corporations with extensive, centralised retail operations that are far larger than eircom's. For example, Vodafone's Annual Report 2011 records revenues of £45.9bn and an adjusted operating profit of £11.8bn. It employed 83,900 and operated in 26 countries. BT's Annual Report 2011 reported revenues of £20.1bn and an EBITDA of £5.9bn. BT employed 92,600 FTEs and operated in 170 countries. Telefonica (O2) had revenues of nearly €61bn and EBITDA of

nearly €26bn in 2010. It employed 133,000 people, had nearly 288 million customers and was present in 25 countries. Sky had adjusted revenues in the 12 months to June 2011 of £6.597bn and an EBITDA of £1,405bn. It employed 16,500 people and had more than 10 million customers. In comparison, in the twelve months to June 2010, eircom revenues were €1.8bn, its adjusted EBITDA was €669m and it employs just over 7,000.[24] One implication of this is that eircom's competitors can take advantage of economies of scope and scale at the retail level between their operations in Ireland and other countries in which they operate.[25]

42. Based on the materials that I have reviewed, ComReg has not shown that either of the necessary conditions for justifying a SEO (or REO) standard apply in the present circumstances. In particular, it has not been shown that the likely users of wholesale access are sub-scale or that if they are, they have the potential to become scale operators in the near to medium term.

43. Before leaving this discussion of the SEO standard, I should comment on one claim by ComReg with which I disagree. ComReg states that the SEO standard provides the correct build/buy signals for an entrant.[26] It is not clear why ComReg believes this to be the case. The SEO standard allows an entrant to buy access and remain sub-scale with impunity, which is exactly the opposite of what ComReg ought to be encouraging. Indeed, under an REO/SEO standard, improvements in the cost efficiency of the entrant would lead to a *higher* wholesale charge (assuming the retail price is unchanged), which would dampen the incentives to improve cost efficiency. In these circumstances, ComReg should move to the EEO standard when considering pricing remedies for eircom's NGA offerings if cost controls are deemed to be necessary at all.

3.2. Correct cost standard

44. At paragraph 5.123 of the NGA Consultation Document, ComReg lists five possible cost standards for a margin squeeze test. These are:

- Average variable costs ("AVC");

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24 There will be some places where UPC may request wholesale access as well. UPC is part of Liberty Global. Liberty Global's UPC Broadband division provides cable services in ten European countries and serves more than 13 million customers. Its annualised revenues for the second quarter of 2011 were $6.3 billion. Liberty Global also owns a majority shareholding in Telenet in Belgium.

25 For instance, Vodafone has recently moved its Irish marketing team to the UK as a cost saving measure (see The Irish Times "Vodafone to relocate marketing to London" (16-8-2011)).

26 See paragraph 5.115 of the Preliminary Consultation.

- Average avoidable cost ("AAC");
- Long run average incremental cost ("LRAIC");
- Long run average incremental cost, with a mark-up for joint and common costs ("LRAIC+"); and
- Average total costs ("ATC").

45. ComReg concludes that the correct standard is LRAIC, LRAIC+ or ATC. In ComReg's view, AVC is not correct because it excludes fixed costs and these are a major component of telecommunications costs. It is not clear why ComReg dismisses AAC, but there is a suggestion that it is because AAC is a short run measure (see Para 5.122).

46. When carrying out a margin squeeze test, the aim is to understand whether the pricing of the firm with significant market power either excludes efficient current competitors or deters efficient entrants. It will only be more profitable for current competitors to exit rather than remain in a market if their revenues from remaining in the market are less than the costs they would save if they exited (i.e. their avoidable costs). So if the concern is with the potential exclusion of existing competitors, then the focus should be on avoidable costs. New entrants will enter as long as their expected revenues are greater than the costs that they will incur if they enter (i.e. incremental costs). So if the concern relates to new entrants being excluded (i.e. because of a regulatory concern to promote competition, rather than just to avoid harm to existing competition), then the focus should be on incremental costs. Importantly, common costs should not in general be included in a margin squeeze analysis as they do not enter into the exit or entry decisions of either existing competitors or potential entrants. This analysis has the following implication.

47. First, the downstream costs of competitors or potential entrants should be assessed on an avoidable or incremental cost standard. This is consistent with the Commission's Article 102 guidelines that propose using AAC or LRAIC.[27] The choice between them comes down to the question of whether the competitive concern is primarily with the exclusion of existing or potential competitors. An avoidable cost standard omits sunk costs that are not avoided on exit. If the concern is about excluding potential entrants, who would incur those sunk costs, then an avoidable cost standard is not correct and instead an incremental cost standard should be chosen. But if the concern is with excluding existing competitors, then an avoidable cost standard is reasonable. It is not the case, contrary to ComReg's suggestion, that avoidable cost standards are by definition short run. Avoidable costs can be assessed over any period, although of

27 See paragraph 26 of "Communication from the Commission - Guidance on the Commission's enforcement priorities in Applying Article [102] of the EC Treaty to abusive exclusionary conduct by dominant undertakings" (24 February 2009).

course the level of costs that are avoidable will generally increase as the length of the period of assessment is increased (i.e. costs that are fixed in the short run become variable, and so avoidable, in the longer term).

48. Second, ComReg is right that AVC omits fixed costs that are incremental to the relevant product and so are right that it is not the correct cost standard if the concern is with potential entrants. If the concern is with existing competitors, then AVC omits fixed costs that would be avoided on exit. So AVC is also not the correct standard for existing competitors, although if few fixed costs would be avoided on exit, then as an empirical matter AVC would be close to AAC.

49. Third, neither ATC nor LRAIC+ is a reasonable cost standard as they both include a mark-up for common costs. If there is a concern about common costs contributing to exclusion, then this can be dealt with by using a combinatorial test. For a discussion of this issue, see section 3.3 below.

50. Fourth, my understanding is that there are not significant fixed costs at the retail level. This implies that at the retail level there should be little difference between the LRAIC standard and the AAC standard.

3.3. Level of aggregation

51. At paragraphs 5.128 to 5.130 of the NGA Consultation Document, ComReg discusses the level of aggregation for application of the margin squeeze test. The issue here is whether eircom should have to pass a margin squeeze test on every individual product (in this case, defined by the amount of bandwidth offered), or whether it should be required to pass at the "portfolio" level only (i.e. all bandwidths offered for a particular type of broadband service). The basic economics of this issue is clear: the correct approach is a combinatorial approach which assesses the impact at both levels. In general, each product should pass a margin squeeze test based on the incremental costs of the EEO of providing that product, given that it already offers the other products in its portfolio; moreover, each portfolio of products should in combination cover their incremental costs.

52. However, there is an important caveat to this. Since margin squeezes are concerned with exclusion, there is little point to carrying out a margin squeeze test at a level that is more disaggregated than the level at which exclusion could occur. The test should be carried out at the levels at which entry and exit decisions are made. So if competition takes place across the full range of broadband speeds, for instance, and eircom's competitors are unlikely to offer just one speed of ultrafast broadband at the retail level (where they are competing not only against eircom and eircom's other wholesale customers, but also UPC), then there is no need to test whether a margin squeeze test is passed at a highly

disaggregated level (i.e. by bandwidth category). Furthermore, even if there are players who choose to supply just a small subset of products, regulatory remedies should not be concerned about their exclusion if competition is driven by firms that compete across a fuller range of products. eircom should not be in the position of having to provide competitive headroom for firms that elect to compete across an inefficiently narrow range of products.

53. The use of a combinatorial approach avoids concerns that applying the test only to individual products means that common costs are omitted. As discussed above, it is correct to omit common costs when considering whether firms are excluded because common costs do not enter into a firm's calculations about either entry or exit. It is only incremental or avoidable costs that enter this calculation. Using a combinatorial test means that costs that are common across a number of products can be included in the margin squeeze analysis by carrying out the test at the level of aggregation at which the common costs become incremental costs (i.e. costs that are common to two products are not incremental to either product on their own but are incremental to the combination of both products).

54. At paragraph 5.129 of the Consultation Document, ComReg asserts that there is

> *"one main advantage of assessing a margin squeeze on every single product: the "replicability" principle is satisfied at the most disaggregated level, giving an alternative operator the freedom not to reproduce the portfolio of the SMP operator in order to compete."*

55. I disagree that the ability to carry out the test at the "most disaggregated level" is an advantage. It only makes sense if efficient competitors actually operate at this level. If the efficient way to operate, due for instance to economies of scope, is for operators to offer the full portfolio of products, then this is the level at which the margin squeeze test should be carried out.

3.4. Cost orientation vs. margin squeeze test

56. At Para 5.106 of the NGA Consultation Document, ComReg refers to concern raised by the European Commission's NGA Recommendation that a margin squeeze test might not be enough on its own because there might be a

> *"significant discrepancy between a cost oriented price and a price that can be considered as abusive".*

57. The underlying concern is that a wholesale price that is significantly above cost might still not imply a margin squeeze if the retail price is set high enough (i.e. even an excessively

high wholesale price would not lead to a margin squeeze if the retail price was correspondingly excessively high). This is a reasonable concern: margin squeeze tests (or retail minus) do not remove market power at the wholesale level as an upstream monopolist can set a monopoly wholesale price and then set a retail price high enough to avoid a margin squeeze. Instead, margin squeeze tests are designed to ensure that a dominant firm cannot exclude efficient competitors in those areas where products or services can be efficiently provided by alternative firms.

58. However, I understand that this is not a concern in this instance because competition from cable can be expected to ensure that eircom will not be able to exercise market power at the wholesale level.[28] Indeed, as discussed above, in the early years of its NGA deployment, a cost orientated wholesale price might well be above the wholesale price that passes a margin squeeze test.[29] So the European Commission's concern is not relevant to the Irish situation. As set forth in Recital (37) of the Recommendations, the conditions under which a retail-minus approach would be justified (competition at the retail level) are, in fact, those that pertain in Type 1 areas of Ireland.

59. Indeed, in this situation setting an access price based on cost[30] would actually harm competition. This is because it would not lead to enough space between the fibre access price and the retail price of cable. The result would be either that:

- eircom priced at a similar level to UPC, in which case eircom's wholesale customers would be unable to match eircom's retail price using eircom's fibre-base access services (i.e. a margin squeeze); or
- eircom would set retail prices so as to avoid a margin squeeze against the cost-oriented wholesale price, in which case eircom's wholesale customers could enter at a similar price to eircom's, but both these competitors and eircom would be charging a price that was higher than UPC's price.

It is hard to see either of these options as producing a regulatory remedy that is in the interests of competition or consumers.

60. At Para 5.106 of the Consultation Document, ComReg refers to another concern raised by the European Commission in relation to reliance on a margin squeeze test alone, rather than also imposing cost orientated pricing. The concern is that this would not give access seekers enough certainty as to the access price they will have to pay. There is a sense in which this is correct: under a margin squeeze approach the access price will

28 See Section 2.2 above.

29 See Section 2.3 for an explanation of why such pricing would not be predatory.

30 As noted earlier (see Section 2.3), there are significant practical difficulties of estimating LRIC, largely because of uncertainty over the likely take up of fibre.

change when the dominant firm's retail price changes, and so an access seeker may not know how the access price will vary over time.[31] However, there is another sense in which a margin squeeze test does give an access seeker certainty: it means that the access seeker knows that if it is as efficient as the incumbent (or more so) at the retail level, then it will be able to compete. If the dominant firm lowers it retail price, then competitors know they will be charged a correspondingly lower wholesale price. Conversely, a cost orientated access price would not give this certainty, as explained above. In the present circumstances, eircom's retail prices would need to be competitive with UPC's, and therefore the application of retail-minus pricing to eircom's NGA products would not give rise to this problem.

3.5. Applying a margin squeeze test at multiple levels

61. In the NGA Consultation Document[32] ComReg indicates that the European Commission's NGA Recommendation anticipates that access seekers will be granted wholesale access to fibre infrastructure at multiple levels (e.g. unbundled access, duct access, sub-loop access, bitstream access, etc.). I understand that it is ComReg's view that there must be sufficient "economic space" between each of these levels (i.e. that eircom must price wholesale access so as to pass a margin squeeze test at each level).

62. I take no view as to the technical or commercial feasibility of rolling out a new fibre-based network subject to the requirement that multiple layers of wholesale products must be made available by the incumbent. As with any regulatory intervention, wholesale access should be mandated if and only if it can be expected to improve economic efficiency and ultimately benefit final consumers. Thus, if there are additional costs associated with providing multiple access points (or with access at particular levels), then it would be appropriate for a regulator to mandate such access only if doing so will clearly benefit consumers, *over and above* mandating access at fewer or different points. In terms of which access points are most beneficial, and therefore which if any should be mandated and hence subject to a margin squeeze test, it is also important to consider issues of economies of scale and scope. In particular, access should be provided where activities

31 I understand that in fact eircom believes that under a margin squeeze approach it would still require ComReg approval to alter the wholesale price and so in effect would not be able to unduly lower its retail price without ComReg's permission. As long as ComReg would not withhold permission for eircom to lower its retail and wholesale price other than where margin squeeze with other products arises, this should not lead to uncertainty for access seekers. Of course, if ComReg did not allow eircom to lower its prices in response to lower off-network competitor prices, this would harm access seekers and reduce their ability to compete.

32 Paragraphs 2.12 – 2.19 of the Consultation Document.

are contestable, in order to ensure that entry is efficient. Entry should be facilitated only in areas of the supply chain where competition can occur efficiently and not in cases where entrants will be operating at a much higher cost than the incumbent.[33]

3.6. Conclusions on applying a margin squeeze test

63. In light of the above, the following are my conclusions in this section:

- ComReg should apply an EEO standard, not a REO/SEO standard. The latter standard would only be justified if (1) there was evidence that the only viable competitors to eircom were currently sub-scale operators, and (2) these sub-scale competitors will become scale operators, and (3) they will do so only if they are protected by a regulatory regime that is predicated on the imposition of an inefficient cost standard.
- The correct cost standard should be an avoidable cost or incremental cost standard, depending on whether the concern is primarily with, respectively, the exit of current players or the deterrence of potential entrants.
- Aggregation issues are solved by taking a combinatorial approach to margin squeeze testing and applying the test where exclusion is likely to occur.
- Consistent with the discussion in Section 2, a margin squeeze approach should be adequate for regulating eircom's NGA prices, if a price control is required at all.
- Regulators should insist on access being allowed only where such access creates incremental welfare benefit. This implies that margin squeeze tests should only be carried out where it can be demonstrated that exclusion might lead to incremental welfare harm.

4. The likely effect of the price of copper-based LLU on NGA roll-out

64. I have been asked to comment on how the price of traditional LLU based on copper can affect the incentives for firms to invest in NGA networks. The importance of this is that the regulated pricing of copper-based LLU has the potential to reduce incentives for eircom to roll-out a fibre network. I note that the majority of eircom's fibre roll-out will be

33 Unless this cost inefficiency is only short term. See Section 3.1 for a discussion of this issue.

FTTC, not FTTH, and so the copper terminating segment running from the cabinet to the customer premise is still involved even where fibre is rolled out. The discussion in this section therefore relates to the effect of the price of pure copper LLU on the pricing of the FTTC plus the copper terminating segment. I refer to this as the effect of copper-based LLU on fibre roll-out.

65. The pricing of copper-based LLU has two effects on the incentives to roll-out NGA:

- First, since fibre and copper are substitute delivery platforms from the consumer perspective, relatively lower LLU prices will increase the demand for LLU and reduce the demand for fibre-based access (and fibre-based retail products).[34] This will reduce the incentive to invest in fibre. Conversely, higher LLU prices will make fibre-based products relatively more attractive for consumers and so increase the demand for fibre, which should increase the incentive for a firm to invest in a fibre network.[35]

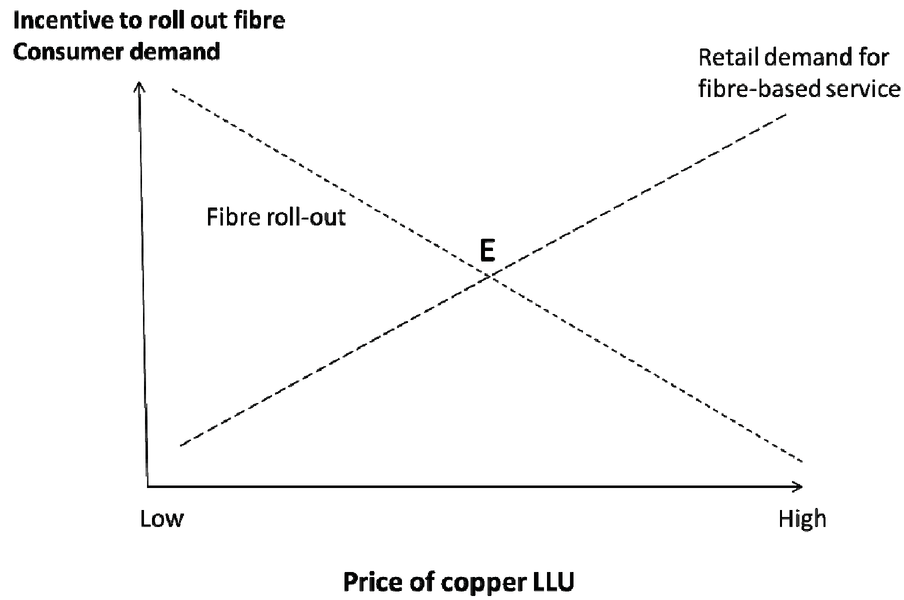
- Second, lower LLU prices (relative to a given NGA price) mean that fibre offers a relatively better return for the dominant firm and this will tend to encourage it to invest in the new technology. Conversely, higher LLU prices will reduce the incremental return from fibre investment and so may encourage the dominant firm to stick with their copper investment.

66. These two effects operate in different directions. In a situation where the incumbent fixed line telecommunications operator faces no platform competition in the provision of broadband services, low LLU prices will encourage consumers to stick with copper, but will encourage the incumbent to invest in fibre. Conversely, high LLU prices will encourage consumers to switch to NGA-based services but potentially reduce the incentive of the dominant firm to roll out fibre. In the absence of platform competition, this suggests that the optimal solution will be as shown below. Here the market "clears" at point E where the level of fibre roll-out and the demand for fibre-based services are in equilibrium.

34 The fact that fibre and copper may not be perfect substitutes because copper is slower does not mean that they are therefore not substitutes. It just means that they are imperfect substitutes.

35 Note that since the expectation is that fibre will be rolled-out to all those areas where copper-based LLU is viable, there is no issue of high LLU prices, set to ensure optimal fibre investment, harming the take-up of LLU in areas where fibre is not going to be present (e.g. rural areas).

Figure 8: Interior solution for copper LLU pricing



67. As a general matter, this implies that there is considerable scope for disagreement over the exact trade-off in any particular case. Thus, for instance, I note that in their March 2011 report, prepared for ETNO, Plum Consulting argue that "a lower copper price would discourage NGA investment"[36] whilst WIK-Consult, in their April 2011 report for ECTA, argue that "[h]igh levels of copper access charges generate negative incentives for incumbents to invest into fibre because of profit cannibalization."[37]

68. However, these analyses omit three important considerations which suggest that the trade-off described above is illusory in Ireland. First, it is my understanding that eircom has already committed to fibre roll-out in areas where it is commercially viable to do so because it faces competition from higher speed retail broadband products being delivered over UPC's upgraded cable network. In order to compete with this alternative platform on the basis of speed and quality of service, I understand that eircom has concluded that it must invest in fibre in order to remain competitive in the long-term (and in order to enable eircom's wholesale customers to compete with cable products as well). eircom has stated that it aims to pass 100,000 premises with fibre by the summer of 2012 and

36 "Costing methodology and the transition to next generation access", A report for ETNO by Plum Consulting, March 2011, page 2.

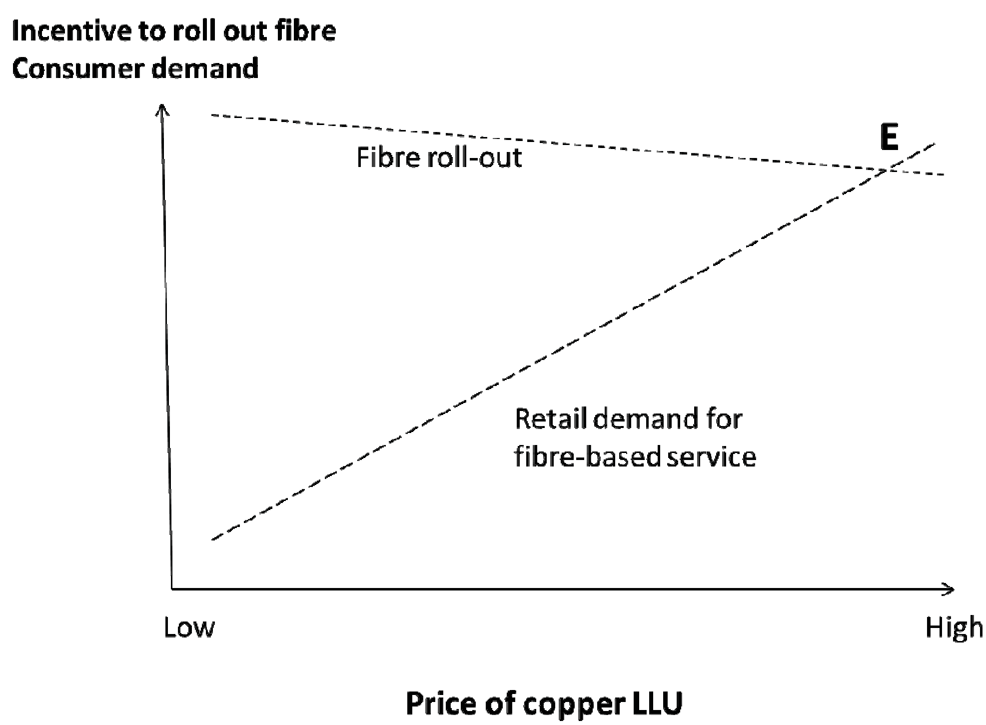
37 "Wholesale pricing, NGA take-up and competition", Study for ECTA by WIK-Consult, 7th April 2011, Executive Summary, paragraph 27.

900,000 homes and 100,000 businesses within four years.[38] It has also stated that generating significant demand for wholesale access to the fibre network is key to the economic case for rolling it out. These facts have two implications.

- Since eircom has already committed to roll-out an NGA network in areas where it is commercially viable for it to do so in order to compete with ultrafast cable broadband, any arguable benefits that might be gained by attempting to motivate eircom to invest in fibre by lowering the price of copper-based LLU would be negligible at best.
- This means that ComReg should put more emphasis on the need to encourage eircom's wholesale customers (and their retail customers, in turn) to switch to NGA-based products, which implies pricing LLU at a similar level to the NGA price.

69. This implies that Figure 8 above becomes Figure 9 below. Here the "fibre roll-out" line is much flatter because eircom is committed to fibre roll out already, so the price of copper LLU has little effect on roll out, except perhaps at the margin (hence the line is slightly downward sloping). This leads to an equilibrium at a higher LLU price.

Figure 9: Optimal LLU pricing when fibre roll-out is fixed



38 See, for instance, slide 2 of "eircom's Plan for the Deployment of Next Generation Access: Presentation to Industry" of 20 September 2011.

70. The second important consideration is that it is generally believed that NGA roll-out and the accompanying uptake of high speed broadband by consumers will have a positive externality for society. The Irish government supports this view. In 2009 the Department of Communications, Energy and Natural Resources (DCENR) issued a report entitled "Next Generation Broadband: Gateway to a Knowledge Ireland". In this document the government argues that the benefits of Next Generation Broadband include positive effects on: economic development, sustainability, social inclusion, education, public services, R&D, and products and services.[39]

71. The European Commission also supports this view. In its "Digital Agenda for Europe" the European Commission argues that fast broadband will have positive benefits for Europe:

> *"We need very fast Internet for the economy to grow strongly and to create jobs and prosperity, and to ensure citizens can access the content and services they want.*
>
> *The future economy will be a network-based knowledge economy with the internet at its centre. Europe needs widely available and competitively-priced fast and ultra fast internet access. The Europe 2020 Strategy has underlined the importance of broadband deployment to promote social inclusion and competitiveness in the EU. It restated the objective to bring basic broadband to all Europeans by 2013 and seeks to ensure that, by 2020, (i) all Europeans have access to much higher internet speeds of above 30 Mbps and (ii) 50% or more of European households subscribe to internet connections above 100 Mbps."*[40]

72. The presence of positive externalities associated with fibre-based services means that there is a positive benefit to encouraging consumers to switch to fibre based services and away from LLU-based services.

73. Third, it is necessary to consider the time consistency of any policy that involves lowering LLU prices. Low LLU prices may damage future incentives to invest in fibre if they are viewed as arbitrary and a form of regulatory expropriation. In particular, if a regulator uses the fact that an investment is sunk to justify a low access price, then future investment may be discouraged, for fear of a similar approach being followed in future. This would likely reduce the speed and scope of any increase in the geographic roll-out of fibre or in future increased FTTH roll-out. Thus whilst static economic efficiency appears to suggest that only forward looking economic costs are relevant to investment incentives, this is not true in a dynamic sense where future investment relies on regulated firms

39 "Next Generation Broadband: Gateway to a Knowledge Ireland", Department of Communications, Energy and Natural Resources, 2009, page 6.

40 "A Digital Agenda for Europe", Communication from the European Commission, 26th August 2010, section 2.4.

having confidence that the regulatory system will not expropriate their sunk cost investments.[41]

74. The implications of these considerations is that long-term efficient investment is more likely to be supported by copper LLU prices being regulated at a level that is at approximately the same level as the NGA price, and without any precipitous reduction based on regulatory intervention. This may involve the sacrifice of some short term static efficiency gains that might be achieved through low LLU prices that cover only forward looking incremental costs. But it will likely lead to greater dynamic efficiency by encouraging fibre roll-out by eircom, wholesale access take-up by competitors and switching to fibre-based retail products by consumers.

4.1. Conclusions on LLU pricing

75. My conclusions in this section are as follows:

- When considering the effect of the LLU price on fibre roll-out, the optimal LLU price (high or low) is ambiguous as there are effects going in opposing directions.
- However, in the case of Ireland, eircom's commitment to a four-year roll-out covering about 60% of homes in response to platform competition means that the optimal policy is likely to be to price copper LLU high in order to encourage consumers to migrate to fibre and thus both take advantage of the positive externalities associated with fibre roll out and avoid any suggestion of ex post regulatory expropriation.

41 I note that Peter Culham of Ofcom made a similar point in his presentation "Pricing Issues in the Transition to NGA" (June 2011).

4 e-net

Next Generation Access Remedies in Wholesale Regulated Markets

Response to ComReg's Consultation Paper 11/40

by

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August 2011

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CONTENTS

1 INTRODUCTION AND SUMMARY

e|net welcomes the opportunity to respond to ComReg's preliminary consultation on the remedies that might apply to Next Generation Access (NGA) wholesale markets.

The timely and efficient development of next generation, high-speed broadband networks and services on a nationwide basis is an urgent imperative for economic recovery in this country. All major stakeholders – Government, ComReg and industry players – must work together to ensure that this important strategic project is undertaken as soon as possible in order to provide the maximum benefit to end-users and the economy as a whole.

Ireland needs to develop, as rapidly as possible, a nationwide optical fibre network, one which has, to the maximum extent possible, fibre deployed at local access level, complemented elsewhere by existing fixed, wireless and mobile broadband infrastructures. We need to do this from a national competitiveness perspective – both to retain existing multinational investment within Ireland and to attract new inward investment – and we need to do so because many of our EU peers have already embarked on such a road.

The recent establishment by the Minister for Communications, Energy and Natural Resources of a National Broadband Task Force (NGBT), bringing together the CEOs of all the main market players in Ireland, is an important first step in ensuring that operators' business plans for NGA deployment are fully aligned with national economic imperatives so that the most efficient and effective rollout of NGA infrastructure can take place and, in doing so, to ensure that advanced broadband services can capable of acting as an engine for economic renewal across the country.

Regulatory policy is clearly key to the successful deployment of NGA services and ComReg is to be commended for undertaking this wide-ranging preliminary consultation on the possible remedies that might be applied to regulated wholesale NGA markets in Ireland. Building on the principles laid down in the European Commission's recent NGA Recommendation, ComReg will – like its peers in other EU Member States – need to break new ground in framing appropriate access obligations for markets and services where the underlying infrastructure has in large part not yet been put in place.

In doing so, ComReg not only needs to ensure that the kinds of competition problems it has had to grapple with in relation to access to current generation infrastructure controlled by the SMP operator do not arise in an NGA environment, it also faces the more fundamental need to ensure that the SMP operator invests in NGA network infrastructure in the first place.

ComReg is not, of course, solely responsible for creating the right environment for the rollout of NGA network infrastructure. As it has pointed out in the Consultation Document, NGA deployment will involve a variety of different stakeholders and potential NGA investors face several risk factors, which means that significant uncertainty remains over how fast and to what degree NGA network deployment will take place.

In attempting to minimise such risks all ComReg can do is deal with the risk factor directly under its control, i.e. regulatory risk, and, as ComReg itself is well aware, the NGA regulatory obligations it imposes need to strike a delicate balance between the competing requirements of investors and access seekers. How ComReg deals with the various issues sketched out in this Consultation Document as it frames its detailed NGA regulatory obligations will be a critical factor in determining the speed at which NGA network infrastructure is rolled out in this country.

e|net is pleased to contribute to this process by providing its response to this initial NGA consultation and we look forward to engaging constructively with ComReg and other stakeholders as this important regulatory process evolves and develops in the months ahead.

2 RESPONSES TO PRELIMINARY CONSULTATION QUESTIONS POSED BY COMREG

Q. 1. Do you consider that the risks identified above are those most closely relevant to investment in NGA? What might be the degree of impact of such risks, how might they change over time and how might they be quantified? Please explain your reasoning.

e|net believes that the risks identified by ComReg in the Consultation Document are all relevant in relation to NGA investment. Demand uncertainty, in particular when coupled with concerns about the current macroeconomic environment within the country, is likely to be the major factor which could put at risk NGA investment plans by operators. The other factors listed by ComReg, while important, are also relevant to any other kind of major infrastructure investment and are risks which can be managed to a greater or lesser degree.

At this point in time, it is difficult to be precise about the likely impact of these risks, except to note that the lack of any real evidence about mass-market consumer demand for NGA-based services and the way in which demand in general within the economy has been so severely curtailed as a result of the economic downturn, means that this risk has got to be viewed as being very significant.

Similarly, it is all but impossible to predict how this risk factor will change over time, given the degree of uncertainty that exists in relation to the macroeconomic environment over the near-to-medium term. Likewise, any attempt to quantify this and the other risks identified by ComReg would inevitably become an exercise in conjecture.

From ComReg's perspective, however, the key risk it needs to focus on is regulatory risk, as this is the only factor directly within its control. By undertaking this NGA consultation at this point in time, ComReg is clearly demonstrating its wish to set out its regulatory policy on NGA in a timely and coherent way. In so doing, ComReg is obviously attempting to ensure that, regardless what other risk factors might be in play, regulatory risk in this area is minimised.

Q. 2. Do you consider that, in the context of the terminology set out in the NGA Recommendation, the above Figures 3 and 4 provide an accurate representation of Eircom's proposed network architecture? Please explain your reasoning.

Q. 3. Do any of Eircom's proposed pilot wholesale products align to the potential access remedies set out in NGA Recommendation? Please explain your reasoning? This question should be addressed in light of the following discussion on WPNIA NGA and WBA NGA.

e|net's understanding is that the Eircom's proposed network architecture enabling wholesale access to NGA-based WPNIA and WBA services are in line with the details provided in the Consultation Document. As ComReg notes, however, the precise nature and design of these products have yet to be finalised by Eircom.

It is not clear at this stage whether or not Eircom's proposed pilot NGA wholesale products align with the potential access remedies as set out in the European Commission's NGA Recommendation.[1] In the Recommendation, it is stated that *"imposition of unbundled access to the fibre loop should be accompanied by appropriate measures assuring co-location and backhaul"* [2], *"access should be given at the most appropriate point in the network"* [3] and that *"NRAs should mandate unbundled access to the fibre loop irrespective of the network architecture and technology implemented by the SMP operator".*[4]

e|net has not, to date, had any visibility of what measures Eircom plans to put in place regarding co-location and backhaul for its proposed wholesale products and we obviously cannot provide any opinion on whether or not Eircom's plans, when announced, will be appropriate.

In addition, e|net is not of the opinion that Eircom's proposed pilot products comply with the Recommendation, to the extent that they do not appear to us to provide access at the most appropriate point of the network. In this regard, we would point to the provisions of the Recommendation quoted above and would remind ComReg that access to the unbundled fibre loop should not be dependent on the network architecture choices made by Eircom and should instead be configured to enable access at the most appropriate point from the point of view of competing operator.

[1] Commission Recommendation of 20 September 2010 on regulated access to Next Generation Access Networks (NGA)(2010/572/EU).
[2] Commission Recommendation, Para.22.
[3] Commission Recommendation, Para.22.
[4] Commission Recommendation, Para.23.

The flexible nature of optical fibre networks means that access to Eircom's fibre network should be enabled wherever this it overlaps with the fibre networks of competing players. As a result, wholesale products in an NGA environment should not be limited to fibre-based equivalents of current generation wholesale products. To put it another way, NGA wholesale products should not be created simply by shifting the principles that apply to Eircom's copper-based local access network to one based on fibre.

Q. 4. Are there any circumstances in which regulated access to civil engineering infrastructure would not be required? Please explain your reasoning.

Q. 5. Having regard to market demand, technical, economic and other considerations, is there a requirement for a duct access remedy? Please explain your reasoning.

Q. 6. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to civil engineering infrastructure?

Q. 7. Should ComReg encourage Eircom to build additional duct capacity for use by third parties and, if so, how? Please explain your reasoning.

As ComReg points out, the Commission's NGA Recommendation clearly states that "access to civil engineering infrastructure is crucial for the deployment of parallel fibre networks".[5] In light of this and bearing in mind the fact that the NGA Recommendation states that national regulators should mandate access to this infrastructure, e|net does not foresee any circumstances in which access to civil engineering infrastructure would not be required.

e|net further believes that not only is there an urgent requirement for a duct access remedy such a requirement extends well beyond the provision of access to civil engineering infrastructure under the control of the SMP operator. Duct sharing should also be mandated in the case of other utility infrastructure, in particular all State-owned assets, a development which we note has already been envisaged by Government and which is being discussed by the Next Generation Broadband Task Force (NGBT).

[5] Consultation Document, Para. 3.10.

e|net is of the view that the factors set out in the NGA Recommendation that national regulators need to take account of when assessing the proportionality of imposing access remedies do not constitute any barrier to the imposition of a comprehensive and workable duct access remedy. The feasibility of such a remedy will obviously be of key importance and ComReg should move rapidly to determine the degree to which duct access is capable of being provided by the SMP operator and, in conjunction with the DCENR, by other infrastructure owners as well.

In relation to the building of additional duct capacity for third parties, e|net is of the view that Eircom should be mandated to put in place such additional capacity, which should be fully mapped and recorded and with details on this capacity made available to other operators in a transparent and non-discriminatory manner.

Q. 8. If a remedy requiring the provision of access to civil engineering infrastructure were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Would a risk premium be warranted? Please provide a reasoned response for each of the principles.

e|net believes that measures to implement each of the principles set out in Annex II of the NGA Recommendation will be necessary to ensure that a duct sharing remedy operates in an effective manner. Many of these measures mirror similar obligations placed on Eircom in relation to the provision of current generation wholesale access and so it makes sense to apply similar obligations on the SMP operator for NGA access, in particular in an area such as duct access as otherwise alternative infrastructure providers could encounter issues in obtaining access in a timely manner.

e|net has no specific comments to make at this point in time on how the principles set out in Annex II of the NGA Recommendation might be best translated into detailed regulatory obligations and we are happy to await proposals from ComReg in this regard.

e|net does not believe that a 'risk premuim' would be appropriate in calculating a cost-based price for duct access, except where the provision of such access gives rise to additional costs to the SMP operator.

Q. 9. What form of price control would be the most appropriate and proportionate means of establishing the price of access to civil engineering infrastructure? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

As ComReg itself makes clear, the *"NGA Recommendation suggests that NRAs have little discretion regarding the pricing methodology to be adopted for pricing access to existing civil engineering infrastructure, namely that a cost oriented approach would apply."* [6] This would appear to deal conclusively with the question as to what form of price control should be applied in relation to the price of access to the SMP operator's civil engineering infrastructure, i.e. that it should be provided on cost-oriented terms.

e|net sees little merit in allowing a period of time for commercial negotiation to take place on the issue of duct access pricing. Eircom would have little incentive to agree a price on a commercial basis and the relative bargaining positions of Eircom and access seekers' would be such that it would be extremely unlikely that such a negotiation process would yield an efficient access price. Moreover, access seekers would have clear incentive to hold out for ComReg intervention, in the hope of achieving a lower price via regulatory intervention than that which Eircom would be willing to offer commercially. In view of this, it would appear to make most sense for ComReg to intervene at the outset and, as it has already done in relation to several current generation wholesale products, to set the access price itself.

[6] Consultation Document, Para. 3.30.

Q. 10. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the terminating segment? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

Q. 11. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the terminating segment?

Q. 12. Where is an appropriate distribution point to which access to the terminating segment should be provided, particularly given the need to ensure that it host a sufficient number of end-user connections to be commercially viable for an access seeker?

Q13. Should ComReg seek to encourage Eircom to deploy multiple-fibre lines in terminating segments and, if so, how? Please explain your reasoning.

e|net believes that there is a clear requirement for a remedy mandating access to the terminating segment of Eircom's FTTH network and we note ComReg's statement that this is a position which is fully supported by the NGA Recommendation.[7] Given the likely existence of other NGA infrastructure and the need to interconnect with Eircom's NGA at points other than its street cabinets or local exchanges, it appears obvious that this kind of access will be required.

ComReg will need to consider each of the factors identified in Article 12 (2) of the Access Directive when considering the proportionality of a remedy in this area. While each of these factors are relevant to some degree, none of them are likely to undermine, on proportionality grounds, the need for a remedy mandating access to the terminating segment of Eircom's FTTH network.

The most appropriate point distribution point to which access to the terminating segment should be provided is where Eircom's NGA network overlaps with that of the alternative provider. As optical networks are far easier to interconnect compared to copper, arrangements for such interconnection should be made bearing this in mind and not by simply replicating arrangements that are already in place in the current, copper-based local access environment.

[7] Consultation Document, Para. 3.39.

Q. 14. If a remedy requiring the provision of access to the terminating segment were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Please provide a reasoned response for each of the principles?

As would be the case for a duct access remedy (see response to Q.8 above), e|net is of the opinion that measures to implement each of the principles set out in Annex II of the NGA Recommendation will be needed to ensure that a remedy requiring the provision of access to the terminating segment operates in an effective manner.

e|net has no specific comments to make at this point in time on how the principles set out in Annex II of the NGA Recommendation might be best translated into detailed regulatory obligations and we are happy to await proposals from ComReg in this regard.

Q. 15. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the terminating segment? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

For the reasons already set out in our response to Q.9 above, e|net does not support the use of commercial negotiations to establish the price of access to the terminating segment of Eircom's FTTH network. We note ComReg's explanation in its Consultation Document that although the NGA Recommendation states cost-oriented pricing should also apply to this type of access, it also states that *"NRAs should account for the additional quantifiable risk associated with NGA investments, and to adjust the access price accordingly"*.[8]

Bearing this in mind and in light of the need to provide appropriate 'build-or-buy' signals to potential alternative NGA infrastructure providers, e|net is of the opinion that a 'retail-minus' price obligation may be the most appropriate one in this particular instance. Such an obligation could also be framed in a way that rewards investment in infrastructure by providing a pricing advantage

[8] Consultation Document, Para. 3.45.

to those operators who access Eircom’s NGA network at a deeper level than those who do not.

Q. 16. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled fibre loop? How might this be achieved in light of Eircom’s proposed or alternative network architectures? Please explain your reasoning.

Q. 17. Are obligations to provide access to associated facilities necessary and, if so, what should these encompass? Please explain your reasoning.

Q. 18. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities?

Q. 19. What do you consider to be an appropriate point in Eircom’s network for the provision of unbundled access to the fibre loop in a FTTH scenario? Please explain your reasoning, including views on associated technical and commercial considerations.

Q. 20. If it is not possible for commercial or technical reasons to provide for unbundled access at this time, what factors might change this over time? What measures should ComReg take on a transitional basis to provide for the nearest equivalent alternative constituting a substitute to physical unbundling and what other safeguards might be necessary?

In line with the NGA Recommendation, e|net believes that there is clear requirement for a remedy mandating access to the unbundled fibre loop.

e|net has no specific comments at this time on how Eircom might provide such access and we are happy to await proposals from ComReg in this regard.

It is obviously the case that, in line with current generation LLU access, if a remedy to provide access to the unbundled fibre loop is to be effective, it must also be accompanied by flanking measures ensuring access to associated facilities such as backhaul and co-location.

ComReg will need to consider each of the factors identified in Article 12 (2) of the Access Directive when considering the proportionality of a remedy mandating access to the unbundled fibre loop. In e|net's view, none of these factors are likely to undermine, on proportionality grounds, the need for such a remedy.

As regards the most appropriate point within Eircom's network for the provision of unbundled access to the fibre loop in a FTTH scenario, e|net takes the view that the SMP operator should be obliged to provide access to the fibre loop at the Metroplitan Point of Presence (MPoP) or, if requested to do so, at any technically feasible point on Eircom's NGA network between the MPoP and the fibre terminating point.

e|net do not consider that there are any good reasons as to why Eircom should not be able to provide access to the unbundled fibre loop and associated facilities.

Q. 21. Is a remedy requiring the development and publication of a reference offer for the provision of access to the unbundled fibre loop and associated facilities necessary and what specific issues should be detailed within it? Please explain your reasoning.

Q. 22. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

Q. 23. What specific non-discrimination remedies are required with respect to the provision of access to the unbundled fibre loop and associated facilities? Please explain your reasoning.

e|net believes that it will be essential for Eircom to develop and publish a reference offer for the provision of access to the unbundled fibre loop and associated facilities. The detail of such a reference offer as well as arrangements for its development and publication (including how it should be updated) are a matter for Eircom, subject to ComReg approval, to deal with. Similarly, the development of specific non-discrimination remedies required to ensure the provision of access to the unbundled fibre loop and associated facilities is a matter for ComReg. e|net does not have any specific comments to make on these issues at this time.

Q. 24. What form of price control would be the most appropriate and proportionate means of establishing the price of unbundled access to the fibre loop? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

Q. 25. Should any cost oriented price for FTTH based services attract a risk premium in principle? If so, to what types of network assets/investments should any premium apply and why?

In developing a price control obligation on the SMP operator, ComReg needs to take account of the very clear difference between setting a regulated price for access to the fibre loop compared to doing so in relation to the unbundled copper local loop. In the latter case, Eircom's network was already built so ComReg's main challenge in setting a regulated price was to ensure that the SMP operator was adequately remunerated for the cost of providing access, while guarding against excessive recovery of costs.

In setting a price for the provision of access to the fibre loop, however, ComReg also needs to provide the SMP operator with sufficient incentive to deploy NGA infrastructure in the first place. Regulatory policy therefore needs to be supportive of NGA network deployment and NGA wholesale pricing should not act as a barrier to such deployment. Instead, the regulated price for wholesale access to the fibre loop should be one that offers a return to entities who plan to deploy NGA infrastructure. In this respect, it would be appropriate for the regulated price for unbundled access to the fibre loop to attract a risk premium. Such a premium should only apply in relation to wholesale products involving new-build fibre deployment.

Q. 26. What types of co-investment arrangements might warrant a separate regulatory treatment in terms of remedies? Please address in your answer the types of commercial relationships and the type of control over physical infrastructure by multiple operators that you think would be necessary for ComReg to consider this option. If possible, please state if you think such an outcome is feasible or desirable.

Q. 27. Do you have any views as to how ComReg should view the evolution of the market for NGA services particularly in the presence of a rival cable network and its impact in supporting effective competition in downstream markets? How should remedies and regulation generally evolve over time and what criteria should ComReg apply to such decisions?

ComReg itself states in the Consultation Document that *"there do not appear to be strong signals in the Irish market at present that NGA co-investment opportunities may arise"*.[9] It further states *"that any multiple fibre deployment that significantly alters the competitive landscape within a given geographic area would trigger a review of the relevant markets"*.[10]

In light of ComReg's statements above, there does not appear to be any point at this juncture in discussing possible separate regulatory treatment in terms of remedies where co-investment takes place. As ComReg points out, there is no evidence of any appetite for such co-investment and if it occurs and, in so doing, alters the competitive landscape, a fresh market review would then be triggered. It would be at this point that ComReg's Q.26 above should be considered detail.

In the same way, the potential competitive impact of other NGA networks (be they cable or LTE mobile) need not be considered now and should instead be analysed in the context of a market review, if and when such rival networks are rolled out to the extent that they provide effective competition in the downstream retail market.

[9] Consultation Document, Para. 3.64.
[10] Consultation Document, Para. 3.67.

Q. 28. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in a FTTN scenario? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

Q. 29. What type of backhaul solutions do you consider are appropriate in an FTTN scenario?

Q. 30. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities.

e|net believes there is a requirement, as per the NGA Recommendation, for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in an FTTN scenario. Without such a remedy, Eircom's retail business would have an advantage in terms of the types of NGA services it could provide that competitors relying on wholesale inputs would not be able to match.

All potential backhaul solutions listed in the NGA Recommendation, i.e. dark fibre (including, where necessary, copper), Ethernet backhaul or duct access, should be considered in an FTTN scenario.

ComReg will need to consider each of the factors identified in Article 12 (2) of the Access Directive when considering the proportionality of a remedy mandating access to the unbundled copper sub-loop and associated facilities in an FTTN scenario. In e|net's view, none of these factors are likely to undermine, on proportionality grounds, the need for such a remedy.

Q. 31. Is a remedy requiring the development and publication of a reference offer for the provision of access to the copper-sub loop necessary and what specific areas should be detailed within it? Please explain your reasoning.

Q. 32. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

Q. 33. What specific non-discrimination remedies are required with respect to the provision of access to the copper sub-loop, including those associated with co-location? Please explain your reasoning.

Please refer to the responses already provided to Q.21 – 23 above which are equally relevant in relation to access to the copper sub-loop in an FTTN context.

Q. 34. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the copper sub-loop? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing commercial negotiation. Please explain your reasoning.

Q. 35. Should fibre or Ethernet backhaul associated with the provision of access to the copper sub-loop attract a risk premium? How might a risk profile associated with specific costs relating to such access to be determined in light of the principles set out in Annex I of the NGA Recommendation, and how should any difference in risk be reflected in a pricing methodology? Please explain your reasoning

In setting an appropriate regulated wholesale price for access to Eircom's copper sub-loop, ComReg should follow the same methodology it has already used to set the price for local loop unbundling. The price of sub-loop access should therefore be a cost-based one, using the LRIC standard.

In relation to backhaul associated with the provision of access to the copper sub-loop (either via fibre or Ethernet), ComReg's approach needs to be one that ensures such connectivity is deployed. As such, the regulated pricing for this service needs to be framed in the same way that pricing to the fibre loop (see responses already provided to Q.24 – 25) must be established, i.e. it should be one that offers a return to entities who plan to deploy NGA infrastructure and so should attract a risk premium.

Q. 36. What circumstances (i.e. degree of availability of effective access to the unbundled loop), would warrant the lifting or variation of WBA access obligations within a given geographic area? Please explain your reasoning.

Q. 37. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to WBA products and associated facilities (including backhaul) in a FTTH and FTTC scenario? Please explain your reasoning.

Q. 38. In a FTTH or FTTC environment, what technical or enhanced service characteristics might need to be reflected in WBA access products? Please explain your reasoning including views on the extent, if any, to which product differentiation is a necessary characteristic of WBA access products.

Q. 39. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to WBA products and associated facilities?

Q. 40. How should the issue of technical protocols and interfaces serving the interconnection of optical networks be approached? Please explain your reasoning.

Given the current situation with regard to network rollout and the fact that NGA rollout has, at yet, to commence to any significant degree, e|net does not believe there is any need for ComReg to be considering the circumstances that might justify the lifting of WBA access obligations in specific parts of the country. If ComReg wishes to do so, it would first need to assess competitive conditions within the market as part of a WBA market review and it would be at this point that this issue could be considered in detail.

e|net takes the view that there is a requirement for a remedy mandating access to WBA products and associated facilities (including backhaul) in an FTTH and FTTC scenario. Operators who avail of current generation WBA services are likely to want to migrate to NGA equivalent services in order to maintain their provision of downstream retail services to end-customers and, given that current generation WBA services are only available as a regulated product, NGA variants will, at least at the outset, need to be accessible in the same way.

e|net has no specific comments to make at this point in time on the technical or enhanced service characteristics that might need to be reflected in WBA access products in an FTTx environment.

ComReg will need to consider each of the factors identified in Article 12 (2) of the Access Directive when considering the proportionality of a remedy mandating access to WBA products and associated facilities (including backhaul) in an FTTH and FTTC scenario. In e|net's view, none of these factors are likely to undermine, on proportionality grounds, the need for such a remedy.

The issue of technical protocols and interfaces serving the interconnection of optical networks is obviously one that would need to be considered in detail. In principle, e|net takes the view that Eircom should be obliged to support whatever standardised protocols and interfaces that their interconnection customers require.

Q. 41. Do you think that a requirement for the SMP operator to notify purchasers of WBA 6 months in advance of its launch of a retail products based on NGA inputs is necessary or adequate and, if so, how might it operate in practice? Please explain your reasoning.

Q. 42. What effective access, transparency or other safeguards are necessary to guarantee non-discrimination and how might such safeguards impact the need for of level of advance notification discussed above? Please explain your reasoning.

Q. 43. What specific non-discrimination remedies are required with respect to the provision of wholesale broadband access? Please explain your reasoning.

Q. 44. Is a remedy requiring the publication of reference offers for specific NG WBA products necessary and if so, what should be contained within such a reference offer? Please provide reasons for your answer.

Q. 45. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

e|net supports the proposal set out in the NGA Recommendation that the SMP operator should notify purchasers of WBA 6 months in advance of its launch of a retail products based on NGA inputs. e|net believes that the way in which such an obligation might work in practice is a matter, in the first instance, for ComReg itself to consider.

Please refer to the responses already provided to Q.21 – 23 above which are equally relevant in relation to non-discrimination and other regulatory measures that should be put in place in respect of Eircom's provision of NG WBA products.

Q. 46. What form of price control would be the most appropriate and proportionate means of establishing the price of WBA access? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

As is the case with current technology wholesale products, ComReg needs to ensure that the pricing of wholesale NGA products is supportive of infrastructure investment and, in particular, that provides the correct incentives for the deployment of NGA infrastructure. Bearing this in mind, it is vital that next generation WBA products are not priced in such a way that they disincentivise operators from climbing the ladder of investment or that WBA pricing acts as a barrier to investment in competing NGA infrastructure. As a result, pricing based on retail-minus principles would appear to be the most appropriate method to use. In addition, given the potential mix of current and next generation technologies that could be used to provide some WBA products, retail-minus pricing would also be far less complex to implement than pricing based on an appropriate cost model would be.

Q. 47. If an effective internal separation of Eircom were to be implemented how should this impact on ComReg's regulatory approach?

e|net does not understand the purpose of this question in the context of this consultation. As far as e|net is aware, there is no proposal for any "effective internal separation of Eircom" to be put in place and, even if such a move were to happen, it would obviously be a topic to be considered in the context of Eircom's current technology choices and organisational arrangements as well as how it might be structured to provide NGA services.

Q. 48. Do you believe that the costing methodology options for determining NGA charges as outlined above are relevant and appropriate? Please provide reasons for your response. Which is the most appropriate methodology and why?

Q. 49. Should ComReg distinguish between new investment (such as NGA specific equipment) and legacy assets (such as trench) which are used in the provision of NGA services? Please explain your reasoning.

Q. 50. What pricing issues might arise where the SMP operator is providing services over both copper and NGA networks concurrently? For example, duplicating infrastructure in the same geographic area for a temporary period or in different geographic areas. Please explain your reasoning.

In e|net's opinion, the costing methodology options outlined by ComReg are relevant and appropriate, given that they are the same ones that apply in determining the prices of other regulated wholesale products and services. It will be for ComReg to decide which is the most appropriate methodology to apply for NGA services and, in doing so, it will important that ComReg ensures the regulated access price is set at a level that encourages investment in NGA infrastructure, while at the same time ensuring that access seekers face fair prices for wholesale NGA services.

ComReg should distinguish between legacy assets and those which require new investment, given the very different risk profiles that apply to them. In addition, the pricing of access to legacy assets by the SMP operator can (unless such practices are prevented via regulatory intervention) be used to perpetuate market power whereas NGA wholesale pricing needs to ensure that investment in NGA infrastructure is encouraged.

The specific pricing issues which ComReg references in Q.50 are ones that it will need to grapple with itself, in particular with regard to how its defines relevant product markets (i.e. where the products in question involve the provision of services over both copper and NGA networks) and what wholesale pricing rules it sets for the SMP operator in such markets.

Q. 51. Do you agree with the application of a risk premium as envisaged in the NGA Recommendation? As part of your response please address, insofar as possible, your views on the nature of any such premium, whether and how it could be measured and what its relationship to Eircom's existing (or a potential split) WACC should be.

Q. 52. Do you agree with the NGA Recommendation that any risk premium should only be applied to NGA/fibre specific assets and not to legacy copper based assets (for example, FTTH versus FTTN)?

Q. 53. Do you believe that the WACC ComReg Decision from 2008 remains appropriate and applicable for NGA investment and allows for sufficient return on investments made and to be made in the future? Please provide reasons for your response.

Q. 54. Do you have any other observations or proposals in relation to NGA investment risk and whether there are mechanisms other that the WACC to account for risk in NGA wholesale pricing?

e|net agrees with the principle that a risk premium as envisaged in the NGA Recommendation should be applied when calculating appropriate NGA wholesale access prices. e|net does not, at this time, have further comments to make on the nature of any such premium or how it might be measured as these are issues that must, in the first instance, be considered by ComReg.

e|net agrees with the NGA Recommendation that any risk premium should only be applied to NGA/fibre specific assets and not to legacy copper based assets but that ComReg will need to be careful about how this principle is applied in practice and, in particular, what it means for wholesale pricing given the potential mix of underlying technologies (both copper- and NGA-based) that may be utilised.

e|net supports the principles underlying ComReg's 2008 WACC Decision but it does need to be borne in mind that the economic landscape (not least in the equity and debt markets) have changed enormously since this Decision was published and so ComReg would be well advised to revisit its own findings from 2008 to see if they remain appropriate today.

In terms of other factors that need to be accounted for in relation to investment risk, e|net believes that while providing the SMP with sufficient encouragement, via wholesale pricing signals, to invest in NGA is very important, such encouragement must not be at the expense of enabling effective NGA wholesale access to take place. In this sense, the aim should be to ensure that the SMP operator gets an adequate margin from the provision of wholesale access and not by the setting of a wholesale price that is no unattractive to access seekers as to prevent any kind of wholesale access taking place.

Q. 55. Do you agree that the factors above identified are the most relevant mitigators of risk? Should such factors be taken into account when determining wholesale pricing arrangements and, if so how? Are any safeguards necessary?

Q. 56. In the context of upfront purchase commitments and volume discounts, are any safeguards necessary to ensure efficient investment and the development of effective competition? Please explain your reasoning.

e|net agrees that the risk factors listed by ComReg are relevant and that they should, in principle, be given consideration when determining wholesale pricing arrangements. How this happens in practice is a matter that needs to be considered by ComReg itself.

While upfront purchase commitments and volume discounts may help to mitigate investment risk and so increase the incentive for SMP operators and others to invest in NGA networks, it needs to be borne in mind that, by their nature, such arrangements would tend to favour larger players at the expense of smaller ones. As such, ComReg needs to bear in mind that the ‘ladder of investment’ is there for all operators and not just for the larger ones and so any improvement to investment incentives that flow from factoring in purchase commitments and discounts need to be set against the possible dampening of effective competition, especially from smaller and potentially more innovative market players, that might as a result take place.

Q. 57. Do you believe that all the relevant and appropriate options were considered above regarding the main principles for a margin squeeze test? Please provide reasons for your response.

Q. 58. Are ex-ante price controls or measures required in order to prevent margin squeeze? If so, what is the appropriate methodology to address margin squeeze and what factors should be considered by ComReg when specifying an imputation test (if this approach is deemed to be necessary)? Please explain your reasoning.

e|net agrees that ComReg has considered all the relevant and appropriate options in relation to the principles that need to be applied in framing a margin squeeze test for wholesale and retail NGA pricing by Eircom.

In monitoring possible anti-competitive pricing by Eircom, ComReg will need to guard against both excessive and predatory pricing practices and so the approach it decides to adopt needs to be one that takes account of both. In this regard, e|net believes that it is particularly important for ComReg to be able to apply the test on a product-by-product basis as not doing so would give Eircom far too much latitude to price on an anti-competitive basis for particular NGA products, depending on the competitive position that pertains in each segment of the market.

Q. 59. Should Eircom be required to maintain existing copper network infrastructure in parallel with NGA network upgrades? If so, then for what period of time? Under what circumstances could a shorter period of parallel operation be appropriate?

Q. 60. What forms of fully equivalent access at the points of interconnection (such as exchanges), might justify an advance notice period for decommissioning of less than 5 years? Please explain your reasoning.

Q. 61. In an NGA setting, what are the most appropriate migration paths that need to be put in place and what are the main technical, operational or commercial issues that would need to be addressed? Please explain your reasoning.

Q. 62. Are commercial arrangements likely to lead to the most effective outcome in ensuring that an efficient and transparent migration process takes place? Please explain your reasoning.

Q. 63. How should ComReg ensure that the systems and procedures put in place by Eircom, including operating support systems, are designed so as to facilitate the switching of alternative providers to NGA-based access products? Please explain your reasoning.

Q. 64. What would be an appropriate and proportionate regulatory approach for ensuring that information around Eircom's network and its extension plans are made available to WPNIA and WBA access seekers? Please consider issues regarding commercial sensitivity and network integrity when explaining your reasoning.

Q. 65. What should be the format and level of detail to be contained in the network information above and how can the strict confidentiality of such information be maintained? Please explain your reasoning.

e|net is of the opinion that Eircom should be obliged to maintain its existing copper infrastructure alongside its upgraded NGA network for a significant period of time. Given that the payback period for investment in communications infrastructure is of the order of 7-10 years, a requirement on Eircom to maintain its existing local access network for up to 10 years would appear to be appropriate.

Such a requirement would be consistent with the ladder of investment principle, in that operators who have responded to the investment signals in relation to current technologies which depend, in part, on the use of Eircom's local access network should be given sufficient time to make a return on this investment before Eircom's copper infrastructure is decommissioned. e|net does not believe that any forms of fully equivalent access at the points of interconnection would justify an advance notice period for decommissioning of less than 5 years.

As regards migration paths from existing to NGA infrastructure, it makes most sense for these to be product-based and demand-driven. Standardised migration procedures agreed by Eircom and OAOs at industry level, augmented where necessary by specific bilateral arrangements, would appear to be the best way to deal with the main technical, operational or commercial issues that would need to be addressed. e|net agrees that commercial arrangements likely to lead to the most effective outcome in ensuring that an efficient and transparent migration process takes place.

In terms of ensuring that the systems and procedures put in place by Eircom are designed so as to facilitate the switching of alternative providers to NGA-based access products, ComReg will need to monitor closely all arrangements for customer acquisition and transfer, within and across products.

As regards information sharing, e|net is of the opinion that Eircom should provide fully detailed mapping information to other operators showing clearly what its network layout is. This information should be updated quarterly, with current and planned network details and access to this information should be available on-line, via a log-in facility. In this respect, confidentiality concern on the part of the SMP operator should not be used as an excuse to provide less than full information, as confidentiality is a contractual issue, not a technical/IT one.

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Magnet Networks welcomes this consultation however, its length and breath of questions was overwhelming.

Q. 1. Do you consider that the risks identified above are those most closely relevant to investment in NGA? What might be the degree of impact of such risks, how might they change over time and how might they be quantified? Please explain your reasoning.

Overall, Magnet Networks believe the risks outlined are those that would need to be considered when investing in NGA. However, Magnet Networks feel that only an incumbent would invest all the way to existing customers' home rather than in new builds, which may be more competitive. An alternative operator might only go to a certain point such as the street cabinet or exchange or new builds. Duct access including ducts that go into a persons' house would be an imperative to encourage an alternative investor to the incumbent. It is very expensive to dig up streets and retrofit houses with fibre.

Q. 2. Do you consider that, in the context of the terminology set out in the NGA Recommendation, the above Figures 3 and 4 provide an accurate representation of Eircom's proposed network architecture? Please explain your reasoning.

Overall, Magnet Networks consider that Figures 3 & 4 outlined in this consultation are a fair representation of eircoms' proposed network infrastructure. However, in FTTC it is envisaged that the OAO will utilise space within eircoms' existing cabinet, that eircom will not build a new cabinet, where possible.

Q. 3. Do any of Eircom's proposed pilot wholesale products align to the potential access remedies set out in NGA Recommendation? Please explain your reasoning? This question should be addressed in light of the following discussion on WPNIA NGA and WBA NGA.

Magnet Networks believe that not all the products proposed align with the NGA recommendations. The main reason for the products not being aligned is due to the fact that it is a trial and participants are viewing it as such. Eircom are providing products that satisfy the participants criteria to gain access to the trial in the short term, however, these may not be the products that will end up being regulated. For eircom the FTTH trial is a learning curve and product offerings must be fluid and allow quick amendments and changes without regulatory constraints.

However, in light of regulation, for WPNIA the product offering does not include an unbundled product. WBA access would more than likely be satisfied by the current FTTH proposed product offerings from eircom.

Q. 4. Are there any circumstances in which regulated access to civil engineering infrastructure would not be required? Please explain your reasoning.

Magnet Networks feels it is necessary to have regulated access to this infrastructure. If we had such access in a more easily accessible way then may be an incentive to invest further into our own network rollout, utilising the civil engineering infrastructure.

Q. 5. Having regard to market demand, technical, economic and other considerations, is there a requirement for a duct access remedy? Please explain your reasoning.

Confidential answer provided.

Q. 6. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to civil engineering infrastructure?

Based on the factors identified at paragraph 1.25, Magnet Networks feel that the need to safeguard competition is paramount. By not opening up infrastructure there is no competition. The rest of the factors pale in light of this. The next major factor to be considered in the technical and economic viability of installing such competing infrastructure. However, Magnet Networks believes that this is a risk that is borne by the company making the commercial decision to invest.

Q. 7. Should ComReg encourage Eircom to build additional duct capacity for use by third parties and, if so, how? Please explain your reasoning.

Magnet Networks believe eircom should be obliged to build such duct capacity for use by third parties. To make eircom do this they must first be functionally separated. When this is done, there will be more emphasis on the wholesale entity to encourage use of their facilities and ducts. Thus, if they were to build ducts and charge a reasonable commercial rate for renting the dark fibre or placing fibre in the duct then this new wholesale company would be incentivised to build the access.

Q. 8. If a remedy requiring the provision of access to civil engineering infrastructure were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Would a risk premium be warranted? Please provide a reasoned response for each of the principles.

Magnet Networks believe the measures outlined in Annex II are necessary. They may be stated as stated in the Annex. Their implementation is more difficult. Again, referencing my answer in Question 7, functional separation would be a good way to initiate the implementation of the principles set out in Annex II. It must be said that it would seem that ComReg has consulted on all or the majority of these points such as current KPI consultation. However, the implementation of the recommendations in these consultations is yet to be seen.

Magnet Networks do not believe that a risk premium is warranted. All eircom is effectively doing is upgrading redundant or old equipment like a business buying new photocopiers or an individual buying a new car. There is always the question where is the value, but that is just a risk that does not need to be rewarded. Also, if one company is getting a benefit for investing it creates an uneven playing field for competitors who wish to invest.

Q. 9. What form of price control would be the most appropriate and proportionate means of establishing the price of access to civil engineering infrastructure? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

Prior to regulatory intervention commercial negotiation should be allowed. This would allow interested parties to potential negotiate a better deal or even some revenue share before a regulated price is set. Though, to ensure commercial negotiations were to work and to in some way indicate to the incumbent this would be a better option than regulated pricing the regulator would need to have indicated the pricing they propose to charge and the conditions of this price.

Q. 10. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the terminating segment? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

Magnet Networks believe there is a requirement to mandate access to the terminating segment. This will be done via the duct access and civil infrastructure.

Q. 11. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the terminating segment?

Based on the factors identified at paragraph 1.25, Magnet Networks feel that the need to safeguard competition is paramount. By not opening up the terminating segment there is a restriction on competition. The rest of the factors pale in light of this. The next major factor to be considered in the technical and economic viability of installing such competing unit. However, Magnet Networks believes that this is a risk that is borne by the company making the commercial decision to invest.

Q. 12. Where is an appropriate distribution point to which access to the terminating segment should be provided, particularly given the need to ensure that it host a sufficient number of end-user connections to be commercially viable for an access seeker.

Based on current unbundling of local loop it would seem the most logical access point is the metropolitan point of presence at the eircom exchange. However, that is not to say that at some point in the future the OAO would not wish to get to the eircom cabinet to get closer to the end user. This would more than likely be based on sufficient number of end user connections.

Q. 13. Should ComReg seek to encourage Eircom to deploy multiple-fibre lines in terminating segments and, if so, how? Please explain your reasoning.

Currently, it is proposed by eircom to place a single fibre to the end user. From Magnet Networks experience a fibre pair rather than a single fibre would be more efficient as a fail over mechanism. Also a true way of future proofing a property is by having a fibre pair. As network providers we are unable to forecast the volume of bandwidth a user will require in time. ComReg may encourage eircom to deploy multi fibre lines into the end users premises via planning legislation.

Q. 14. If a remedy requiring the provision of access to the terminating segment were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Please provide a reasoned response for each of the principles?

Magnet Networks believe the measures outlined in Annex II are necessary. They may be stated as stated in the Annex. Their implementation is more difficult. Again, referencing my answer in Question 7, functional separation would be a good way to initiate the implementation of the principles set out in Annex II. It must be said that it would seem that ComReg has consulted on all or the majority of these points such as current KPI consultation. However, the implementation of the recommendations in these consultations is yet to be seen.

Magnet Networks doe not believe that a risk premium is warranted it. All eircom is effectively doing is upgrading redundant or old equipment like a business buying new photocopiers or an individual buying a new car. There is always the question where is the value, but that is just a risk that does not need to be rewarded. Also, if one company is getting a benefit for investing it creates an uneven playing field for competitors who wish to invest.

Q. 15. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the terminating segment? e.g. cost model (cost plus or *retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.*

Magnet Networks feel that initially commercially negotiations should be endeavoured. However, it would be necessary for ComReg to have indicated that they were going to regulate on a cost-oriented basis. This would allow eircom flexibility to decide what pricing they were willing to offer i.e. below their costs or otherwise. If eircom were functionally separated it would allow the wholesale/access section to take more independent decisions without having to consider the impact on their retail side. This would hopefully, lead to a more competitive as well as better priced wholesale/access market.

Q. 16. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled fibre loop? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

It would be appropriate to commence the consultation and the technical design for the unbundling of fibre. Magnet Networks envisages the unbundling of fibre works in the same way as the local loop is unbundled. There is jumpering of a terminated fibre segment in a fibre exchange. Eircom's network architecture does not inhibit the unbundling of the fibre.

Q. 17. Are obligations to provide access to associated facilities necessary and, if so, what should these encompass? Please explain your reasoning.

The associated facilities would be similar to those already required for LLU. However, the technical person may require retraining in fibre splicing or fibre maintenance to ensure that the technician handles the fibre correctly.

Q. 18. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities?

Based on the factors identified at paragraph 1.25, Magnet Networks feel that the need to safeguard competition is paramount. By not opening up unbundled facilities there is no competition. The rest of the factors pale in light of this. The next major factor to be considered in the technical and economic viability of opening up such access. However, Magnet Networks believes that this is a risk that is born by the company making the commercial decision to invest.

Q. 19. What do you consider to be an appropriate point in Eircom's network for the provision of unbundled access to the fibre loop in a FTTH scenario? Please explain your reasoning, including views on associated technical and commercial considerations.

As with LLU Magnet Networks feel that the current appropriate point is at the point of presence which is namely the eircom exchange. However, with scalability and demand the competitor may choose to move closer to the end user and unbundle the fibre at the cabinet level.

Q. 20. If it is not possible for commercial or technical reasons to provide for unbundled access at this time, what factors might change this over time? What measures should ComReg take on a transitional basis to provide for the nearest equivalent alternative constituting a substitute to physical unbundling and what other safeguards might be necessary?

Magnet Networks believe that there should be no factors that inhibit the unbundling of fibre.

Q. 21. Is a remedy requiring the development and publication of a reference offer for the provision of access to the unbundled fibre loop and associated facilities necessary and what specific issues should be detailed within it? Please explain your reasoning.

It is imperative that a reference offer for the provision of access to unbundled fibre is published. The offer should not only include price and all the relevant legal provisions around payment terms, liability etc, but it should also include such details as:-

1. Stringent and detailed process manuals
2. Stringent and detailed service levels agreement.
3. A price list that is competitive and cost orientated.

Q. 22. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

The current model utilised by Industry in relation to the current access reference offer can be extended and utilised by those seeking access to the fibre network.

Q. 23. What specific non-discrimination remedies are required with respect to the provision of access to the unbundled fibre loop and associated facilities? Please explain your reasoning.

Overall, Magnet Networks believe that unbundling fibre is similar to unbundling copper so all the requirements would be similar.

Q. 24. What form of price control would be the most appropriate and proportionate means of establishing the price of unbundled access to the fibre loop? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning

As previously stated starting off with commercial negotiations from a functionally separated wholesale access entity may provide a better competitive price. However, a time line has to be put in place for these negotiations so that if they are unsuccessful a regulated cost orientated price may be imposed.

Q. 25. Should any cost oriented price for FTTH based services attract a risk premium in principle? If so, to what types of network assets/investments should any premium apply and why?

As previously stated, FTTH should not attract a risk premium as it is essentially upgrading from one delivery mechanism to another. Eircom will be utilising the same duct paths and NTU as well as the same cabinets. By upgrading eircom will increase their attractiveness to customers and thus, become more competitive.

Q. 26. What types of co-investment arrangements might warrant a separate regulatory treatment in terms of remedies. Please address in your answer the types of commercial relationships and the type of control over physical infrastructure by multiple operators that you think would be necessary for ComReg to consider this option. If possible, please state if you think such an outcome is feasible or desirable.

Magnet Networks can't see any co-investment opportunities taking place. If there was a co-investment it would only be along national routes via MANs provided by E-Net. This co-investment would then be sold on an access or dark fibre basis and the final tail to the customer's premises would have to be built by the retailer or alternatively, accessed via an eircom duct or a line purchased or leased from eircom.

Q. 27. Do you have any views as to how ComReg should view the evolution of the market for NGA services particularly in the presence of a rival cable network and its impact in supporting effective competition in downstream markets? How should remedies and regulation generally evolve over time and what criteria should ComReg apply to such decisions?

It is necessary for ComReg to consistently review the market on a regular basis to monitor if the cable network has SMP. It may be necessary to start looking at bundled offerings. ComReg should apply all remedies and utilise the criteria within its remit.

Q. 28. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in a FTTN scenario? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

Magnet Networks believe that in time SLU will be required and it would be advantageous that if all the documentation are ready. However, the application of the copper SLU is applicable to the FTTC.

Q. 29. What type of backhaul solutions do you consider are appropriate in an FTTN scenario?

There is only one solution fibre via duct access.

Q. 30. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities.

Based on the factors identified at paragraph 1.25, Magnet Networks feel that the need to safeguard competition is paramount. By not opening up the fibre loop and associated facilities there is no competition. The rest of the factors pale in light of this. The next major factor to be considered in the technical and economic viability of installing such competing infrastructure. However, Magnet Networks believes that this is a risk that is born by the company making the commercial decision to invest.

Q. 31. Is a remedy requiring the development and publication of a reference offer for the provision of access to the copper-sub loop necessary and what specific areas should be detailed within it? Please explain your reasoning.

Magnet Networks believe it is. SLU will be limited to the area in which exchanges have been unbundled or have licences outstanding for that exchange to be unbundled. Why it is limited to these exchanges is because OAO's will have unbundled these exchanges and will have assessed that SLU is a viable commercial investment.

Q. 32. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

As per question 22 the current system of publication and updating is seemingly sufficient.

Q. 33. What specific non-discrimination remedies are required with respect to the provision of access to the copper sub-loop, including those associated with co-location? Please explain your reasoning.

Magnet Networks believe the area around the cabinet, cabinet space, jumpering and tie cables is the most contentious. An OAO should not be charged if eircom do not have sufficient space in their cabinets to allow unbundling of that cabinet. Eircom retail do not face the cost of having to build another cabinet next to an existing cabinet and all associated facilities.

Q. 34. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the copper sub-loop? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing commercial negotiation. Please explain your reasoning.

Magnet Networks favours starting with a commercial negotiation with a back stop for such negotiation at which time a regulated cost orientated price is imposed. Again, Magnet Networks reiterate the commercial benefit of having a functionally separated incumbent.

Q. 35. Should fibre or Ethernet backhaul associated with the provision of access to the copper sub-loop attract a risk premium? How might a risk profile associated with specific costs relating to such access to be determined in light of the principles set out in Annex I of the NGA Recommendation, and how NGA should any difference in risk be reflected in a pricing methodology? Please explain your reasoning.

Magnet Networks feel that no risk premium should be applied. Eircom are not first movers in the fibre to the home space their advantage is ubiquity and an already existing duct infrastructure. Other companies have taken the risk of doing FTTH and did not have a risk premium, they bore the risk of investment. It must be noted that FTTH services can not be charged at prices greater than copper pricing so such FTTH first providers do not enjoy higher retail pricing resulting from their investment.

Q. 36. What circumstances (i.e. degree of availability of effective access to the unbundled loop), would warrant the lifting or variation of WBA access obligations within a given geographic area? Please explain your reasoning.

Currently, Magnet Networks are unable to see an a circumstance for lifting the WBA obligation. However, the situation would only arise when each exchange has reached a saturation point for backhaul carriers i.e. an OAO wishing to unbundle have a choice of suppliers to use from that exchange. Currently, an OAO must build their own OAO backhaul to this exchange. Also, an OAO cannot cross connect in an exchange to another OAO's equipment which would allow a sharing of backhaul.

Q. 37. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to WBA products and associated facilities (including backhaul) in a FTTH and FTTC scenario? Please explain your reasoning.

With the aim of fostering innovation in consumer services and competition in pricing it is beneficial for there to be a mandated access to WBA. This would also ensure that the incumbent doesn't engage in predatory pricing of unregulated services over those currently within the regulated marketplace i.e. bundling.

Q. 38. In a FTTH or FTTC environment, what technical or enhanced service characteristics might need to be reflected in WBA access products? Please explain your reasoning including views on the extent, if any, to which product differentiation is a necessary characteristic of WBA access products.

Based on eircoms trial there does not seem to be a need for an FTTH/C access product currently. This access product is being provided by eircom for the purpose of the trial.

Q. 39. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to WBA products and associated facilities?

Based on the factors identified at paragraph 1.25, Magnet Networks feel that the need to safeguard competition is paramount. By not opening up infrastructure there is no competition. The rest of the factors pale in light of this. The next major factor to be considered in the technical and economic viability of installing such competing infrastructure. However, Magnet Networks believes that this is a risk that is born by the company making the commercial decision to invest.

Q. 40. How should the issue of technical protocols and interfaces serving the interconnection of optical networks be approached? Please explain your reasoning.

All technical protocols should adhere to industry standards as published by the ITU-T and are available from multiple vendors. For the benefits of the consumer there should also be a pragmatic view of the deployment of these technologies in other European markets, as devices that are manufactured by multiple vendors in higher volumes will automatically have a lower price point resulting in lower costs to the consumer.

Q. 41. Do you think that a requirement for the SMP operator to notify purchasers of WBA 6 months in advance of its launch of a retail products based on NGA inputs is necessary or adequate and, if so, how might it operate in practice? Please explain your reasoning.

Yes, as currently OAO have no or limited visibility of new products. OAO's often find out at a very late stage in the new product offering lifecycle to put a retail product around the offering, falling behind the product already launched by the incumbents retail arm. The SMP retail arm seem to have an input into product development and in that sense they can use their market knowledge to establish and shape a wholesale product to undermine its competitors and to shape the retail market.

Q. 42. What effective access, transparency or other safeguards are necessary to guarantee non-discrimination and how might such safeguards impact the need for of level of advance notification discussed above? Please explain your reasoning.

The safeguard would essentially be an Industry work group which focuses solely on product development. This will allow all of industry to shape products in the future and would require eircom retail to attend and by everyone working together would ensure a consistent development of new wholesale products.

Q. 43. What specific non-discrimination remedies are required with respect to the provision of wholesale broadband access? Please explain your reasoning.

To ensure parity and equivalence with the SMP retail arm especially with regard to price of access. It would seem that the SMP retail arm does not have the build constraints that the OAO have e.g. backhaul to the exchange, cross connects, power etc.

Q. 44. Is a remedy requiring the publication of reference offers for specific NG WBA products necessary and if so, what should be contained within such a reference offer? Please provide reasons for your answer

As per answer outlined at question 21.

Q. 45. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

As per answer outlined at question 22.

Q. 46. What form of price control would be the most appropriate and proportionate means of establishing the price of WBA access? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

As per question 24, Magnet Networks believe initially commercial negotiations would be the best and after a fixed period of time regulation.

Q. 47. If an effective internal separation of Eircom were to be implemented how should this impact on ComReg's regulatory approach?

There should be no affect on ComReg's regulatory approach. Until there is true functional separation with iron cast Chinese walls, and employees in different buildings and separate engineering staff than it is imperative that the regulator stays vigilant.

Q. 48. Do you believe that the costing methodology options for determining NGA charges as outlined above are relevant and appropriate? Please provide reasons for your response. Which is the most appropriate methodology and why?

Magnet Networks believe that the current cost model is the most appropriate cost model. Magnet Networks also feel that the bottom up model is the most appropriate. In Magnet Networks view the relevant cost model is that already used by ComReg in assessing cost models in this and other markets namely, BULRAIC.

Q 49. Should ComReg distinguish between new investment (such as NGA specific equipment) and legacy assets (such as trench) which are used in the provision of NGA services? Please explain your reasoning.

Magnet Networks believe that there should be a distinction made between the new investment and the legacy assets. Having the legacy assets such as ducts, cabinets, exchanges allows eircom upgrade their network to NGA cheaper than a new entrant. The new entrant would have large costs such as civil engineer, planning obligations, road opening licences as well as land acquisition for exchanges etc. Thus, NGA is just an incremental cost to eircom.

Q. 50. What pricing issues might arise where the SMP operator is providing services over both copper and NGA networks concurrently? For example, duplicating infrastructure in the same geographic area for a temporary period or in different geographic areas. Pleas explain your reasoning.

The issue identified in the question is really the only real pertinent question. However, in the FTTH trial only customers who request the fibre be bought into their house will be able to access the fibre. In relation to FTTC, eircom are less likely to suffer duplication as they will just replace the copper to the cabinet with fibre and leave the copper to the resident's home as copper. Having unbundled the copper in the exchange these OAO should be able to invoice eircom the cost of upgrading to equipment that enables them to unbundle fibre.

Thus, overall Magnet Networks does not feel that there is a major issue with duplication of services and its impact on pricing.

Q. 51. Do you agree with the application of a risk premium as envisaged in the NGA Recommendation? As part of your response please address, insofar as possible, your views on the nature of any such premium, whether and how it could be measured and what its relationship to Eircom's existing (or a potential split) WACC should be.

No, Magnet Networks categorically disagrees with the NGA recommendation of a risk premium. Magnet Networks believe that NGA is just an upgrade and is intrinsic in the moving forward of the incumbent. Eircom has several things other operators do not have, namely:-

1. Network ubiquity – its network and ducting is all around Ireland and thus, its cheap to pull new fibre cables through that duct.
2. Brand recognition
3. Wholesale element – eircom is guaranteed resale of its services to other operators who wish to access them including Magnet Networks who would like to provide triple play services and wish to utilise eircom NGA network to do this.
4. First mover advantage- eircom will be the first all Ireland fibre provider.

All of these are advantages that are not easily replicated by other providers and such, allows eircom some form of premium on their service, which the WACC generously provides.

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Q. 52. Do you agree with the NGA Recommendation that any risk premium should only be applied to NGA/fibre specific assets and not to legacy copper based assets (for example, FTTH versus FTTN)?

Magnet Networks do not believe a risk premium should be applied.

Q. 53. Do you believe that the WACC ComReg Decision from 2008 remains appropriate and applicable for NGA investment and allows for sufficient return on investments made and to be made in the future? Please provide reasons for your response.

Magnet Networks believe the WACC is currently too high.

Q. 54. Do you have any other observations or proposals in relation to NGA investment risk and whether there are mechanisms other that the WACC to account for risk in NGA wholesale pricing?

Magnet Networks feel that the WACC accounts sufficiently for any risk eircom is deemed to take.

Q. 55. Do you agree that the factors above identified are the most relevant mitigators of risk? Should such factors be taken into account when determining wholesale pricing arrangements and, if so how? Are any safeguards necessary?

Magnet Networks agree in part with the factors identified except large volume upfront purchase. Magnet Networks believe that this may skew the pricing somewhat especially in favour of that large purchaser. Also, in this market the only large purchase would be eircom retail.

The safeguards required are that the SMP cannot offer pricing at a price lower than the floor set by the regulator as it would be below cost selling and put all OAO at a competitive disadvantage. It would penalise new entrants and would allow a duopoly or some form of foreclosure of the market.

Q. 56. In the context of upfront purchase commitments and volume discounts, are any safeguards necessary to ensure efficient investment and the development of effective competition? Please explain your reasoning.

As Magnet Networks has outlined in Question 55 discounts should not be allowed at a price lower than the price floor indicated by ComReg.

Q. 57. Do you believe that all the relevant and appropriate options were considered above regarding the main principles for a margin squeeze test? Please provide reasons for your response.

ComReg have considered all the relevant options for assessing margin squeeze. Magnet Networks feel that there may be difficulty in obtaining information on volume discounts as these are more likely to be negotiated on a commercial basis and thus due to confidentiality and different negotiated clauses may prove difficult to assess.

Q. 58. Are ex-ante price controls or measures required in order to prevent margin squeeze? If so, what is the appropriate methodology to address margin squeeze and what factors should be considered by ComReg when specifying an imputation test (if this approach is deemed to be necessary)? Please explain your reasoning.

It is imperative that there are ex ante price control. It is facile to ask such a question considering the monopoly that the incumbent has in the access market.

Magnet Networks believe to ensure consistency with other margin squeeze tests, the SEO must be used. For the imputation test then it would be appropriate to look at it per product range or portfolio rather than per product as ComReg have pointed out, an OAO does not necessarily replicate the incumbents product offering.

These are the tests outlined in both the Telefonica case (Comp 38.784) and the Deutsche Telecom case (2003 OJ 263/9).

Q. 59. Should Eircom be required to maintain existing copper network infrastructure in parallel with NGA network upgrades? If so, then for what period of time? Under what circumstances could a shorter period of parallel operation be appropriate?

This is a difficult question to answer. Some people, such as Magnet Networks have invested heavily in unbundling exchanges and if eircom were to remove such access Magnet Networks would have stranded assets. The alternative is that eircom have a project plan to migrate LLU providers to unbundling the fibre at no extra cost or increased rental charge to encourage migration. If this is not the case, then Magnet Networks believe that eircom should be required to maintain both infrastructure at no extra cost to either fibre providers or those accessing the copper network. If they are to maintain dual infrastructure Magnet Networks suggest a 5 year period to allow Magnet Networks sweat their existing asset before it becomes stranded.

The only reason a shorter period would be allowable is if eircom migrate the LLU provider across to unbundled FTTH at no extra access charge or equipment charge i.e. eircom pay for the new required equipment or incentivise the LLU OAO to purchase the equipment i.e. rebates etc.

Q. 60. What forms of fully equivalent access at the points of interconnection (such as exchanges), might justify an advance notice period for decommissioning of less than 5 years? Please explain your reasoning

Magnet Networks cannot think of any justification for decommissioning an exchange without giving 5 years notice. The only incident is if eircom pay for the full migration to NGA including equipment upgrades whilst keeping access prices at LLU pricing.

Q. 61. In an NGA setting, what are the most appropriate migration paths that need to be put in place and what are the main technical, operational or commercial issues that would need to be addressed? Please explain your reasoning.

Where NGA plans to use existing Infrastructure (existing copper path) it is imperative that the migration has proper scheduling including the ability of the consumer to appoint a specific date / time. Where the NGA service is being provided over new infrastructure the migration of existing services, such as telephone number, should also be scheduled. In this scenario there is a possibility of double billing during the specific window (paying for existing and new service). Comreg should ensure there is no charging for new infrastructure until existing services are migrated and that this process also halts charging for the existing infrastructure. As phone number may be critical to the household or business there should also be a "back out" window ensuring any issues are dealt with quickly.

Q. 62. Are commercial arrangements likely to lead to the most effective outcome in ensuring that an efficient and transparent migration process takes place? Please explain your reasoning.

No due to monopoly and eircoms position of power.

Q. 63. How should Comer ensure that the systems and procedures put in place by Xircom, including operating support systems, are designed so as to facilitate the switching of alternative providers to NGA-based access products? Please explain your reasoning.

Ensure that eircom retail are forced to use the same provisioning / OSS tools that other OAOs are using will ensure transparency and motivate eircom wholesale to resolve any issues with these systems.

Q. 64. What would be an appropriate and proportionate regulatory approach for ensuring that information around Eircom's network and its extension plans are made available to WPNIA and WBA access seekers? Please consider issues regarding commercial sensitivity and network integrity when explaining your reasoning.

Via email or a log in website as microsite of eircoms wholesale site.

Q. 65. What should be the format and level of detail to be contained in the network information above and how can the strict confidentiality of such information be maintained? Please explain your reasoning.

As stated at question 64, must be extremely detailed network information. This may be done via a wholesale microsite with secure log in to those who have signed access agreements.

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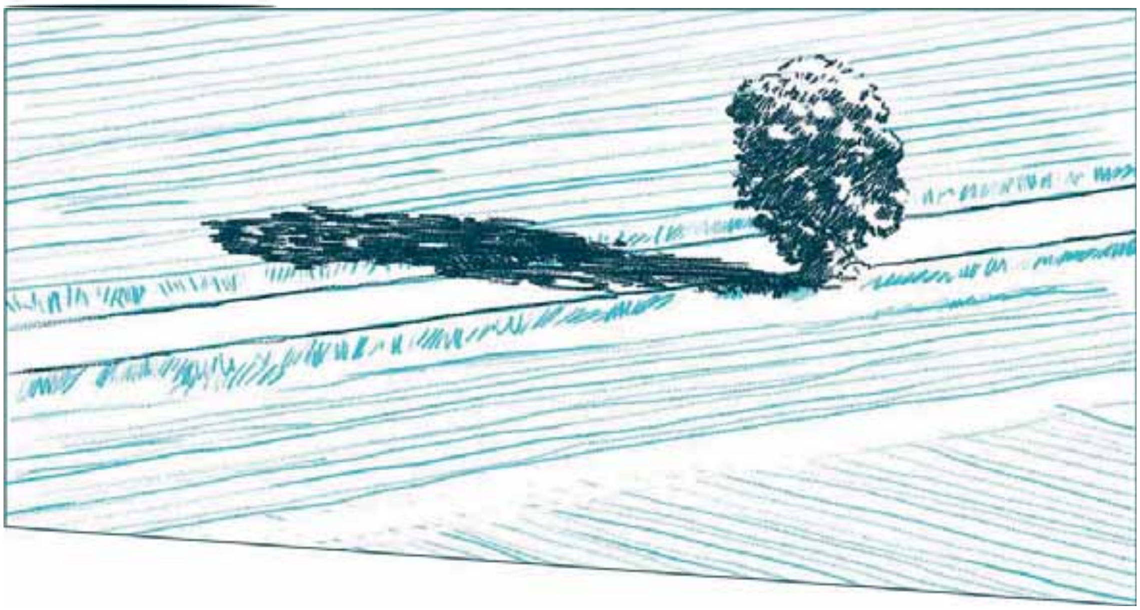

Regulatory Affairs: July 2011

Response to ComReg Preliminary Consultation on Remedies in Wholesale Regulated Markets (11/40)

Introduction

Telefonica welcomes the opportunity to submit comments to ComReg's consultation on NGA Remedies. Access to NGA and the regulatory environment around fixed infrastructure are important strategic issues for Telefonica in Ireland.

Telefonica would express a general concern that ComReg are overly complicating the access remedies which may be required for NGA investment. ComReg cannot apply the same set of remedies in the same way to new investment as it does to regulating copper. ComReg needs to ensure the remedies it chooses safeguard the existing fixed competition with a clear preference for commercial solutions to these issues and intervene when access at reasonable terms is not progressing.

Telefonica has attempted to respond to all of the questions posed by ComReg but would note that many of the questions were repetitious and the key issues for consultation could have been summarised in a more condensed consultation and consultation questions.

Telefonica O2 Fixed Line Activities

O2 has developed in recent years a suite of products which has offered a wider choice of mobile and fixed services to its business customers. O2 has invested in developing its capability to offer converged services which are in response to demands from our customer base for products covering our traditional mobile services and fixed and broadband services.

O2's offerings in the market have been part of increasing cross platform competition in the Irish market as the communications market becomes increasingly competitive. O2 have further demonstrated this by rolling out cloud based services that can only be accessed via mobile and fixed service platforms

Response to questions

Q. 1. Do you consider that the risks identified above are those most closely relevant to investment in NGA? What might be the degree of impact of such risks, how might they change over time and how might they be quantified? Please explain your reasoning

Telefonica O2 agree with ComReg's assessment of the risks associated with NGA investment. Telefonica would however raise the discussion on ladder of investment which preceded the discussion on risks. In paras 2.9 -2.19 ComReg discusses the theoretical ladder of investment argument which suggests small investments in fixed infrastructure will be followed by increasing investments in fixed infrastructure which are made by the rational investor wishing to minimise risk. The ladder of investment however ignores market entry by commercial arrangements where third party operators can offer fixed services using the underlying fixed infrastructure of existing fixed operators. Operators such as TelefonicaO2 wishing to offer a full portfolio of services to clients may partner with other operators who possess, for the right price, access to fixed infrastructures. Without having competences in fixed technology Telefonica O2 does not step on the ladder but partners with others. This type of competition is not discussed by ComReg in its discussion of the ladder of investment. Yet this type of competition is crucial to the development of retail offerings in the high speed broadband market in Ireland.

Q. 2. Do you consider that, in the context of the terminology set out in the NGA Recommendation, the above Figures 3 and 4 provide an accurate representation of Eircom's proposed network architecture? Please explain your reasoning

No Comments. As mentioned above Telefonica would purchase access to these components but would not, given its current business model, make investments in fixed infrastructure.

Q. 3. Do any of Eircom's proposed pilot wholesale products align to the potential access remedies set out in NGA Recommendation? Please explain your reasoning? This question should be addressed in light of the following discussion on WPNIA NGA and WBA NGA

No Comments. It is key to ensure there is sufficient wholesale access to NGA infrastructure where such infrastructure is controlled by a dominant operator.

Q. 4. Are there any circumstances in which regulated access to civil engineering infrastructure would not be required? Please explain your reasoning

No

Q. 5. Having regard to market demand, technical, economic and other considerations, is there a requirement for a duct access remedy? Please explain your reasoning

Yes. Given the opportunities which exist for additional investment from duct access, it would be important to have remedies allowing only access to ducts.

Q. 6. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to civil engineering infrastructure?

Telefonica would view the need to safeguard competition within the context of efficient infrastructure based investment.

Q. 7. Should ComReg encourage Eircom to build additional duct capacity for use by third parties and, if so, how? Please explain your reasoning

No additional duct capacity purely for the provision of access to third parties would appear disproportionate. There needs to be regulated access to new ducts and existing ducts currently used by eircom.

Q. 8. If a remedy requiring the provision of access to civil engineering infrastructure were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Would a risk premium be warranted? Please provide a reasoned response for each of the principles

It would be appropriate given the cost of civil infrastructure to add a risk premium, particularly if such access is from new access infrastructure.

Q. 9. What form of price control would be the most appropriate and proportionate means of establishing the price of access to civil engineering infrastructure? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning

Telefonica O2 would welcome a time for commercial negotiation to take place in the first instance. Prices need to reflect the additional risk but ComReg's role is protecting competitors from the risk of abuse of dominance.

Q. 10. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the terminating segment? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

There should be a mandated access to terminating segment, in line with the NGA recommendation.

Q. 11. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the terminating segment?

As discussed above the need to safeguard competition should be the key consideration in proportionality considerations

Q. 12. Where is an appropriate distribution point to which access to the terminating segment should be provided, particularly given the need to ensure that it host a sufficient number of end-user connections to be commercially viable for an access seeker

No Comments

Q. 13. Should ComReg seek to encourage Eircom to deploy multiple-fibre lines in terminating segments and, if so, how? Please explain your reasoning

This would suggest ComReg have a role in compelling investment from eircom which would seem outside the scope of ComReg's remit

Q. 14. If a remedy requiring the provision of access to the terminating segment were to be appropriate, are measures to implement each of the principles set out in Annex II of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Please provide a reasoned response for each of the principles?

The principles set out in Annex II and para 3.17 would appear disproportionate and overly complex to administer and create unnecessary delay and complexity.

Q. 15. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the terminating segment? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

As discussed above commercial settlements are preferable to a regulated solution

Q. 16. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled fibre loop? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning

Yes access is a key requirement

Q. 17. Are obligations to provide access to associated facilities necessary and, if so, what should these encompass? Please explain your reasoning

Yes, the relevant facilities should be a matter for discussions with eircom and access seekers

Q. 18. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities?

As discussed above the need to safeguard competition is crucially important

Q. 19. What do you consider to be an appropriate point in Eircom's network for the provision of unbundled access to the fibre loop in a FTTH scenario? Please explain your reasoning, including views on associated technical and commercial considerations

No Comments

Q. 20. If it is not possible for commercial or technical reasons to provide for unbundled access at this time, what factors might change this over time? What measures should ComReg take on a transitional basis to provide for the nearest equivalent alternative constituting a substitute to physical unbundling and what other safeguards might be necessary?

For transitional arrangements ComReg should consider the possibility of commercial negotiations as a first step prior to a regulated solution

Q. 21. Is a remedy requiring the development and publication of a reference offer for the provision of access to the unbundled fibre loop and associated facilities necessary and what specific issues should be detailed within it? Please explain your reasoning

There should a need for regulated components in a reference offer to be published

Q. 22. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning

Existing procedures for updating the RIO should remain

Q. 23. What specific non-discrimination remedies are required with respect to the provision of access to the unbundled fibre loop and associated facilities? Please explain your reasoning

Non-discrimination should be applied to ensure wholesale charges reflect costs and are not discriminatory to retail offerings

Q. 24. What form of price control would be the most appropriate and proportionate means of establishing the price of unbundled access to the fibre loop? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning

As discussed above commercial negotiations should be the first option

Q. 25. Should any cost oriented price for FTTH based services attract a risk premium in principle? If so, to what types of network assets/investments should any premium apply and why?

Yes a risk premium should apply specifically in relation to those investments related to new investments in NGA technologies

Q. 26. What types of co-investment arrangements might warrant a separate regulatory treatment in terms of remedies. Please address in your answer the types of commercial relationships and the type of control over physical infrastructure by multiple operators that you think would be necessary for ComReg to consider this option. If possible, please state if you think such an outcome is feasible or desirable.

There are a number of co-investment models which already exist (eg Netherlands) and ComReg should encourage such collaboration given the need for NGA investment.

Q. 27. Do you have any views as to how ComReg should view the evolution of the market for NGA services particularly in the presence of a rival cable network and its impact in supporting effective competition in downstream markets? How should remedies and regulation generally evolve over time and what criteria should ComReg apply to such decisions?

ComReg should monitor the roll out of NGA high speed broadband products in the retail market. Intervention should only be on the basis of denial of legitimate access. ComReg should also conduct regular market reviews of markets 4 and 5 as prescribed by the new regulations to ensure a monitoring of markets

Q. 28. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in a FTTN scenario? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

This access should be mandated on the basis of demand if access seekers believe there is a business case for such level of access

Q. 29. What type of backhaul solutions do you consider are appropriate in an FTTN scenario?

No Comments

Q. 30. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities

As discussed the need to safeguard competition is important to consider in terms of the factors detailed in Article12.2

Q. 31. Is a remedy requiring the development and publication of a reference offer for the provision of access to the copper-sub loop necessary and what specific areas should be detailed within it? Please explain your reasoning

Please see earlier answer in relation to the provision of RIOs

Q. 32. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

See earlier response on RIOs.

Q. 33. What specific non-discrimination remedies are required with respect to the provision of access to the copper sub-loop, including those associated with co-location? Please explain your reasoning

See earlier response in relation to Non-Discrimination

Q. 34. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the copper sub-loop? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing commercial negotiation. Please explain your reasoning.

See earlier response in relation to commercial negotiation

Q. 35. Should fibre or Ethernet backhaul associated with the provision of access to the copper sub-loop attract a risk premium? How might a risk profile associated with specific costs relating to such access to be determined in light of the principles set out in Annex I of the NGA Recommendation, and should any difference in risk be reflected in a pricing methodology? Please explain your reasoning

Yes if such premium relates to new investment

Q. 36. What circumstances (i.e. degree of availability of effective access to the unbundled loop), would warrant the lifting or variation of WBA access obligations within a given geographic area? Please explain your reasoning

ComReg need to assess the level of competition in geographic areas before deciding if SMP exists in those areas. Access remedies should only apply if SMP exists

Q. 37. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to WBA products and associated facilities (including backhaul) in a FTTH and FTTC scenario? Please explain your reasoning

ComReg needs to assess such questions based on competitive analysis and demand from access seekers.

Q. 38. In a FTTH or FTTC environment, what technical or enhanced service characteristics might need to be reflected in WBA access products? Please explain your reasoning including views on the extent, if any, to which product differentiation is a necessary characteristic of WBA access products

No comments

Q. 39. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to WBA products and associated facilities?

As discussed earlier the safeguarding of competition is the most important factor

Q. 40. How should the issue of technical protocols and interfaces serving the interconnection of optical networks be approached? Please explain your reasoning.

No comments

Q. 41. Do you think that a requirement for the SMP operator to notify purchasers of WBA 6 months in advance of its launch of a retail products based on NGA inputs is necessary or adequate and, if so, how might it operate in practice? Please explain your reasoning.

No this appears disproportionate to the competition problems which could exist

Q. 42. What effective access, transparency or other safeguards are necessary to guarantee non-discrimination and how might such safeguards impact the need for of level of advance notification discussed above? Please explain your reasoning.

Advance notification of retail price and product changes needs to be considered against other safeguards at wholesale level related to pricing and access.

Q. 43. What specific non-discrimination remedies are required with respect to the provision of wholesale broadband access? Please explain your reasoning.

Nothing other than the existing remedies

Q. 44. Is a remedy requiring the publication of reference offers for specific NG WBA products necessary and if so, what should be contained within such a reference offer? Please provide reasons for your answer

Yes but not over and above those transparency remedies which exist

Q. 45. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

No comments

Q. 46. What form of price control would be the most appropriate and proportionate means of establishing the price of WBA access? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning

As above commercial negotiations are preferable

Q. 47. If an effective internal separation of Eircom were to be implemented how should this impact on ComReg's regulatory approach?

An effective internal separation should reduce ComReg's need for regulatory oversight

Q. 48. Do you believe that the costing methodology options for determining NGA charges as outlined above are relevant and appropriate? Please provide reasons for your response. Which is the most appropriate methodology and why?

All of the costing methodologies are extremely complex and would require significant time to implement. ComReg should consider other options for cost orientation including benchmarking or commercial negotiations to fix prices.

Q. 49. Should ComReg distinguish between new investment (such as NGA specific equipment) and legacy assets (such as trench) which are used in the provision of NGA services? Please explain your reasoning

Yes, it is important in terms of assessing a risk premium if such is necessary

Q. 50. What pricing issues might arise where the SMP operator is providing services over both copper and NGA networks concurrently? For example, duplicating infrastructure in the same geographic area for a temporary period or in different geographic areas. Pleas explain your reasoning.

Given that SMP exists the only difference in pricing is the risk premium associated with new investments

Q. 51. Do you agree with the application of a risk premium as envisaged in the NGA Recommendation? As part of your response please address, insofar as possible, your views on the nature of any such premium, whether and how it could be measured and what its relationship to Eircom's existing (or a potential split) WACC should be

Yes risk premium is appropriate and ideally calculated on the basis of a higher WACC.

Q. 52. Do you agree with the NGA Recommendation that any risk premium should only be applied to NGA/fibre specific assets and not to legacy copper based assets (for example, FTTH versus FTTN)?

Yes

Q. 53. Do you believe that the WACC ComReg Decision from 2008 remains appropriate and applicable for NGA investment and allows for sufficient return on investments made and to be made in the future? Please provide reasons for your response.

Yes

Q. 54. Do you have any other observations or proposals in relation to NGA investment risk and whether there are mechanisms other that the WACC to account for risk in NGA wholesale pricing?

No other observations.

Q. 55. Do you agree that the factors above identified are the most relevant mitigators of risk? Should such factors be taken into account when determining wholesale pricing arrangements and, if so how? Are any safeguards necessary?

Yes the factors highlighted are important in assess risks

Q. 56. In the context of upfront purchase commitments and volume discounts, are any safeguards necessary to ensure efficient investment and the development of effective competition? Please explain your reasoning.

There are limited risks here and what is required is enough variation in the range and price of services available to access seekers.

Q. 57. Do you believe that all the relevant and appropriate options were considered above regarding the main principles for a margin squeeze test? Please provide reasons for your response.

Yes. Telefonica would again state that ComReg appear to be in search of a problem. Margin squeeze issues apply across the regulatory landscape and the rules and tests have been consulting on in other ComReg documents. The regulation of NGA access and prices does not present a different price squeeze problem for ComReg . If such competition problems emerge in regulated markets ComReg have sufficient information and powers to intervene.

Q. 58. Are ex-ante price controls or measures required in order to prevent margin squeeze? If so, what is the appropriate methodology to address margin squeeze and what factors should be considered by ComReg when specifying an imputation test (if this approach is deemed to be necessary)? Please explain your reasoning.

See response above to Q57

Q. 59. Should Eircom be required to maintain existing copper network infrastructure in parallel with NGA network upgrades? If so, then for what period of time? Under what circumstances could a shorter period of parallel operation be appropriate?

There should be parallel regulation of copper infrastructure however with incentives to ensure access seekers migrate to own fibre or regulated fibre. The relevant period of times depends on the pace of roll out of fibre.

Q. 60. What forms of fully equivalent access at the points of interconnection (such as exchanges), might justify an advance notice period for decommissioning of less than 5 years? Please explain your reasoning.

This is a matter for negotiation between access seekers. Telefonica will not be seeking such access.

Q. 61. In an NGA setting, what are the most appropriate migration paths that need to be put in place and what are the main technical, operational or commercial issues that would need to be addressed? Please explain your reasoning.

No comments

Q. 62. Are commercial arrangements likely to lead to the most effective outcome in ensuring that an efficient and transparent migration process takes place? Please explain your reasoning

Telefonica believes these may be the most appropriate mechanisms to achieve quick transitions and should be explored

Q. 63. How should ComReg ensure that the systems and procedures put in place by Eircom, including operating support systems, are designed so as to facilitate the switching of alternative providers to NGA-based access products? Please explain your reasoning.

No comments

Q. 64. What would be an appropriate and proportionate regulatory approach for ensuring that information around Eircom's network and its extension plans are made available to WPNIA and WBA access seekers? Please consider issues regarding commercial sensitivity and network integrity when explaining your reasoning.

No comments

Q. 65. What should be the format and level of detail to be contained in the network information above and how can the strict confidentiality of such information be maintained? Please explain your reasoning.

No comments

7 Vodafone Ireland Ltd.

Vodafone response to the ComReg Preliminary Consultation on Next Generation Access Remedies in Wholesale Regulated Markets

Ref. ComReg Document 11/40 Response Date: 24 Aug 2011

INTRODUCTION

Vodafone welcomes the opportunity to provide views on this preliminary consultation on Next Generation Access (NGA) Remedies in Wholesale Regulated Markets. As ComReg has recognised, the market for the provision of electronic communications services in Ireland is at a critical juncture and it is therefore imperative that the greatest possible degree of regulatory certainty is now provided to effectively facilitate efficient investment in NGA network infrastructure. Vodafone considers that the European Commission's NGA Recommendation provides appropriate guidance to regulators around the principles that should govern the implementation of remedies in a NGA network environment while also providing greater clarity to communications operators around the general framework that will apply. We therefore strongly support the conclusions of the NGA Recommendation and believe that ComReg should generally adhere to it in its regulatory approach.

Vodafone agrees that ComReg should also take account of the particular conditions in the Irish communications market in the implementation of NGA remedies, and the NGA Recommendation allows significant flexibility to do so. Key areas such as the appropriate economic principles for setting prices for different forms of regulated wholesale access are addressed by the Recommendation at a high level, but the detailed approach remains to be determined as the subject of the present consultation. We provide our detailed views in relation to appropriate costing methodologies and related issues in subsequent sections of this paper.

Major and timely investments will be necessary if a geographically extensive NGA fibre network is to be deployed in line with public policy objectives, and widespread take-up of ultra-fast broadband services by end users achieved. This will clearly require the provision of sufficient incentives for efficient investment in NGA specific network assets. However these objectives would also be advanced by network ownership/operation structures and NGA technical network architectures that maximise the scope for robust competition on the basis of both service and price differentiation.

In the absence of sufficiently pro-competitive NGA network financing/ownership models and network architecture emerging then Vodafone believes that it will be vital for ComReg to ensure that wholesale access to the NGA fibre network of the incumbent is mandated on a regulated basis at all levels of that network, and on terms which maximise the scope for efficient OAOs to innovate and compete on all the key price and non-price aspects of their retail services.

However in the period prior to actual widespread NGA deployment investment decisions must be made in respect of solutions based on facilities currently available in the market (notably LLU). The payback period for such investments may be significant and certainty in respect of NGA deployment plans, as well as the attendant regulatory environment, is critical. Vodafone believes that this aspect must also be taken into account in the approach to NGA remedies.

Vodafone's position in relation to the key issues raised in the consultation document are set out in full in response to the consultation questions below, and in the attached Annexes.

RESPONSE TO CONSULTATION QUESTIONS

Q1. Do you consider that the risks identified above are those most closely relevant to investment in NGA? What might be the degree of impact of such risks, how might they change over time and how might they be quantified? Please explain your reasoning.

Yes. Vodafone agrees that the general categories of risk identified by ComReg are those most relevant to investment in NGA and must therefore be considered in the assessment of the appropriate WACC for NGA network investment. However these risks are difficult to quantify accurately.

Regulatory risk is of course the category of risk most susceptible to change through the regulatory approach adopted by ComReg. Vodafone believes that ComReg, by providing maximum clarity at the outset in relation to the nature of the regulatory remedies that it will apply under the various possible scenarios related to factors such as the particular network architecture adopted in the NGA network that is deployed, and potential ownership and operational structures for a NBA network (from sole ownership and control by a vertically integrated SMP operator to a fully fledged co-investment and co-ownership model), can effectively minimise regulatory risk as a factor in the determination of the appropriate WACC.

All of the other risk categories highlighted in the consultation have a material impact on the overall risks associated with investment in NGA. However on the assumption that regulatory risk is appropriately addressed through the provision of the maximum degree of regulatory certainty by ComReg, Vodafone considers that demand uncertainty, the largely sunk nature of investments, and macro-economic uncertainty have the largest impact on the risks associated with investment in NGA.

Vodafone agrees with ComReg that as macroeconomic uncertainty faces all operators it is captured within the cost of capital faced by firms in the industry. We would also anticipate that the extent of impact of many elements of the overall risk of investment, such as demand uncertainty, will decline over time as consumer willingness to pay for super-fast broadband, among other factors, becomes better known (through for example the experience of other countries that deploy NGA networks).

Vodafone considers that the factor of execution risk and project deployment costs is significant but can be reduced through appropriate and timely actions by public policy makers in areas such as local authority planning regulations.

In addition, for OAOs there is a risk associated with the build or buy decisions that face operators prior to certainty on NGA deployment timescales. If operators choose to invest in current generation LLU they risk being tied to a legacy infrastructure from which it is impossible to make an adequate return. In the alternative if they delay investment decisions pending NGA deployment certainty then there is a strong risk that there will be a hiatus in the current competitive evolution which is seeing an increase in infrastructure based competition. Vodafone notes that from eircom's perspective the first of these scenarios limits the available funds for potential co-investment but leaves it a clear competitive field. The second has the effect of supporting its wholesale revenues by delaying alternative operators from climbing the ladder of investment.

Q2. Do you consider that, in the context of the terminology set out in the NGA Recommendation, the above Figures 3 and 4 provide an accurate representation of Eircom's proposed network architecture? Please explain your reasoning.

Given eircom's recent announcements in respect of the actual roll-out of NGA type services within the next 12 months it is not clear that a question relating to the proposed eircom "pilot" remains relevant. Vodafone considers that the initiation by ComReg of a supplementary consultation on these issues, once it becomes clear what eircom's proposals in respect of its mass market solutions are, would be appropriate.

Q3. Do any of Eircom's proposed pilot wholesale products align to the potential access remedies set out in the NGA Recommendation? Please explain your reasoning. This question should be addressed in light of the following discussion on WPNIA NGA and WBA NGA.

Please see the response to question 2.

Q4. Are there any circumstances in which regulated access to civil engineering infrastructure would not be required? Please explain your reasoning.

It is possible that regulated access to civil engineering infrastructure may not be necessary in the circumstance where an effective model of co-investment of a NGA network were implemented. This would be the case where there was participation in co-investment by a sufficient number of operators competing in the retail market so that no SMP was present. The absence of regulated access to civil engineering infrastructure in this case would be justified as the co-investing operators would have access to their own wholesale inputs and the incumbent operator would not have strategic control of these inputs.

In all other circumstances Vodafone considers that a general obligation of access to civil engineering infrastructure, such as duct capacity, would be appropriate and necessary to impose on the SMP operator so as to allow for the possibility of competition on the basis of the deepest level of infrastructure competition possible through wholesale access. An obligation of access must also facilitate access for other fibre uses such as mobile backhaul given the benefits this would provide in advancing the provision of advanced communications services (such as wide coverage next generation mobile broadband services) more generally.

Vodafone believes that, in addition to an obligation to provide access to duct capacity, an obligation to provide access to dark fibre is also necessary to maximise the scope for efficient competition on the basis of this highest level of wholesale access. While regulated access to dark fibre is particularly important where ducts may have insufficient or no capacity to accommodate access for any OAO that seeks, it is Vodafone's view that both types of access should be available.

Q5. Having regard to market demand, technical, economic and other considerations, is there a requirement for a duct access remedy? Please explain your reasoning.

In line with the response to question 4, Vodafone considers that a requirement for a duct access remedy is appropriate as it is necessary to enable competition on the basis of the most infrastructure intensive form of competition possible via wholesale access. However taking into account factors such as Ireland's modest population size and relatively low population density, the considerable degree of demand uncertainty, likely practical difficulties of implementation, and the very substantial costs that would be required to be incurred, Vodafone considers that the duplicate network investment associated with access to duct capacity for deploying fixed services is very unlikely to be commercially feasible for any OAO to undertake, at least for the foreseeable future.

Separately, Vodafone believes it is important that duct access be opened for all potential uses including mobile backhaul. This will not only enable operators to roll out data intensive LTE networks more widely than otherwise but, once that fibre is rolled out, operators would have an incentive to use it or wholesale it to others. While this is very unlikely to lead to ubiquitous fixed fibre access, it should at least have a positive impact on corporate and SME connectivity.

Q6. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to civil engineering infrastructure?

Vodafone considers that factors (a) and (b) as identified in Article 12(2) of the Access Directive and set out at paragraph 1.25 of the present consultation are the most relevant factors when assessing proportionality considerations with respect to the adoption of a regulatory remedy of access to civil engineering infrastructure.

While all of the factors indentified in the Access Directive must be taken into account, Vodafone considers that the greatest weight must be attached to (a) the technical and economic viability of using or installing competing facilities and (b) the feasibility of providing the access proposed, in relation to the capacity available.

Vodafone considers that a reasoned assessment of the technical and economic viability of competition via accessing civil engineering infrastructure and replicating all the other elements of the SMP operator's network investment can only conclude that this approach is very unlikely to be feasible for any operator to pursue for the foreseeable future. Consequently we consider that it would be disproportionate for a remedy of regulated access to civil engineering infrastructure to be implemented in a manner that considerably increased the costs of NGA roll-out to facilitate demand for duct access by multiple OAOs when this is extremely unlikely to materialise. Any prospective competitive advantages of substantial investment specifically to provide for a large amount of additional duct capacity to facilitate possible access seeker demand are likely, on the basis of existing information, to be far outweighed by the disadvantages in terms of the increased costs of deployment of a NGA network (which may lead to a more limited geographic reach of the network, higher prices for NGA wholesale inputs for OAOs, and resulting higher retail prices for services delivered over the NGA network – with clear negative implications for overall consumer welfare).

While it is very desirable, in principle, that access for third party access seekers to civil engineering infrastructure (including duct capacity) is available so that the option of competition on the basis of this form of wholesale access is not precluded, and other types of fibre use can be accommodated, care should be taken to ensure that any costs incurred in achieving this objective are proportionate.

Alternatives such as dark fibre access and wavelength unbundling should also be considered. Wavelength unbundling could form part of the specifications of the X-GPON2 standards which are currently being considered by the pre-standards group FSAN[1] and which is aiming for commercial launches by 2015. However, this timing remains uncertain and Vodafone is concerned that these products will not emerge without concerted support of policy-makers for 'unbundlability' in fibre networks. Vodafone has carried out a recent study with WIK Consult which examined both the costs and competitive benefits of different fibre topologies[2]. WIK conclude that 'unbundlable' networks are demonstrably superior in terms of effective and sustainable future competition than closed GPON networks. Vodafone believes therefore that policy-makers should focus on unbundlability, whether delivered by point-to-point networks or wavelength unbundling rather than wide-spread network replication.

With regard to duct capacity, dark fibre, and wavelength unbundling, Vodafone considers that an objective of facilitating access to capacity for a limited number of access seekers is likely to be sufficient to satisfy any potential demand for this form of wholesale access that may emerge. This approach is in our view also consistent with the need to safeguard competition in the long term, factor (d) as identified at paragraph 1.25 of the current consultation.

Q7. Should ComReg encourage Eircom to build additional duct capacity for use by third parties and, if so, how? Please explain your reasoning.

Please see the response to question 6.

Q8. If a remedy requiring the provision of access to civil engineering infrastructure were to be appropriate, are measures to implement each of the principles set out in Annex 2 of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Would a risk premium be warranted? Please provide a reasoned response for each of the principles.

Vodafone strongly agrees with each of the equivalence principles regarding access to civil engineering infrastructure as set out in Annex 2 of the NGA Recommendation. We believe that it is essential that these are effectively implemented so as to safeguard against anti-competitive discrimination and ensure a level playing field, from a competitive perspective, for any OAO(s) seeking to compete against the SMP operator in the retail market while requiring access to such infrastructure. The necessity for effective implementation of these principles is demonstrated by the breaches notified to Eircom in respect of its non-discrimination and transparency obligations in the current generation WBA market and other markets in the past.

[1] *Full Service Access Network - www.fsan.org*

[2] *'Architectures and competitive models in fibre networks' WIK-Consult report for Vodafone: http://www.vodafone.com/content/dam/vodafone/about/public_policy/position_papers/vodafone_report_final_wkconsult.pdf*

Equal Access to Information

The principle of information equality covers the availability, timing of availability, and accuracy of relevant information to OAOs as is provided by the SMP operator to its own downstream arm. Relevant information includes information that wholesale customers would reasonably require in the course of their business such as:

- Product information including knowledge of new product development, changes to existing products, pricing packages or investment plans;

- Information about a process surrounding a product upon which the customers are dependent to order, supply or manage a product or to develop a downstream product effectively;

- Information about technical features of a product such as technical standards, interfaces, and points of interconnection;

- Information about product performance and reliability, and associated service level commitments, repair procedures etc.

A requirement on the SMP operator to provide all of these types of information should be specified as part of the non-discrimination and transparency remedies associated with regulated access to civil engineering infrastructure. Eircom’s retail arm must only have access to these types of information to the extent that similar information is available to external wholesale customers.

Equivalent Ordering and Information Systems

Vodafone considers that the optimal approach to ensure equal treatment in service provisioning processes is the imposition of an equivalence of input obligation. The SMP operator should be obliged to use the same ordering and information systems for ordering wholesale services by its own retail and its external wholesale customers, in which they have access to the same wholesale products and related services. The same systems and processes should also be used for the processes of maintenance and repair.

If the same ordering and information systems are used for providing wholesale services any discrimination can be readily revealed, such as delays in supplying the wholesale service, repair times and the proportion of refusals to supply.

Vodafone also considers that, consistent with the position in the NGA Recommendation, a requirement on Eircom to have measures in place to de-clutter currently used ducts is appropriate and necessary to impose to facilitate potential demand for access to duct capacity.

SLAs and Associated Targets

Vodafone believes that in order to ensure that the same product is being offered to wholesale customers, the SMP operator should be required to enter into Service Level Agreements (SLA) with its customers. The performance of the service levels set out in the SLAs should be regularly measured through the publishing of Key Peformance Indicators (KPIs) showing the service levels of both internal and external service provisioning. SLAs and KPIs should be in place for all NG wholesale products, including access to civil engineering infrastructure.

Reference Offer

Vodafone believes that it is essential that the SMP operator is required to provide a fully detailed and transparent reference offer in a timely manner. Our views on the appropriate specification of reference offers are set out in response to subsequent consultation questions in this response.

Risk Premium

With the possible exception of investment in civil engineering infrastructure that may need to be undertaken specifically to deploy a NGA network, Vodafone does not believe that a risk premium or price premium for access to civil engineering infrastructure should apply as this would over-compensate the network owner for investments incurred historically and related to current generation services. This would distort both investment decisions and the dynamics of competition in the market.

Q9. What form of price control would be the most appropriate and proportionate means of establishing the price of access to civil engineering infrastructure? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

Vodafone considers that the adoption of a cost oriented methodology using the most appropriate cost model, by reference in particular to the specific characteristics of civil engineering infrastructure (including ducts), is the optimal form of price control to implement to determine the price of access to civil engineering infrastructure.

Given the, at best, very limited scope for replicability of civil engineering infrastructure such as ducts, Vodafone does not believe that setting access prices for these network assets on the basis of efficient replacement costs is consistent with effectively achieving the objectives of promoting competition, maximising end user welfare, and encouraging efficient investment in NGA infrastructure. Instead we consider that setting access prices on the basis of the maintenance costs of civil engineering infrastructure using a renewals accounting based methodology is the best approach as it appears most consistent with the nature of the infrastructure and the need to maximise regulatory certainty. This is fully in line with Annex I of the NGA Recommendation which makes a clear distinction between replicable and non-replicable assets and suggests using a different cost base for each type of asset.[3]

Duct assets in particular are among the longest lived in the telecommunications network (with a regulatory asset life of 40 years currently determined by ComReg to be appropriate) and for practical purposes the duct infrastructure constitutes a single asset. The asset valuation is also primarily related to the capitalised labour costs involved in installing and maintaining the duct

[3] In determining the cost base used for cost-orientation obligations, pursuant to Article 13 (1) of Directive 2002/19/EC, NRAs should consider whether duplication of the relevant NGA access infrastructure is economically feasible and efficient. Where this is not the case, the overriding aim is to create a genuine level playing field between the downstream arm of the SMP operator and alternative network operators. A consistent regulatory approach may therefore imply that NRAs use different cost bases for the calculation of cost-oriented prices for replicable and non-replicable assets, or at least adjust the parameters underpinning their cost methodologies in the latter case.

network rather than the underlying physical inputs. Given the very long life of this infrastructure, the risk of setting allowable revenues which result in inefficient over-recovery or under-recovery of assets is significant. In addition the deployment of NGA may require significant up-front expenditure in upgrading the existing duct network to allow fibre rollout. Effectively encouraging these investments to be made will require providing investors with certainty on the future recovery of the associated costs.

In light of the above factors, and as duct assets will be used for the provision of both current and next generation broadband services, minimising the level of prices consistent with efficient investment and providing a smooth and predictable profile of allowable revenue appear to be the central matters to address in the approach to access pricing of civil engineering infrastructure (including ducts). The renewals accounting based approach is in Vodafone's the most appropriate methodology to achieve these goals. See Annexe 2 of the attached Frontier Economics paper 'Access Network Costing' for a full account of this approach.

Vodafone does not consider that the potential alternative option of applying a cost oriented benchmark based on the determinations of other NRAs would be appropriate in setting the access price for civil engineering infrastructure. Given differing conditions across countries (labour costs, asset lives, valuation of asset base, accounting methodology), a benchmarked rate for access to civil engineering infrastructure in Ireland may not be closely related to the actual underlying efficient cost of providing access to civil engineering infrastructure incurred by the NGA network owner(s) and should not therefore be considered unless the costs of developing a cost oriented model are disproportionate relative to the benefits, which Vodafone does not believe is likely to be the case.

With respect to the third general option proposed by ComReg, Vodafone considers that given the likely strategic incentives for a dominant vertically integrated NGA network operator not to engage constructively with OAOS seeking access to civil engineering infrastructure during a designated time period for negotiation, utilising this time period merely to delay the emergence of competition based on wholesale access to this infrastructure, this does not appear to be an appropriate approach to use.

Q10. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the terminating segment? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

Having regard to all relevant considerations, Vodafone consider that it is essential that there is a requirement for a remedy mandating access to the terminating segment and we are fully in agreement with the clear position of the NGA Recommendation in respect of access to the terminating segment. In particular Vodafone agrees with the strong emphasis placed by the NGA Recommendation on the determination of the appropriate distribution point, taking account of both technical and economic factors.

It is essential that the distribution point(s) to which access to the terminating segment is mandated can host a sufficiently large number of end user connections to be commercially feasible for efficient OAOs to utilise. Vodafone considers that the minimum distribution to which OAOs must be able to interconnect must allow for connection to at least 2,000-3,000 households. Any point of interconnection below this level of the network would host too few connections and require incurring a level of costs so substantial as to pose, for all practical purposes, an insurmountable barrier to use of this form of WPNIA based access by OAOs so as to achieve minimum efficient scale.

Vodafone considers that Eircom's proposal to provide unbundled access from the cabinet in a FTTC scenario in its pilot is contrary to the NGA Recommendation as the distribution point at the cabinet will generally not be able to host connections to more than 200-500 households. As pointed out in our response to question 2 it may be necessary to conduct a supplementary consultation once eircom's proposals in respect of mass market deployment become clear. While this point of interconnection may be technically feasible, it is not an economically viable means of WPNIA based access for an efficient OAO to achieve sufficient scale to compete effectively. For this reason, the network architecture to be used in the Eircom pilot is not the basis on which a broader deployment of an NGA network could be undertaken by the SMP operator without essentially precluding any prospects for competition on the basis of wholesale access to the terminating segment.

It is therefore vital in the interests of the promotion of sustainable competition and the maximisation of end user welfare in particular that ComReg mandate access to the terminating segment at a level sufficient to host at least 2,000-3,000 household connections. This can be most effectively achieved in the context of deployment by the SMP operator of a point to point (P2P) architecture by the SMP operator for its NGA network and ComReg must use all available regulatory tools to incentivise the use of this architecture from the outset.

Vodafone also considers that it is important that there is flexibility in terms of the points in the network at which OAOs can interconnect. While it is essential, at a minimum, that access to the terminating segment is mandated at a level sufficient to host at least 2,000-3,000 connections, OAOs should have a number of options in terms of points of interconnect at different levels of the network to provide the widest scope for competition on the basis of wholesale access. In particular Vodafone believes that access at relatively high levels of the network, such as at national or regional points of interconnect, should be facilitated. Efficient OAOs competing on this basis could, once they build sufficient scale in terms of customer numbers, move to forms of wholesale access involving greater use of their own network infrastructure elements.

Q11. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the terminating segment?

Vodafone considers that factors (a) and (d) as identified in Article 12(2) of the Access Directive and set out at paragraph 1.25 of the present consultation are the most relevant factors when assessing proportionality consideration with respect to the adoption of a regulatory remedy of access to the terminating segment.

While all of the factors indentified in the Access Directive must be taken into account, Vodafone considers that the greatest weight must be attached to (a) the technical and economic viability of using or installing competing facilities and (d) the need to safeguard competition in the long term, with particular attention to economically efficient infrastructure-based competition.

Q12. Where is an appropriate distribution point to which access to the terminating segment should be provided, particularly given the need to ensure that it host a sufficient number of end-user connections to be commercially viable for an access seeker.

For the reasons set out in the response to question 10, the appropriate distribution point to which access to the terminating segment should be provided to be commercially viable for an efficient access seeker is at a level in the access network sufficient to host at least 2,000-3,000 end-user connections.

Q13. Should ComReg seek to encourage Eircom to deploy multiple-fibre lines in terminating segments and, if so, how? Please explain your reasoning.

Vodafone believes that the most important determinant of competition is actually the location of the distribution point from which the drop segment – whether this is single or multiple-fibre – then runs. Multiple fibre lines in themselves will not safeguard competition if the distribution points from which they are accessed are not economically viable for efficient access seekers to use.

Vodafone must emphasise however that we consider that the situation in which the SMP operator deployed on its own a national NGA network on the basis of a GPON network architecture would be the least desirable option, of the approaches to NGA deployment potentially available, with respect to the promotion of competition and the maximisation of end user welfare. In the scenario where a co-investment model of NGA network roll-out were implemented (specifically the joint funding and construction of a single NGA network, whether GPON or P2P, in which the connection to the customer is allocated by the co-investment company to whichever investor acquires that retail customer), customers can readily switch between different owners of the joint network since all have equal rights to a particular customer connection. In these circumstances, multi-fibre will normally add no additional competitive benefit (an exception might be if the co-investment network company uses a passive GPON architecture). The co-investment model would therefore solve the problem which multiple-fibre lines is intended to address, without a need for ComReg to encourage it or require it as a feature.

Similarly it is Vodafone's view that a NGA network rolled out using a P2P network architecture – which is capable of being fully unbundled (and to which consequent access remedies should apply), would not obviously require multiple fibre line deployment since customers could be readily switched between retail service providers using the same fibre.

Q14. If a remedy requiring the provision of access to the terminating segment were to be appropriate, are measures to implement each of the principles set out in Annex 2 of the NGA Recommendation necessary and, if so, how might each be appropriately stated and implemented? Pleas provide a reasoned response for each of the principles.

Vodafone strongly agrees with each of the equivalence principles regarding access to the terminating segment as set out in Annex 2 of the NGA Recommendation. We believe that it is essential that these are effectively implemented so as to safeguard against anti-competitive discrimination and ensure a level playing field, from a competitive perspective, for any OAO(s) seeking to compete against the SMP operator in the retail market while requiring access to the terminating segment. The necessity for effective implementation of these principles is demonstrated by the breaches notified to Eircom in respect of its non-discrimination and transparency obligations in the current generation WBA market and other markets in the past.

Equal Access to Information

The principle of information equality covers the availability, timing of availability, and accuracy of relevant information to OAOs as is provided by the SMP operator to its own downstream arm. Relevant information includes information that wholesale customers would reasonably require in the course of their business such as:

- Product information including knowledge of new product development, changes to existing products, pricing packages or investment plans;
- Information about a process surrounding a product upon which the customers are dependent to order, supply or manage a product or to develop a downstream product effectively;
- Information about technical features of a product such as technical standards, interfaces, and points of interconnection;
- Information about product performance and reliability, and associated service level commitments, repair procedures etc.

A requirement on the SMP operator to provide all of these types of information should be specified as part of the non-discrimination and transparency remedies associated with regulated access to the terminating segment. Eircom's retail arm must only have access to these types of information to the extent that similar information is available to external wholesale customers.

Decisions on network standards, topology and deployment will be made by eircom well in advance of product development. As outlined previously these decisions fundamentally affect the investment and wholesale purchase decisions of other operators. Therefore any non-discrimination and supporting transparency obligations should also comprehend the network elements that might support regulated NGA services.

Equivalent Ordering and Information Systems

Vodafone considers that the optimal approach to ensure equal treatment in service provisioning processes is the imposition of an equivalence of input obligation. The SMP operator should be obliged to use the same ordering and information systems for ordering wholesale services by its own retail and its external wholesale customers, in which they have access to the same wholesale products and related services. The same systems and processes should also be used for the processes of maintenance and repair.

If the same ordering and information systems are used for providing wholesale services any discrimination can be readily revealed, such as delays in supplying the wholesale service, repair times and the proportion of refusals to supply.

SLAs and Associated Targets

Vodafone believes that in order to ensure that the same product is being offered to wholesale customers, the SMP operator should be required to enter into Service Level Agreements (SLA) with its customers. The performance of the service levels set out in the SLAs should be regularly measured through the publishing of Key Peformance Indicators (KPIs) showing the service levels of both internal and external service provisioning. SLAs and KPIs should be in place for all NG wholesale access products, including access to the terminating segment.

Reference Offer

Vodafone believes that it is essential that the SMP operator is required to provide a fully detailed and transparent reference offer in a timely manner. Our views on the appropriate specification of reference offers are set out elsewhere in this response.

Q15. What form of price control would be the most appropriate and proportionate means of establishing the price of access to the terminating segment? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

Vodafone considers that the adoption of a cost oriented methodology using the most appropriate cost model, by reference in particular to the specific characteristics of the network elements relating to the terminating segment, is the optimal form of price control to implement to determine the price of this form of wholesale access. However, a ‘retail minus’ cross check may also be required to allow operators to adopt penetration pricing in the early years of fibre rollout without engaging in a margin squeeze. The regulated price should be the lower of the cost plus or retail minus methodologies.

See Annexe 2 of the attached Frontier Economics paper ‘Access Network Costing’ for a full account of the appropriate approach to costing of the network assets relevant to the terminating segment.

Q16. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled fibre loop? How might this be achieved in light of Eircom’s proposed or alternative network architectures? Please explain your reasoning.

Having regard to all relevant considerations, Vodafone consider that it is essential that there is a requirement for a remedy mandating access to the unbundled fibre loop and we are in agreement with the clear position of the NGA Recommendation in respect of ensuring that this form of wholesale access is available to OAOs on a regulated basis.

Vodafone agrees that the most appropriate point in the NGA network for access by OAOs to the unbundled fibre loop is the metropolitan point of presence (MPoP). Taking account of both technical <u>and</u> economic factors, it is essential that the distribution point(s) to which access to the unbundled fibre loop are mandated can host a sufficiently large number of end user connections to be commercially feasible for efficient OAOs to utilise. The MPoP is the most appropriate point of interconnection as Vodafone considers that potential access points at lower levels of the network would host too few connections and require incurring a level of costs so substantial as to pose, for all practical purposes, an insurmountable barrier to use of this form of NG WPNIA product by OAOs so as to achieve minimum efficient scale.

Vodafone considers that Eircom's proposal to provide unbundled access from the cabinet in a FTTC scenario in its pilot is contrary to the NGA Recommendation as the distribution point at the cabinet will generally not be able to host connections to more than 200-500 households. While this point of interconnection may be technically feasible, it is not an economically viable means of WPNIA based access for an efficient OAO to achieve sufficient scale to compete effectively. For this reason, the network architecture proposed to be used in the Eircom pilot is not the basis on which a broader deployment of an NGA network could be undertaken by the SMP operator without essentially precluding any prospects for competition on the basis of wholesale access to the unbundled fibre loop.

For practical purposes, access to the unbundled fibre loop is currently only feasible in the context of deployment by the SMP operator of a point to point (P2P) architecture by the SMP operator for its NGA network and, in the interests of promoting competition and end-user welfare in particular, ComReg must therefore use all available regulatory tools to incentivise the deployment of this architecture in a wider NGA network deployment.

Q17. Are obligations to provide access to associated facilities necessary and, if so, what should these encompass? Please explain your reasoning.

Vodafone considers that obligations on the SMP operator to provide access to facilities associated with access to the unbundled fibre loop are essential to enable effective use of the unbundled fibre loop by OAOs. Access to associated facilities must include access to co-location and backhaul.

An obligation on the SMP operator to provide access to co-location is essential as, in its absence, the SMP operator may not make sufficient provision in terms of floor space, power supplies and other elements that are required to make it physically and technically possible for OAOs to access the unbundled fibre loop. A specific requirement for the SMP operator to manage its infrastructure efficiently so as to facilitate co-location for OAOs is warranted in this context.

An obligation to provide access to backhaul is also necessary as it may not be economically feasible for OAOs to provide their own backhaul, or to obtain it on feasible terms from third parties, in many instances.

Q18. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the unbundled fibre loop and associated facilities?

Vodafone considers that factors (c) and (d) as identified in Article 12(2) of the Access Directive and set out at paragraph 1.25 of the present consultation are the most relevant factors when assessing proportionality consideration with respect to the adoption of a regulatory remedy of access to the unbundled fibre loop.

While all of the factors indentified in the Access Directive must be taken into account, Vodafone considers that the greatest weight must be attached to (c) the initial investment by the facility owner, taking account of any public investment made and the risks involved in making the investment and (d) the need to safeguard competition in the long term, with particular attention to economically efficient infrastructure-based competition.

Vodafone considers that the key public policy objectives for roll-out of fibre based networks are to ensure the widest possible availability of ultra-fast broadband services, and for these services to be priced at a level that encourages rapid and extensive take-up by end-users. These dual objectives require an appropriate balance being struck between providing effective incentives for efficient investment, and facilitating prices at attractive levels that allow for strong early take-up by firms and consumers.

Q19. What do you consider to be an appropriate point in Eircom's network for the provision of unbundled access to the fibre loop in a FTTH scenario? Please explain your reasoning, including views on associated technical and commercial considerations.

Vodafone considers that the metropolitan point of presence (MPoP) or local exchange is the most appropriate point in Eircom's NGA network for the provision of unbundled access to the local loop in a FTTH scenario. Taking account of both technical <u>and</u> economic factors, it is essential that the distribution point(s) to which access to the unbundled fibre loop are mandated can host a sufficiently large number of end user connections to be commercially feasible for efficient OAOs to utilise. The MPoP is the most appropriate point of interconnection in a FTTH network architecture as Vodafone considers that potential access points at lower levels of the network would host too few connections and require incurring a level of costs so substantial as to essentially preclude the use of this form of NG WPNIA product by OAOs so as to achieve minimum efficient scale.

Q20. If it is not possible for commercial or technical reasons to provide for unbundled access at this time, what factors might change this over time? What measures should ComReg take on a transitional basis to provide for the nearest equivalent alternative constituting a substitute to physical unbundling and what other safeguards might be necessary?

Vodafone considers that competition by OAOs on the basis of access to the unbundled fibre loop, even where the NGA network architecture would be optimised for doing so (i.e. P2P), faces serious challenges due to the high market share threshold required to achieve the minimum efficient scale that would justify the significant up-front costs of this form of wholesale access. Competition on the basis of access to the unbundled fibre loop may therefore only be commercially viable in a limited number of areas even in the best case.

Vodafone nonetheless believes that the prospects for sustainable competition on the basis of access to the unbundled fibre loop must be maximised in terms of ensuring that the most pro-competitive network architecture is used in a broader NGA network deployment. The situation where it would not be possible for commercial or technical reasons to provide for unbundled access would clearly be an unfavourable outcome in terms of the achievement of ComReg's statutory objectives, including the promotion of competition and the welfare of end users. However as full NGA network deployment has not yet commenced this sub-optimal scenario is avoidable. It remains open to the SMP operator to deploy a P2P architecture for its NGA network, which would facilitate effective unbundled access, and ComReg must therefore use all available regulatory tools at this pre-deployment stage to incentivise the adoption of this architecture in a wider NGA network deployment.

Vodafone considers that unbundling of a GPON network is not currently feasible but that potential future technologies such as wave-division multiplexing (WDM-PON) could change this position in future. The standards for this technology remain under development and its prospects remain uncertain, however Vodafone believes that its pro-competitive implications warrant ComReg making every endeavour in relevant fora to achieve standardisation of this technology.

The impact of a WDM-PON technology on the feasibility of unbundled access, if it emerges at all, would arise only over the medium term. Therefore in the event that it is not possible for commercial or technical reasons to provide for physical unbundled access in the near term, such as where the SMP operator adopts a GPON architecture for wide-scale NGA network deployment, we consider that it is essential that ComReg adopt measures to provide for the nearest equivalent alternative constituting a substitute to physical unbundling.

Vodafone believes that a virtual unbundled access product (VULA), with technical interfaces specified to maximise the scope for service differentiation, and a regulated price structure with a relatively low marginal costs and relatively high fixed costs structure would be the nearest equivalent alternative to physical unbundling. Vodafone considers that the provision of a VULA product by the SMP operator should be mandated by ComReg in the event that it is not feasible to provide for unbundled access. However Vodafone believes that this product should also be required to be available to OAOs on a longer term basis even where the overall NGA network architecture facilitates unbundling, at least outside of those limited areas where use of physical unbundled access inputs by access seekers may have the potential to be commercially viable. Vodafone's views in relation to the technical specification and pricing approach to a VULA product is set out in detail in the response to consultation questions 38 and 46.

Q21. Is a remedy requiring the development and publication of a reference offer for the provision of access to unbundled fibre loop and associated facilities necessary and what specific issues should be detailed within it? Please explain your reasoning.

Yes. A remedy requiring the development and timely publication of an updated reference offer for access to the unbundled fibre loop is essential to enable OAOs who may seek to avail of regulated access to the unbundled fibre loop and associated facilities to do so on terms that are transparent, detailed and non-discriminatory. This approach would also be in accordance with the NGA Recommendation.

Vodafone considers that the reference offer must at least contain the minimum conditions specified in Annex 2 of the Access Directive.

Q22. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

Vodafone agrees with the position of the NGA Recommendation that a reference offer should be published not later than 6 months after the imposition of an obligation to grant access. This will provide visibility to OAOs on the terms of an offer of unbundled access to the fibre loop in a timely manner which provides necessary visibility to assess the merits of competition on the basis of this form of wholesale access.

Q23. What specific non-discrimination remedies are required with respect to the provision of access to the unbundled fibre loop and associated facilities? Please explain your reasoning.

Non-discrimination remedies are required so as to safeguard against anti-competitive discrimination and ensure a level playing field, from a competitive perspective, for any OAO(s) seeking to compete against the SMP operator in the retail market while requiring access to the unbundled fibre loop and associated facilities. The necessity for effective implementation of remedies adhering to the principles set out below is demonstrated by the breaches notified to Eircom in respect of its non-discrimination and transparency obligations in the current generation WBA market and other markets in the past.

Equal Access to Information

The principle of information equality covers the availability, timing of availability, and accuracy of relevant information to OAOs as is provided by the SMP operator to its own downstream arm. Relevant information includes information that wholesale customers would reasonably require in the course of their business such as:

- Product information including knowledge of new product development, changes to existing products, pricing packages or investment plans;
- Information about a process surrounding a product upon which the customers are dependent to order, supply or manage a product or to develop a downstream product effectively;
- Information about technical features of a product such as technical standards, interfaces, and points of interconnection;
- Information about product performance and reliability, and associated service level commitments, repair procedures etc.

A requirement on the SMP operator to provide all of these types of information should be specified as part of the non-discrimination and transparency remedies associated with regulated access to the unbundled fibre loop and associated facilities. Eircom's retail arm must only have access to these types of information to the extent that similar information is available to external wholesale customers.

Decisions on network standards, topology and deployment will be made by eircom well in advance of product development. As outlined previously these decisions fundamentally affect the investment and wholesale purchase decisions of other operators. Therefore any non-discrimination and supporting transparency obligations should also comprehend the network elements that might support regulated NGA services.

Equivalent Ordering and Information Systems

Vodafone considers that the optimal approach to ensure equal treatment in service provisioning processes is the imposition of an equivalence of input obligation. The SMP operator should be obliged to use the same ordering and information systems for ordering wholesale services by its own retail and its external wholesale customers, in which they have access to the same wholesale products and related services. The same systems and processes should also be used for the processes of maintenance and repair.

If the same ordering and information systems are used for providing wholesale services any discrimination can be readily revealed, such as delays in supplying the wholesale service, repair times and the proportion of refusals to supply.

SLAs and Associated Targets

Vodafone believes that in order to ensure that the same product is being offered to wholesale customers, the SMP operator should be required to enter into Service Level Agreements (SLA) with its customers. The performance of the service levels set out in the SLAs should be regularly measured through the publishing of Key Peformance Indicators (KPIs) showing the service levels of both internal and external service provisioning. SLAs and KPIs should be in place for all NG wholesale products, including access to civil engineering infrastructure.

Reference Offer

Vodafone believes that it is essential that the SMP operator is required to provide a fully detailed and transparent reference offer in a timely manner. Our views on the appropriate specification of reference offers are set out in response to other consultation questions in this response.

Q24. What form of price control would be the most appropriate and proportionate means of establishing the price of unbundled access to the fibre loop? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

Vodafone considers that the adoption of a cost oriented methodology using the most appropriate cost model, by reference in particular to the specific characteristics of relevant network assets, is the optimal form of price control to implement to determine the price of unbundled access to the fibre loop. This would involve applying a 'renewals accounting' approach to non-replicable assets such as ducts while applying a CCA Regulated Asset Base approach to new fibre investment A 'retail minus' cross check may also be required to allow operators to adopt penetration pricing in the early years of fibre rollout without engaging in a margin squeeze. The regulated price should be the lower of the cost plus or retail minus methodologies.

Vodafone considers that an economic depreciation approach for fibre costing could most effectively take account of the likely limited demand for ultra-fast broadband services during the period when the NGA network would be rolled out.

See Annexe 2 of the attached Frontier Economics paper 'Access Network Costing' for a full account of what Vodafone considers to be the appropriate approach to costing of the network assets relevant to the price of unbundled access to the fibre loop.

Vodafone does not consider that the potential alternative option of applying a cost oriented benchmark based on the determinations of other NRAs would be appropriate in setting the price of unbundled access to the fibre loop. Given differing conditions across countries (labour costs, asset lives, valuation of asset base, accounting methodology), a benchmarked rate for access to the unbundled fibre loop in Ireland may not be closely related to the actual underlying efficient cost of providing access to the fibre loop incurred by the NGA network owner(s) and should not therefore be considered unless the costs of developing a cost oriented model are disproportionate relative to the benefits, which Vodafone does not believe is likely to be the case.

With respect to the third general option proposed by ComReg, Vodafone considers that given the likely strategic incentives for a dominant vertically integrated NGA network operator not to engage constructively with OAOS seeking unbundled access to the fibre loop during a designated time period for negotiation, utilising this time period merely to delay the emergence of competition based on this type of wholesale access, this does not appear to be an appropriate approach to use.

Q25. Should any cost oriented price for FTTH based services attract a risk premium in principle? If so, to what types of network assets/investments should any premium apply and why?

Yes. However the risk premium associated with the higher risk of investment in FTTH network deployment relative to that in existing copper infrastructure should only apply to those network asset elements and investments that are specifically required for the roll-out of NGA. If the risk premium were to apply to all of the network assets and investments made by the access network owner, including those relating to investments in the existing copper network, then the owner would be over-compensated for investment in current generation network assets. In addition such an approach would create distorted investment signals that could encourage inefficient levels of investment in network elements unrelated to NGA investments for which the regulated rate of return exceeded the actual underlying risk adjusted rate of return. At the same time, the incentives for efficient investment in a NGA network could be dampened, and rollout of this network slowed or reduced in geographic scope, as the allowed cost of capital for investments specific to NGA network roll-out would be the same as those for capital expenditure on the copper network, even though the former is higher.

The risk premium should therefore apply primarily to fibre related investments and should not generally apply to network elements that are not specifically related to NGA network rollout, such as civil engineering infrastructure. However in relation to the example given by ComReg of expenditure on duct remediation specifically for the purposes of allowing fibre pull-through, as this investment would be specifically required for the roll-out of the FTTH network a risk premium should also apply to this type of investment.

Q26. What types of co-investment arrangements might warrant a separate regulatory treatment in terms of remedies. Please address in your answer the types of commercial relationships and the type of control over physical infrastructure by multiple operators that you think would be necessary for ComReg to consider this option. If possible, please state if you think such an outcome is feasible or desirable.

Vodafone believes that an arrangement involving a number of existing market players, including the incumbent, investing jointly (potentially also with institutional/financial investors) in a single, separate 'passive only' fibre network company (NetCo) which would rent the passive infrastructure (unbundled loops) to all of them as well as other non co-investing operators would warrant much lighter regulation, or possibly the withdrawal of a SMP designation and associated regulatory remedies imposed on this basis. An effectively designed and implemented co-investment model along these lines would lower the risks of investment for all participants, could access necessary funding more readily, and support the emergence of effective competition in the provision of wholesale access. Vodafone believes that a co-investment arrangement with the following general features would effectively advance key public policy objectives (such as maximising the scope of availability, and consumer take-up, of very high speed internet access) while also justifying a lighter touch approach to regulation:

a) An agreement between the co-investors to establish a single 'passive only' NetCo which they jointly own and manage

b) Some co-investors are NetCo customers which provide telecommunications services in the downstream retail market while others are financial investors with no downstream activities

c) Clear governance rules balance co-investor's interests, including decisions on capital expenditure, network maintenance or upgrades and future network build

d) An up-front agreement on the initial geographic scope and topology of the NetCo's network

e) Sufficient commercial and regulatory certainty over the future regulatory treatment of the NetCo, with certainty in particular in relation to the setting of wholesale prices

Although it would be impractical to set out the detail of how ownership and control arrangements would be specified, it would be essential that the single shared network while being jointly owned and managed by the investing operators, should not be controlled by any one of them. The network company would also have to structurally separate from any and all of its co-investors including in terms of its staffing arrangements.

The network architecture of the NetCo fibre network should be feasible to unbundle, either P2P or employing WDM over GPON. Also participation in the NetCo (in terms of specific identity of the co-investors) should be determined on the basis of transparent, fair and non-discriminatory criteria but with threshold or allocation tools to limit participation on those that placing the highest value on it.

The regulatory treatment of the above general co-investment arrangement would of course be subject to market review, following consideration of specific market conditions, however it would be important that ComReg would set out clearly, on the basis of the information provided on how the model would operate, its intended regulatory treatment of the NetCo prior to investment being initiated. This ComReg position would also have to indicate the circumstances that would be likely to lead to different conclusions on the appropriate regulatory approach. If the NetCo included a significant number of existing service provider co-investors then this should be sufficient to ensure lighter or no SMP regulation.

It is Vodafone's view that 4 or more existing service provider co-investors would be sufficient to ensure much lighter, or no, SMP regulation. It may also be the case that 3 service provider co-investors would be sufficient to ensure a light touch regulatory approach under certain conditions, however a careful assessment of the structure of the NetCo in terms of its implications for downstream competition would be necessary to establish this. If just 2 service provider co-investors (including the incumbent) participated in the NetCo then Vodafone does not believe that this would be sufficient to warrant a materially different regulatory approach to the intensive regulation required where the vertically integrated incumbent operator had exclusive ownership and control of an NGA fibre network.

Q27. Do you have any views as to how ComReg should view the evolution of the market for NGA services particularly in the presence of a rival cable network and its impact in supporting effective competition in downstream markets? How should remedies and regulation generally evolve over time and what criteria should ComReg apply to such decisions?

Vodafone considers that it is important that ComReg continuously monitor the market and be prepared to adjust regulatory remedies, where objectively justified and proportionate, in line with changes in relevant market features such as the scope for OAOs to compete effectively with the SMP operator and any development in competitive pressures from alternative network infrastructures on other platforms such as cable.

As set out in the response to question 26, the emergence of an effective model of co-investment in a NGA network by a sufficient number of operators participating in the retail market would in Vodafone's view require a fundamental review of the whole approach to regulatory remedies. In the event that co-investment does not occur, the extent of the regulatory obligations required to be imposed on the vertically integrated SMP operator will depend primarily on the choices it takes in relation to network architectures and the degree to which these facilitate competition. For example if the SMP operator adopts a P2P network architecture in a wide scale NGA network roll-out, or facilitates use of the wave division multiplexing technology, then this would effectively facilitate use of physical unbundled access products and would in principle warrant a less prescriptive approach to regulatory remedies than other potential choices of network architecture such as GPON. If the resulting use by OAOs of commercially and technically viable unbundled access products led to strong competitive pressures at the retail level in at least some geographic areas, then this might potentially warrant the future withdrawal of the obligation on the SMP operator to provide NG WBA products in these discrete areas.

Vodafone does not believe that the presence of a rival cable network, and such competitive pressure as it may currently or prospectively exert at the retail level in the provision of NGA services, is in itself likely to warrant a significant change to the regulatory approach, at least within the next 3 years. This is the case as, even within the particular geographic areas likely to be covered by both the cable network and any wide scale fibre based network rolled out by eircom (assumed to be generally the more densely populated urban areas over the medium term) it is very unlikely that the presence of these two vertically integrated NGA network operators, and the operators of the other very limited scale FTTH networks currently in the market, would be sufficient on its own to ensure effective competition in the retail market. Moreover broadband services provided over the mobile platform are unlikely to act as effective substitutes for next generation fixed broadband and other communications services offered over fibre based networks at the retail level, at least over the medium term.

It is clear that robust competition in the provision of next generation retail services in these areas would therefore depend on the availability to OAOs of commercially and technically viable NG wholesale access products provided by the current SMP operator at various levels along the ladder of investment. The availability of these forms of wholesale access is unlikely to be available in the absence of a regulatory obligation on eircom to provide them on appropriate terms due to the likely incentives for the vertically integrated SMP operator to restrict the availability of wholesale access, or to fail to offer such access on viable terms. Furthermore Vodafone notes that it does not appear that wholesale access to the cable platform will be available given ComReg's confirmation that UPC has indicated that it has no plans to offer wholesale access to its network.[4] Even if wholesale access via cable were to be made available, contrary to current information, the switching costs for an OAO using wholesale access products of the SMP operator of moving to the cable platform would be very high.

Q28. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to the unbundled copper sub-loop and associated facilities (including backhaul and access to street cabinets) in a FTTN scenario? How might this be achieved in light of Eircom's proposed or alternative network architectures? Please explain your reasoning.

Having regard to all relevant considerations, Vodafone consider that it is essential that there is a requirement for a remedy mandating access to the unbundled copper sub-loop and we are fully in agreement with the clear position of the NGA Recommendation in respect of mandating this form of wholesale access. We also agree that it is important that the remedy of access to associated facilities, including backhaul and co-location in cabinets, is imposed. These obligations are appropriate to impose on the SMP operator as they are a prerequisite to enable OAOs who may wish to compete on the basis of use of this form of wholesale access to do so.

Vodafone notes that while it is important that access to the unbundled copper sub-loop on a regulated basis is an option for access seekers, the economics of OAOs competing on the basis of use of this form of wholesale access appears to be particularly challenging, and consequently demand from OAOs for this form of wholesale access, in the context of a wide-scale NGA network deployment by the SMP operator, is likely to be very limited at best. This is the case as the commercial feasibility of any form of unbundled wholesale access is closely tied to the number of end user connections that can be supported by the associated distribution point. It is essential that the distribution point(s) to which access to the terminating segment is mandated can host a sufficiently large number of end user connections to be commercially feasible for efficient OAOs to utilise.

[4] *ComReg document 1140, paragraph 1.37, page 12*

Vodafone considers that the minimum distribution to which OAOs must be able to interconnect must allow for connection to at least 2,000-3,000 households. Any point of interconnection below this level of the network would host too few connections and require incurring a level of costs so substantial as to pose, for all practical purposes, an insurmountable barrier to use of this form of WPNIA based access by OAOs so as to achieve minimum efficient scale.

Vodafone considers that eircom's proposal to provide unbundled access from the cabinet in a FTTC scenario in its pilot is contrary to the NGA Recommendation as the distribution point at the cabinet will generally not be able to host connections to more than 200-500 households. While this point of interconnection may be technically feasible, it is not an economically viable means of WPNIA based access for an efficient OAO to achieve sufficient scale to compete effectively. For this reason, the GPON network architecture to be used in the eircom pilot is not the basis on which a broader deployment of an NGA network could be undertaken by the SMP operator without essentially precluding any prospects for competition on the basis of unbundled wholesale access.

It is therefore vital in the interests of the promotion of sustainable competition and the maximisation of end user welfare in particular that ComReg, in a FTTC environment, also mandate access at a level sufficient to host at least 2,000-3,000 household connections. This can be most effectively achieved in the context of deployment by the SMP operator of a point to point (P2P) architecture by the SMP operator for its NGA network and ComReg must use all available regulatory tools to incentivise the use of this architecture from the outset.

Q29. What type of backhaul solutions do you consider are appropriate in an FTTN scenario?

Vodafone agrees with the position of the NGA Recommendation that the requirement of access to the copper sub-loop in a FTTN scenario should be supported by the availability of appropriate backhaul. We consider that, at a minimum, an Ethernet backhaul solution should be available.

Q30. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access to the copper sub-loop and associated facilities?

Vodafone considers that factors (d) as identified in Article 12(2) of the Access Directive and set out at paragraph 1.25 of the present consultation - the need to safeguard competition in the long term - is the key factor when assessing proportionality considerations with respect to the adoption of a regulatory remedy of access to the copper sub-loop.

Setting regulated prices based on the replacement cost of copper cable in the context of a wide-scale NGA network deployment would not seem to provide appropriate price signals for efficient future investment by potential entrants or existing OAOs. As the likelihood of future investment in copper cables is very limited, incentivising future investment in copper should not be a primary consideration. A more important consideration is likely to be maximising overall productive efficiency by ensuring the copper asset is adequately utilised.

Q31. Is a remedy requiring the development and publication of a reference offer for the provision of access to the copper sub-loop necessary and what specific areas should be detailed within it? Please explain your reasoning.

Yes. A remedy requiring the development and timely publication of a reference offer for access to the copper sub-loop is essential to enable OAOs who may seek to avail of regulated access to the copper sub-loop and associated facilities (in particular backhaul and facilities for co-location) to do so on terms that are transparent, detailed and non-discriminatory. This approach would also be in accordance with the NGA Recommendation.

Vodafone considers that the reference offer must at a minimum, as set out in the NGA Recommendation, contain the minimum conditions specified in Annex 2 of the Access Directive.

Q32. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

Vodafone agrees with the position of the NGA Recommendation that a reference offer should be published not later than 6 months after the imposition of an obligation to grant access. This will provide visibility to OAOs on the terms of the provision of access to the copper sub-loop in a timely manner which provides necessary visibility to assess the merits of competition on the basis of this form of wholesale access.

Q33. What specific non-discrimination remedies are required with respect to the provision of access to the copper sub-loop, including those associated with co-location? Please explain your reasoning.

Non-discrimination remedies are required so as to safeguard against anti-competitive discrimination and ensure a level playing field, from a competitive perspective, for any OAO(s) seeking to compete against the SMP operator in the retail market while requiring access to the copper sub-loop and associated facilities including co-location and backhaul. The necessity for effective implementation of remedies adhering to the principles set out below is demonstrated by the breaches notified to eircom in respect of its non-discrimination and transparency obligations in the current generation WBA market and other markets in the past.

Equal Access to Information

The principle of information equality covers the availability, timing of availability, and accuracy of relevant information to OAOs as is provided by the SMP operator to its own downstream arm. Relevant information includes information that wholesale customers would reasonably require in the course of their business such as:

- Product information including knowledge of new product development, changes to existing products, pricing packages or investment plans;

- Information about a process surrounding a product upon which the customers are dependent to order, supply or manage a product or to develop a downstream product effectively;

- Information about technical features of a product such as technical standards, interfaces, and points of interconnection;

- Information about product performance and reliability, and associated service level commitments, repair procedures etc.

A requirement on the SMP operator to provide all of these types of information should be specified as part of the non-discrimination and transparency remedies associated with regulated access to the copper sub-loop and associated facilities. eircom's retail arm must only have access to these types of information to the extent that similar information is available to external wholesale customers.

Decisions on network standards, topology and deployment will be made by eircom well in advance of product development. As outlined previously these decisions fundamentally affect the investment and wholesale purchase decisions of other operators. Therefore any non-discrimination and supporting transparency obligations should also comprehend the network elements that might support regulated NGA services.

Equivalent Ordering and Information Systems

Vodafone considers that the optimal approach to ensure equal treatment in service provisioning processes is the imposition of an equivalence of input obligation. The SMP operator should be obliged to use the same ordering and information systems for ordering wholesale services by its own retail and its external wholesale customers, in which they have access to the same wholesale products and related services. The same systems and processes should also be used for the processes of maintenance and repair.

If the same ordering and information systems are used for providing wholesale services any discrimination can be readily revealed, such as delays in supplying the wholesale service, repair times and the proportion of refusals to supply.

SLAs and Associated Targets

Vodafone believes that in order to ensure that the same product is being offered to wholesale customers, the SMP operator should be required to enter into Service Level Agreements (SLA) with its customers. The performance of the service levels set out in the SLAs should be regularly measured through the publishing of Key Peformance Indicators (KPIs) showing the service levels of both internal and external service provisioning. SLAs and KPIs should be in place for all NG wholesale products, including access to the copper sub-loop.

Reference Offer

Vodafone believes that it is essential that the SMP operator is required to provide a fully detailed and transparent reference offer in a timely manner. Our views on the appropriate specification of reference offers are set out in response to other consultation questions in this response.

Q34. What form of price control would be the most appropriate and proportionate means of establishing the price of unbundled access to the copper sub-loop? E.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

Vodafone considers that the adoption of a cost oriented methodology using the most appropriate cost model, by reference in particular to the specific characteristics of the copper sub-loop, is the optimal form of price control to implement to determine the regulated price of access to this unbundled wholesale input.

Given that copper is no longer likely to be the Modern Equivalent Asset (MEA), Vodafone does not believe that setting access prices for the copper sub-loop on the basis of the replacement cost of copper cable is consistent with effectively achieving the objectives of promoting competition, maximising end user welfare, and encouraging efficient investment in NGA infrastructure. In particular a reliance on replacement costs as the basis for access pricing would not appear to provide appropriate price signals for investment, either by existing operators or potential new entrants. Using replacement costs could mean that wholesale access prices could be strongly influenced by fluctuations in copper prices, creating considerable uncertainty around future profitability and possibly leading to significant under-recovery or over-recovery of costs relative to the efficient level.

As there is little prospective economic and consumer benefit from further significant investment in the copper cables, incentivising investment in the copper network should not be a relevant consideration in the pricing of unbundled access to the copper sub-loop. Vodafone considers that more relevant factors in setting the regulated access price are to ensure both that prices are set at the absolute minimum level consistent with the principle of cost orientation so that the copper loop is effectively utilised, and that downstream retail prices are not distorted by variations in the copper price on the commodity markets.

Vodafone considers that setting the regulated price for access to the copper sub-loop using a HCA valuation of the existing copper network (within the areas where NGA network deployment is most likely to occur over the next 3-5 years) and a renewals accounting based methodology for ducts is the best approach in terms of achieving the above objectives.

See Annexe 2 of the attached Frontier Economics paper ‘Access Network Costing’ for a full account of what Vodafone considers to be the appropriate approach to costing of the network assets relevant to the price of unbundled access to the copper sub-loop.

Vodafone does not consider that the potential alternative option of applying a cost oriented benchmark based on the determinations of other NRAs would be appropriate in setting the price for access to the unbundled copper sub-loop. Given differing conditions across countries (labour costs, asset lives, valuation of asset base, accounting methodology), a benchmarked rate for access to the copper sub-loop in Ireland may not be closely related to the actual underlying efficient cost of providing access incurred by the owner of the copper network.

With respect to the third general option proposed by ComReg, Vodafone considers that given the likely strategic incentives for a dominant vertically integrated NGA network operator not to engage constructively with OAOS seeking access to the copper sub-loop during a designated time period for negotiation, utilising this time period merely to delay the emergence of competition based on wholesale access to this wholesale input, this does not appear to be an appropriate approach to use.

Q35. Should fibre or Ethernet backhaul associated with the provision of access to the copper sub-loop attract a risk premium? How might a risk profile associated with the specific costs relating to such access to be determined in light of the principles set out in Annex 1 of the NGA Recommendation, and how should any difference in risk be reflected in a pricing methodology? Please explain your reasoning.

Q36. What circumstances (i.e. degree of availability of effective access to the unbundled loop), would warrant the lifting or variation of WBA access obligations within a given geographic area? Please explain your reasoning.

As set out in the response to question 26, the emergence of an effective model of co-investment in a NGA network by a sufficient number of operators participating in the retail market would in Vodafone's view require a fundamental review of the whole approach to regulatory remedies. In the event that co-investment does not occur, the extent of the regulatory obligations required to be imposed on the vertically integrated SMP operator will depend primarily on the choices it takes in relation to network architectures and the degree to which these facilitate competition. For example if the SMP operator adopts a P2P network architecture in a wide scale NGA network roll-out, or facilitates use of the wave division multiplexing technology, then this would effectively facilitate use of physical unbundled access products and would in principle warrant a less prescriptive approach to regulatory remedies than other potential choices of network architecture such as GPON. If the resulting use by OAOs of commercially and technically viable unbundled access products led to strong competitive pressures in a given geographic area, then this might potentially warrant the variation or withdrawal of the obligation on the SMP operator to provide NG WBA products in that geographic area. However the work done by Vodafone with WIK[5] suggests that the unbundling economics of fibre will be significantly more challenging than they are with copper. Therefore, we do not expect large numbers of fibre unbundlers to emerge (even if the chosen topology would permit it) such that WBA will become unnecessary.

Q37. Having regard to market demand, technical, economic and other considerations, is there a requirement for a remedy mandating access to WBA products and associated facilities (including backhaul) in a FTTH and FTTC scenario? Please explain your reasoning.

There is little if any scope for replication of NGA networks in Ireland on a significant basis. This is due to major factors including the substantial up-front costs that would be involved in such

[5] *'Architectures and competitive models in fibre networks' WIK-Consult report for Vodafone: http://www.vodafone.com/content/dam/vodafone/about/public_policy/position_papers/vodafone_report_final_wkconsult.pdf*

replication and the difficulties of achieving the necessary economies of scale given that population density is low and the population itself is quite dispersed geographically. In addition competition by OAOs on the basis of unbundled access, even assuming that the NGA network architecture would be appropriate for doing so (i.e. P2P or WDM PON) faces serious challenges due to the high market share threshold required to achieve the minimum efficient scale that would justify the significant up-front costs of this form of wholesale access. Competition on the basis of access to the terminating segment and/or the unbundled fibre loop may therefore only be commercially viable, if undertaken at all, in a limited number of areas.

Taking account of these considerations, Vodafone believes that there is a clear requirement for a remedy mandating access to WBA products and associated facilities (including backhaul) in both a FTTH and FTTC scenario, at least in the context where the vertically integrated SMP operator were to have exclusive ownership and control of a NGA network. In the absence of an effective regulatory remedy mandating access to WBA products and associated facilities there would, given the clear strategic incentives for the current SMP operator, be no reason for it to voluntarily offer WBA services to access seekers at all, or on terms that were viable and sufficiently flexible to provide the necessary wide scope for service differentiation to support competition. Without regulated access to appropriately specified NG WBA products offering wide scope for service differentiation there would be no viable basis for many, or any, existing and potential new entrant OAOs to offer wireline next generation broadband services to retail end-users on a widespread basis. This would inevitably lead, at a minimum, to a radical diminution of competition in the retail market.

Q38. In a FTTH or FTTC environment, what technical or enhanced service characteristics might need to be reflected in WBA access products? Please explain your reasoning including views on the extent, if any, to which product differentiation is a necessary characteristic of WBA access products.

Given the limited scope for OAOs to utilise passive or unbundled access remedies for NGA, for the economic and technical reasons outlined in the response to question 37, it is vital in either a FTTH or FTTC environment that OAOs have access to fit-for-purpose WBA products that offer control over the key technical parameters. This would provide the necessary wide scope to OAOs to innovate and differentiate their retail offerings from their competitors (including the SMP operator). Vodafone agrees with the position of the NGA Recommendation in this regard, in particular in relation to its view that there is a need to carefully specify WBA remedies in terms of technical protocols and interfaces to allow for more service flexibility and enhanced service characteristics. Consequently we believe that it is essential that ComReg is deeply involved in the specification of the details of such NG WBA products if effective competition is to be ensured.

Vodafone notes that, in light of the limited potential for use of passive or unbundled access remedies and the need to facilitate service differentiation, NRAs in Austria, Denmark, and the U.K. have now either proposed or implemented NG WBA remedies which are virtual versions of physical unbundling. We note in particular that Ofcom has concluded that competition in the U.K. would be advanced by a virtual unbundled local access (VULA) product. VULA is specified so as to allow control of technical and enhanced service characteristics comparable to that of LLU operators, and which therefore offers equivalent scope in terms of the ability to compete.

The factors underlying the proposals of the above mentioned NRAs for virtual unbundling products are in our view similar to those in Ireland and we believe that the availability of a VULA product on a regulated basis would most effectively promote competition, in particular in those areas where physical unbundled wholesale access inputs is not commercially or technically viable for OAOs to utilise.

Vodafone therefore recommends that ComReg should (at least in areas where physical unbundling remedies are unlikely to be either economically or technically viable) require the SMP operator to make available a VULA product in any broader FTTH or FTTC NGA network deployment.

Vodafone considers that the most important technical and enhanced service characteristics for WBA access products in general (and VULA in particular) are:

1. Flexible support of consumer premises equipment
2. Control over the quality of service delivered to the end customer
3. Flexibility on points of interconnection
4. Ability to support multicast
5. Availability of Ethernet interfaces

Secure delivery of services is also essential, so any WBA products need to provide basic transport security, allowing the OAOs to choose the appropriate higher layer of security to the traffic. They should also be transparent to whatever security procedure the OAOs wish to implement.

1. Flexible support of consumer premises equipment

The consumer premises equipment (CPE) will be a key area of service differentiation and branding in the NGA environment. A ‘wires only’ or one-box solution (where the NTU is a passive device such as a wall socket and the CPE is provided and managed by the OAO) incurs less cost, enables more straightforward fault diagnosis, and offers greater scope for service differentiation for access seekers relative to a two-box solution (where the NTU is an active device owned and managed by the access network owner). From the perspective of retail customers the one-box solution also offers the distinct advantages of taking up less space, power and cabling while allowing for simpler fault diagnosis (as there is one rather than two potential points of failure) relative to a two-box solution.

Vodafone considers that the making available by the SMP operator of an option for a one-box solution for CPE of OAOs should be facilitated by ComReg to the greatest extent practicable given NGA network architecture and other factors. However in the sub-optimal scenario where installation of a two-box solution was the sole form of CPE arrangement available then Vodafone considers that the solution should:

a) Enable installation by the OAO of the active NTU supplied by the access network provider or a compatible NTU purchased by them in the end user premises in an agreed manner along with the OAO’s own CPE. In this way the OAO will at least be fully associated with the full installation.

b) Ensure all active NTUs should support (at the OAO’s request) an Open ATA (Analogue Terminal Adaptor) so that OAOs can supply the customer with an analogue voice service using their voice server if required.

c) Ensure that the active NTU should present a single Ethernet port with no Eircom branding visible.

Vodafone notes that Eircom is currently proposing to provide a one-box solution as part of its FTTC pilot but not as part of its FTTH pilot. In order to provide the necessary wide scope for service differentiation that will be required for OAOs in order to support competition in a NGA environment, Vodafone considers however that it is important that flexible support of CPE through the availability of the option of a one-box solution is specified by ComReg for NG WBA products in any broader NGA roll-out to the fullest extent practicable, and irrespective of the network architecture used.

2. Control over QoS delivered to the end customer

Network operators achieve effective end-to-end QoS by ensuring that networks apply consistent treatment to the discrete categories of traffic types carried over the network. Services such as voice, e-mail, browsing, video-on-demand, video broadcast, high speed internet, and business services have very different requirements in terms of bandwidth, delay, jitter etc. Therefore the primary aspects of quality of service concern the ability to define traffic classes and influence traffic management. Vodafone believes that the SMP operator ideally needs to support at least 3-5 different classes of QoS in order to effectively meet the different requirements of the various types of NGA services that will be available, although there should be flexibility to expand these requirements for any new services that may emerge in future. OAOs should also be able to control the way in which packets are prioritised, thereby allowing them to effectively offer services which require different levels of QoS.

Vodafone observes that Eircom is currently proposing to support 3 different QoS classes that will be maintained end to end in the wholesale bitstream access options offered as part of its NGA pilot. We consider that it is essential that the SMP operator should be required by ComReg to support at least 3 QoS classes, and ideally more, in any NG WBA products offered in the context of a broader NGA network deployment.

3. Flexibility on points of interconnection

The necessary flexible NG WBA products that should be required to be offered by the SMP operator to OAOs should present a range of options as to how and where the latter connect to the NGA network in order to collect the traffic of their end-customers. At a high level, Vodafone considers that National, Regional, and Local interconnection options would, at a minimum, be required to be available to OAOs to enable them to make optimal choices on the form of active wholesale access they would use in competing to provide services in the retail market.

A National WBA product variant would involve the OAO procuring backhaul and core bandwidth from the SMP operator with the latter using its NGA network to transport the aggregated traffic from all areas of the country covered by the network to the point of interconnection.

A Regional WBA product variant would enable interconnection at several points at a number of regional nodes which act as aggregation points for all NGN systems within specific regional geographic areas. OAOs could utilise their own core network capacity but could still use backhaul network capacity from the SMP operator.

A Local WBA product variant would enable OAOs to collect the traffic directly at the location where the Access Node is located. This would enable OAOs to reduce their own backhaul or aggregation network capacity or to obtain this from a third party other than the SMP operator. This product may be of particular relevance to LLU operators on the current generation fixed network as they could potentially leverage their existing power and fibre connectivity where the access node was collocated with the existing copper local exchange. This local access option would also be a central element of a VULA service in particular.

OAOs should also have the flexibility to migrate between the different product variants as their circumstances (number of customers, access to capital for investment etc.) change so that they have the option of competing on the basis of greater reliance on their own network elements.

Eircom is not currently proposing to offer flexible interconnection in the WBA products available as part of its NGA pilot. Vodafone considers that in any broader NGA network deployment it is imperative that ComReg specify, in detail, obligations for the SMP operator to provide access to a range of WBA products enabling access at various points of interconnection that are commercially and technically viable for efficient OAOs to utilise.

4. Ability to support multicast

Emerging next generation retail broadband services include broadcast TV and video-on-demand, particularly as part of a triple-play bundle including voice and standard broadband. Multicast is the optimal means of delivering video services as it sends a single copy of the multimedia stream towards the end customers, replicating it for individual customers as close as possible to the end-customer. It is therefore imperative that multi-cast functionality is supported as a central element of NG WBA products offered by the SMP operator over its NGA network. In the absence of such a requirement OAOs may be unable to offer IP TV commercially.

Multi-cast functionality is currently proposed to be supported by Eircom in its FTTH and FTTC pilots and Vodafone considers that ComReg must ensure that multi-cast functionality is supported in any WBA products offered by the SMP operator in a wider NGA network roll-out.

5. Availability of Ethernet Interfaces

Vodafone believes that NG WBA products must be based upon Ethernet technology. Ethernet is well defined, low cost and ubiquitous as it is based on an existing highly competitive ecosystem. The Ethernet packet interface is also highly interoperable, and can be supported by many different types of physical media. The alternative option of an IP interface provides functionality at too high a level and may therefore limit innovation and differentiation. Vodafone notes that Eircom is currently proposing to provide wholesale Bitstream access based on Ethernet as part of its FTTH and FTT pilot and we believe that this must also be a feature of NG WBA products offered by the SMP operator in any wider deployment of a NGA network.

Q39. What are the most relevant factors identified in Article 12(2) of the Access Directive (and set out at paragraph 1.25 of this paper) when assessing proportionality considerations with respect to any remedy governing access WBA products and associated facilities?

Vodafone considers that factors (a) and (d) as identified in Article 12(2) of the Access Directive and set out at paragraph 1.25 of the present consultation are the most relevant factors when assessing proportionality considerations with respect to the adoption of a regulatory remedy of access to the unbundled fibre loop.

We believe that the greatest weight must be attached to (a) the technical and economic viability of using or installing competing facilities and (d) the need to safeguard competition in the long term, with particular attention to economically efficient infrastructure-based competition.

Given the limited scope for OAOs to utilise passive or unbundled access remedies for NGA, for the economic and technical reasons outlined in the response to previous questions, it is vital in either a FTTH or FTTC environment that OAOs have access to fit-for-purpose WBA products that offer control over the key technical parameters and innovative price structures.

Q40. How should the issue of technical protocols and interfaces serving the interconnection of optical networks be approached? Please explain your reasoning.

Please see the answer to question 38.

Q41. Do you think that a requirement for the SMP operator to notify purchasers of WBA 6 months in advance of its launch of a retail products based on NGA inputs is necessary or adequate and, if so, how might it operate in practice? Please explain your reasoning.

As there is unlikely to be an SMP designation in a retail market associated with NGA Vodafone would not see the need for this provided always that (1) there is a minimum of six months lag between the launch of the supporting NGA wholesale product and the associated NGA retail product and (2) that the non-discrimination obligation is sufficiently robust that eircom retail does not receive by whatever means information about impending wholesale products which would allow it to commence retail product development in advance of OAOs who would need to avail of the same wholesale input to compete.

Q42. What effective access, transparency or other safeguards are necessary to guarantee non-discrimination and how might such safeguards impact the need for of level of advance notification discussed above? Please explain your reasoning.

Please see the response to question 38.

Q43. What specific non-discrimination remedies are required with respect to the provision of wholesale broadband access? Please explain your reasoning.

Non-discrimination remedies are required so as to safeguard against anti-competitive discrimination and ensure a level playing field, from a competitive perspective, for any OAO(s) seeking to compete against the SMP operator in the retail market while requiring regulated access to NG WBA products. The necessity for effective implementation of remedies adhering to the principles set out below is demonstrated by the breaches notified to eircom in respect of its non-discrimination and transparency obligations in the current generation WBA market and other markets in the past.

Equal Access to Information

The principle of information equality covers the availability, timing of availability, and accuracy of relevant information to OAOs as is provided by the SMP operator to its own downstream arm. Relevant information includes information that wholesale customers would reasonably require in the course of their business such as:

- Product information including knowledge of new product development, changes to existing products, pricing packages or investment plans;

- Information about a process surrounding a product upon which the customers are dependent to order, supply or manage a product or to develop a downstream product effectively;

- Information about technical features of a product such as technical standards, interfaces, and points of interconnection;

- Information about product performance and reliability, and associated service level commitments, repair procedures etc.

A requirement on the SMP operator to provide all of these types of information should be specified as part of the non-discrimination and transparency remedies associated with regulated access to the copper sub-loop and associated facilities. eircom's retail arm must only have access to these types of information to the extent that similar information is available to external wholesale customers.

Decisions on network standards, topology and deployment will be made by eircom well in advance of product development. As outlined previously these decisions fundamentally affect the investment and wholesale purchase decisions of other operators. Therefore any non-discrimination and supporting transparency obligations should also comprehend the network elements that might support regulated NGA services.

Equivalent Ordering and Information Systems

Vodafone considers that the optimal approach to ensure equal treatment in service provisioning processes is the imposition of an equivalence of input obligation. The SMP operator should be obliged to use the same ordering and information systems for ordering wholesale services by its own retail and its external wholesale customers, in which they have access to the same wholesale products and related services. The same systems and processes should also be used for the processes of maintenance and repair.

If the same ordering and information systems are used for providing wholesale services any discrimination can be readily revealed, such as delays in supplying the wholesale service, repair times and the proportion of refusals to supply.

SLAs and Associated Targets

Vodafone believes that in order to ensure that the same product is being offered to wholesale customers, the SMP operator should be required to enter into Service Level Agreements (SLA) with its customers. The performance of the service levels set out in the SLAs should be regularly measured through the publishing of Key Peformance Indicators (KPIs) showing the service levels of both internal and external service provisioning. SLAs and KPIs should be in place for all NG wholesale products, including access to the copper sub-loop.

Reference Offer

Vodafone believes that it is essential that the SMP operator is required to provide a fully detailed and transparent reference offer in a timely manner. Our views on the appropriate specification of reference offers are set out in response to other consultation questions in this response.

Q44. Is a remedy requiring the publication of reference offers for specific NGA WBA products necessary and if so, what should be contained within such a reference offer? Please provide reasons for your answer.

Vodafone agrees with the position of the NGA Recommendation that a reference offer should be published not later than 6 months after the imposition of an obligation to grant access. This will provide visibility to OAOs on the terms and specification of NG WBA products in a timely manner which provides necessary visibility to assess the merits of competition on the basis of this form of wholesale access.

Vodafone agrees with the NGA Recommendation that there be a requirement for the SMP operator to provide at least six months advance notice to OAOs of any changes that would allow it to modify/enhance its own retail products in the downstream market. This is necessary to avoid discriminatory behaviour on the part of the SMP operator through withholding details of changes such that there would be insufficient time for OAOs to adapt their own business plans and retail propositions. In the absence of this requirement there would be a considerable risk of exploitation by the SMP operator of its informational advantage in a manner that would confer an unfair advantage to its own retail arm.

Q45. What arrangements should be put in place for the publication of a reference offer and how should it be kept updated in light of ongoing developments? Please explain your reasoning.

Vodafone agrees with the position of the NGA Recommendation that a reference offer should be published not later than 6 months after the imposition of an obligation to grant access. This will provide visibility to OAOs on the terms and specification of NG WBA products in a timely manner which provides necessary visibility to assess the merits of competition on the basis of this form of wholesale access.

Q46. What form of price control would be the most appropriate and proportionate means of establishing the price of WBA access? e.g. cost model (cost plus or retail minus), cost-oriented benchmark, or allowing for commercial negotiation. Please explain your reasoning.

Appropriate Form of Price Control

Vodafone considers that the adoption of a cost oriented methodology using an appropriate cost model is the most appropriate and proportionate form of price control to implement to determine the price of WBA access. The SMP operator should be able to recover all relevant costs which have been efficiently incurred and no more. These costs should include a reasonable return on capital employed and where applicable (investments specific to NGA network deployment) this return should be adjusted to take account of the associated risks.

Both a cost-plus model and a retail-minus margin squeeze test should be used in determining the appropriate regulated price of WBA access. The use of a retail-minus margin squeeze test in addition to a cost-plus model would act as a cross-check, and the model approach giving the lowest calculated access price should determine the access price. Vodafone considers that such an approach is necessary to ensure that the key regulatory objectives of avoiding the risk of excessive retail pricing and/or a margin squeeze of OAOs are met.

Importance of Wholesale Price Structure

In determining the appropriate price of WBA access, Vodafone considers that it is important that the structure of pricing in addition to the price level is taken into account. It is generally accepted across Europe that competition by OAOs on the basis of LLU has been stronger than competition on the basis of Bitstream wholesale inputs in the provision of current generation communication services. Vodafone considers that this is due both to the greater control of technical service characteristics <u>and</u> the much greater flexibility to offer differentiated retail tariffs arising from the relatively low per line marginal costs for OAOs allowed by the former type of wholesale access. There would therefore be considerable competition and consumer welfare benefits from ComReg ensuring that WBA access options with both of these key characteristics are available to OAOs in a NGA network environment (in those areas where use of physical unbundling wholesale inputs is unlikely to be commercially feasible).

Accordingly Vodafone believes that NGA Bitstream services should include a VULA product that has a pricing structure comparable to that of existing LLU products. Essentially the VULA pricing structure must allow for reduced recurring line charges that form a relatively small proportion of the total costs to an OAO, with other charges which do not vary as directly with the number of lines (such as for installation, co-location, backhaul, systems interface costs etc.) being introduced or increased so as to account for the major proportion of total costs, thereby still allowing recovery by the SMP operators of its efficiently incurred costs overall.

Vodafone would emphasis that the availability of a VULA product with this general pricing structure would be an additional, albeit key, access option for OAOs and would therefore complement rather than replace other NG WBA products. The detail of Vodafone's views in relation to the appropriate approach to access pricing for WBA wholesale inputs is elaborated in the document "Wholesale Pricing for Next Generation Access Networks: A New Approach" commissioned by Vodafone from Towerhouse Consulting LLP and which is included as an appendix to this consultation submission.

Alternative Options for Price Control

Vodafone does not consider that the potential alternative option of applying a cost oriented benchmark based on the determinations of other NRAs would be appropriate in setting the price for WBA access. Given differing conditions across countries (labour costs, asset lives, valuation of asset base, accounting methodology), a benchmarked rate for access WBA products in Ireland may not be closely related to the actual underlying efficient cost of providing access incurred by the NGA network owner(s) and could therefore lead to inefficient over-investment or under-investment in different forms of wholesale access.

With respect to the third general option proposed by ComReg, Vodafone considers that given the likely strategic incentives for a dominant vertically integrated NGA network operator not to engage constructively with OAOS seeking access to properly specified and efficiently priced WBA products during a designated time period for negotiation, utilising this time period merely to delay the emergence of competition based on this form of wholesale access, the option of allowing for commercial negotiation is not an appropriate approach to adopt.

Q47. If an effective internal separation of Eircom were to be implemented how should this impact on ComReg's regulatory approach?

Vodafone considers that a full and effective separation of Eircom into two independent companies operating in the wholesale and retail spheres respectively would, provided that there were guarantees regarding equivalence of access for all wholesale access seekers, represent a major change in market structure that would in principle permit lighter regulation. This step may also be beneficial in facilitating the emergence of an effective co-investment arrangement.

As Eircom is not functionally or otherwise separated, Vodafone agrees with ComReg that guarantees of equivalence of access are not present. The issue of a significant move toward a light touch regulatory approach, either on an overall national basis or in certain geographic areas, does not therefore arise at present.

Any such potential functional separation is likely to take some time to implement after a decision is made to do so and therefore this issue would be more appropriately addressed at that time and in the context of the actual circumstances of the separation.

Q48. Do you believe that the costing methodology options for determining NGA charges as outlined above are relevant and appropriate? Please provide reasons for your response. Which is the most appropriate methodology and why?

We support the position of the Commission NGA Recommendation on this issue, in particular we consider that the use of different cost bases for the calculation of cost oriented prices for replicable versus non-replicable assets, as referred to by the Recommendation, is the appropriate approach to use in Ireland. Non-replicable assets such as copper and ducts are never really replaced, but rather require ongoing maintenance, and their costing for the purpose of determining NGA charges should therefore be based on their maintenance costs rather than their replacement cost. This approach will avoid over-recovery of cost by the vertically integrated incumbent while facilitating the penetration pricing by OAOs that will be required to drive significant take-up of ultra-fast broadband services over the NGA network at an early stage.

As set out in the Frontier Economics document 'Access Network Costing' included as an Annex to this submission, Vodafone considers that the appropriate costing approach will vary according to the particular characteristics of the network components concerned.

Q49. Should ComReg distinguish between new investment (such as NGA specific equipment) and legacy assets (such as trench) which are used in the provision of NGA services? Please explain your reasoning.

Yes. Vodafone agrees in principle that ComReg should distinguish between new investment and legacy assets, although this may present practical challenges.

Q50. What pricing issues might arise where the SMP operator is providing services over both copper and NGA networks concurrently? For example, duplicating infrastructure in the same geographic area for a temporary period or in different geographic areas. Please explain your reasoning.

Vodafone foresees that a situation might exist where the volume of services carried on the legacy copper network would decline as the volumes associated with the NGA increase. In this circumstance the unit cost of the copper might appear to increase. In this case, consideration may need to be given to changing the treatment of copper based pricing to reflect the fact that the copper would be in the process of being wound down. This will depend on the circumstances that apply at the time and may best be considered in a future consultation at the appropriate time.

Q51. Do you agree with the application of a risk premium as envisaged in the NGA Recommendation? As part of your response please address, insofar as possible, your views on the nature of any such premium, whether and how it could be measured and what its relationship to Eircom's existing (or a potential split) WACC should be.

Yes. Vodafone agrees that the application of a risk premium reflective of the risks faced by operators investing in NGA provided that this risk premium applies only to investments specifically required for roll-out of an NGA network. A risk premium should not in general apply to investment in infrastructure such as ducts or the copper access network as these have been, or are, incurred in the provision of current generation communications services where the associated investment risks are well known and lower than for NGA deployment. An exception may relate to any investment in upgrading ducts that is strictly necessary for fibre pull through.

Vodafone has no objection in principle to the continued use of a WACC approach to determining the risk premium. We consider however that if this approach is used there now appears to be a strong rationale to adopt a split WACC between NGA/fibre specific assets and investments versus legacy assets/investments. This approach appears to be warranted at this time as the risks of NGA network investment are clearer now than when ComReg's current decision on the appropriate

WACC for the SMP operator was made in 2008. Moreover there also appears to be a strong rationale for this approach in terms of the need to provide accurate price signals to encourage efficient investment in NGA specific assets. In this context we note that the current WACC of 10.21% determined by ComReg for eircom was set at a level that takes account of the need to incentivise investment in next generation networks. The absence of any wide-scale rollout of a NGA network by the SMP operator to date indicates that the use of single WACC has not provided sufficient incentive for significant investment in NGA network assets.

If a split WACC approach is adopted then it would appear to follow that the NGA specific WACC will be higher, other things equal, than if a common WACC for all investments – as currently implemented – were used. Consequently the regulated WACC for investments that are not specifically related to NGA deployment, such as ducts and legacy copper based assets, should relate directly to the well known and relatively lower risks of investment in such assets. The WACC for investment in these assets must omit any element of risk premium for NGA investments with a higher risk profile and should therefore, other things equal, be at a lower rate than if a common WACC for all investments were used.

Q52. Do you agree with the NGA Recommendation that any risk premium should only be applied to NGA/fibre specific assets and not to legacy copper based assets (for example, FTTH versus FTTN)?

Yes. Please see the response to question 51.

Q53. Do you believe that the WACC ComReg Decision from 2008 remains appropriate and applicable for NGA investment and allows for sufficient return on investments made and to be made in the future? Please provide reasons for your response.

Please see the response to question 51.

Q54. Do you have any other observations or proposals in relation to NGA investment risk and whether there are mechanisms other than the WACC to account for risk in NGA wholesale pricing?

Q55. Do you agree that the factors above identified are the most relevant mitigators of risk? Should such factors be taken into account when determining wholesale pricing arrangements and, if so how? Are any safeguards necessary?

Vodafone is in broad agreement with the factors identified by ComReg as the most relevant mitigators of risk. We have no objection in principle of the use of long-term up-front supply contracts and volume discounts in sharing, and thereby reducing, the costs and risks of NGA network investments, where there is demand for such arrangements.

Any potential arrangements whereby OAOs make large up-front expenditures or pre-commit to paying for certain volumes of traffic or subscribers, irrespective of whether these volumes are later realised, effectively take on a proportion of the investment risks and thereby reduce the investment risk faced by the incumbent operator in rolling out an NGA network. This has clear potential economic and social benefits in terms for example of a NGA network with a greater geographic and population coverage than would have been deployed in the absence of such cost and risk sharing mechanisms. The implications of cost and risk sharing approaches in general (co-investment, long term up-front supply contracts, volume discounts, full unbundling, and VULA wholesale products as proposed by Vodafone - with their low variable cost and high fixed cost structure) should therefore be reflected in the terms, including pricing, of access to NGA network infrastructure by those OAOs that undertake them. It is appropriate that access prices for these arrangements should be reduced, and price structures adjusted where relevant, to reflect the lower risk premium resulting from risk sharing mechanisms.

Vodafone agrees that the issue of geographic coverage is a key risk mitigation factor and that roll-out of an NGA network initially in urban areas, where the scope for exploiting economies of scale and density are most favourable involves a significantly lower level of investment risk than NGA network investment that also included more rural areas in its early stages.

Vodafone accepts that investment risk is likely to change over time as uncertainty in relation to factors such as the demand for services provided over NGA networks declines. We strongly agree with the position of the NGA Recommendation in relation to the need for the maximum possible level of clarity around how various possible changes in market conditions would be likely to influence subsequent changes to the risk premium for NGA investments. Moreover Vodafone considers that it is essential that a very high degree of transparency is provided by ComReg in relation to how its future policy on this issue may evolve in advance of the commencement of significant NGA network deployment if regulatory certainty is to be maximised.

ComReg's proposal that the application of risk premia to access pricing should be considered on an individual network element basis is appropriate given the very different risk profile of investment in fibre relative to investment in ducts. As the civil engineering infrastructure is the result of historic investment in the provision of existing services associated with the copper network, for which service demand is well-known and mature, no risk premium should be attributed to this network component in those forms of wholesale access of which it is a constituent part.

Q56. In the context of upfront purchase commitments and volume discounts, are any safeguards necessary to ensure efficient investment and the development of effective competition? Please explain your reasoning.

Yes. With regard to long term up-front supply contracts and volume discounts, we would agree that appropriate safeguards for investment and effective competition should be put in place. The criteria set out by ComReg in section 5.78 of the consultation would require that the prices set:

- are not exclusive and do not limit access by other operators to the relevant wholesale product,
- do not create the potential for margin squeeze;

- only reflect the reduction of risk for the investor (i.e. the discount should not exceed the risk reduction)
- do not preclude the operator from engaging in secondary trading

These criteria are in Vodafone's view objectively justified and should guide ComReg's assessment of the terms and pricing of upfront purchase commitments and volume discounts. This approach is necessary so as to maintain correct incentives for efficient investment in the various levels of wholesale access, and to sustain and extend competition.

Q57. Do you believe that all the relevant and appropriate options were considered above regarding the main principles for a margin squeeze test? Please provide reasons for your response.

Yes. Vodafone considers that all the main relevant options in relation to the main principles for a margin squeeze test have been set out and considered by ComReg.

Q58. Are ex-ante price controls or measures required in order to prevent margin squeeze? If so, what is the appropriate methodology to address margin squeeze and what factors should be considered by ComReg when specifying an imputation test (if this approach is deemed to be necessary)? Please explain your reasoning.

Yes. Vodafone considers that it is essential that an ex-ante margin squeeze test is imposed by ComReg on the vertically integrated SMP operator in addition to cost oriented price controls for the various forms of regulated wholesale access. An appropriately specified margin squeeze test would act as an appropriate and necessary means of verifying the outcome of price controls determined on the basis of a cost oriented methodology and would also effectively minimise any scope for excessive retail pricing or foreclosure of competition in the downstream market. Where the margin squeeze test indicates that the price of any given form of wholesale access should be lower than that indicated by the outcome of the cost oriented methodology then Vodafone believes that the lower price implied by the margin squeeze test should be used. This would act to address any hidden source of margin for the SMP incumbent that may not have been accounted for in the cost oriented methodology used.

We are in general agreement with the key features of a margin squeeze test as set out by ComReg in the present consultation. The use of a SEO (Similarly Efficient Operator) test is warranted in order to accurately take account of the significant and enduring scale differences between the vertically integrated SMP operator and OAOs including Vodafone. The use of an EEO (Equally Efficient Operator) test would set an inappropriately high threshold for the detection of a margin squeeze between the price of wholesale access and retail prices which, by adversely affecting the commercial feasibility of efficient but sub-scale OAOs, could seriously impede competition in the downstream market while providing inaccurate build/buy signals to entrants.

Vodafone believes that the minimum market share for the margin squeeze test on a SEO basis should be set at 15% as this equates to the retail market share already held by the leading competitors to the SMP operator in the provision of existing fixed retail broadband services, and could reasonably be regarded as a likely minimum medium-term target market share for other existing OAOs or potential new entrants.

Vodafone considers that appropriate cost standard on which a margin squeeze test should be assessed is that of average total cost (ATC) as this most fully takes account of the central role of fixed costs in providing communications services. Vodafone considers that any methodology that failed to allow for a fixed cost allocation would not reflect the requirement for an OAO to earn its cost of capital, and this would greatly inhibit the scope for downstream competition by purchasers of the SMP operator's regulated wholesale access products.

It is our view that the margin squeeze test should apply to each individual product, rather than to a product range or portfolio.

Q59. Should Eircom be required to maintain existing copper network infrastructure in parallel with NGA network upgrades? If so, then for what period of time? Under what circumstances could a shorter period of parallel operation be appropriate?

Vodafone recognises that the decommissioning of facilities which currently support competition on the basis of unbundled access wholesale inputs is a necessary part of the move to the provision of NGA network based services in the medium to long term and is also key to the commercial feasibility of NGA network investment. However it is also appropriate that OAOs competing on the basis of current generation unbundled wholesale access inputs have the opportunity to earn a return on their investments.

Vodafone strongly agrees with position of the NGA Recommendation in relation to the migrations from current generation copper products to NGA products, which we believe strikes the correct balance between these two factors, and we consider that it is appropriate for ComReg to adhere closely to the principles of the NGA Recommendation in its provisions for migration remedies.

We agree that a 5 year advance notice period for closure of any existing WPNIA facility is appropriate as it broadly aligns with the time period envisioned for recovery of investments in unbundling of the local loop. A shorter period of notification could be allowed either as a result of commercial agreement, or where the SMP operator could make available fully equivalent access. This should take the form of an equivalent wholesale product (such as VULA) at a price which would allow existing users of unbundled wholesale access inputs to face the same economics as are available to them under existing arrangements.

The SMP operator would then have the option to decide whether they wished to adhere to the 5 year notice period and maintain facilities for competitors, or whether they wished to provide an appropriate virtual unbundled wholesale product which would allow them to accelerate decommissioning.

Q60. What forms of fully equivalent access at the points of interconnection (such as exchanges), might justify an advance notice period for decommissioning of less than 5 years? Please explain your reasoning.

Please see the answer to question 59.

Q61. In an NGA setting, what are the most appropriate migration paths that need to be put in place and what are the main technical, operational or commercial issues that would need to be addressed? Please explain your reasoning.

Q62. Are commercial arrangements likely to lead to the most effective outcome in ensuring that an efficient and transparent migration process takes place? Please explain your reasoning.

Commercial arrangements, in the absence of regulation and a regulator prescribed migration framework, are unlikely to lead to the most effective outcome in ensuring that an effective migration process occurs. In the absence of regulation it is not clear that the vertically integrated SMP operator would have clear or sufficient incentives to facilitate seamless migration from current generation ULL products to NGA network based wholesale inputs with at least equivalent functionality and economics as wholesale access seekers would then be in a position to compete effectively against the SMP operator's own retail arm. Regulation will therefore have a central role to play in the process of effecting an optimal migration process.

Q63. How should ComReg ensure that the systems and procedures put in place by Eircom, including operating support systems, are designed so as to facilitate the switching of alternative providers to NGA-based access products? Please explain your reasoning.

Vodafone believes that formulation of effective mechanisms for ensuring the appropriate system design would require iterative engagement between stakeholders and that this might best be dealt with through an industry forum, the output of which would be an advanced draft for the purposes of final consultation by ComReg.

Q64. What would be an appropriate and proportionate regulatory approach for ensuring that information around Eircom's network and its extension plans are made available to WPNIA and WBA access seekers? Please consider issues regarding commercial sensitivity and network integrity when explaining your reasoning.

It is clear from recent press announcements that eircom is making NGA investment decisions and promulgating these to its retail arm without wider industry visibility. In light of this empirical evidence the current transparency and non-discrimination mechanisms appear to be inadequate.

Q65. What should be the format and level of detail to be contained in the network information above and how can the strict confidentiality of such information be maintained? Please explain your reasoning.

Vodafone believes that formulation of effective processes and mechanisms for the dissemination of network information would require iterative engagement between stakeholders and that this might best be dealt with through an industry forum, the output of which would be an advanced draft for the purposes of final consultation by ComReg.

WIK-Consult • Report

Study for Vodafone

Architectures and competitive models in fibre networks

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Executive Summary

With the finalization of the EC's NGA Recommendation there is much debate about how to best deliver the next generation of high-speed broadband networks. Actual FTTH roll-out, however, remains limited in Europe, with most of it based upon GPON technology.

The high capital costs and the long asset life of fibre mean that the technology choices made today will dictate the forms of competition and regulation that develop in these markets for years to come.

This report examines the cost differences and competitive outcomes for different FTTH technologies to determine the impact different technology choices might be expected to have on prices, market entry, penetration and market shares over the long term. Understanding these issues should help policymakers decide whether they should be incentivising particular technology choices today in order to maximize consumer surplus and total welfare in the future.

The various technology scenarios we modelled are:

Technologies suitable for unbundling[1]:

Incumbent	Competitor (Entrant)
Ethernet P2P[2]	Fibre LLU at MpoP
GPON over P2P[3]	Fibre LLU at MPoP
WDM PON	WDM unbundling at Core Nodes

Bitstream-only technologies[4]:

Incumbent	Competitor (Entrant)
GPON	Bitstream access at Core Nodes
GPON	Bitstream access at the MPoP

1 While these technologies have been modelled on the basis of entrant unbundling, this does not preclude, of course, additional bitstream-based entry.
2 P2P – Point-to-Point; PMP – Point-to-Multipoint.
3 This consists of a physical Point-to-Point architecture but with the incumbent using GPON plant "moving the splitters back" to the MPoP with dedicated fibre links in both the drop and feeder segments. Further details are provided in Chapter 2.
4 Due to the underlying Point-to-Multipoint fibre plant GPON cannot be unbundled at central sites. Accordingly wholesale access is bitstream-only.

The modelling approach

Our basic cost modelling relied upon a bottom-up cost modelling consistent with a Greenfield Long Run Incremental Cost approach[5]. We considered both a static model where the relevant FTTH roll-out is completed and the network has (fully) substituted the copper access network and a dynamic approach which considered the time path of investment according to a particular roll-out over time. For purpose of this study we created a hypothetical country of approximately 22 million households referred to as "Euroland". We defined 8 areas or clusters, each having typical network parameters derived out of detailed geo-modelling of access networks in several actual European countries. To determine the extent of viable roll-out we then modelled the total cost of providing NGA services in each cluster and assessed its profitability against demand represented by a typical ARPU of €44.25 per customer per month while entrants earned a 5% lower ARPU.[6]

These cost modelling results provide an indication of the competitive conditions we might expect in the NGA market for each technology as the critical market shares for viability indicated the potential number of competitors which could be supported.

We then developed two competition models which show the strategic interaction between the infrastructure provider and its competitors allowing end-user prices, consumer and producer surplus for all technologies to be compared.[7] We considered models both with and without a second vertically integrated broadband infrastructure (representing cable) to which no other firms have access. The "with cable" model is known as "No-Hinterland", while that without cable is the "Hinterland" model. In both types of models the number of entrants is determined endogenously.

Overall results

Our overall results reveal a clear distinction between technologies that can be physically unbundled and those bitstream-only technologies that cannot.

1. Scenarios based on networks suitable for unbundling generate greater consumer surplus and total welfare than those based on GPON bitstream access.

While our results are less clear on which technology suitable for unbundling should be preferred, this is an important conclusion for European policymakers because it sug-

5 As there often is available infrastructure from existing networks which may be reused to generate investment savings we also undertook Brownfield sensitivity calculations.

6 In the dynamic extension of the model we accounted for growing demand over the 20 year period of the model up to a maximum of 70% penetration.

7 In our competitive models, the incumbent owns and invests in an FTTH network to which entrants must obtain access in order to provide NGA services. As we found that infrastructure replication is only theoretically viable in the densest cluster we do not consider it to be of major relevance to FTTH competition so did not consider it further.

gests that the current trend – towards bitstream-only GPON – is clearly inferior to any option that is suitable for unbundling. Such architectures, whether P2P, GPON over P2P or WDM PON would deliver greater consumer surplus and total welfare. P2P architectures are available today, but WDM PON would require the adoption of new standards in Europe.

In addition, we find in our modelling that

2. GPON (i.e. closed and not suitable for unbundling) is only about 10% cheaper to roll-out than Ethernet P2P so open technologies can achieve the same coverage as closed GPON. In our basic model, the benefits of Ethernet P2P outweigh the additional investment costs and deliver higher consumer surplus and total welfare.

3. Proper pricing for wholesale access is essential, with a particularly strong impact on the unbundling options. Increasing wholesale prices by 10% can have a significant impact on the critical market shares for entrants and their competitive coverage at the given ARPU.

4. Under other assumptions, WDM PON would be the best choice if that technology becomes commercially available for the access network.

Networks suitable for unbundling generate greater consumer surplus and total welfare.

The table below summarizes our basic model results for monthly consumer surplus (CS) and total welfare (W) per month.

	Hinterland ("no cable")					No-Hinterland ("with cable")				
		CS		W			CS		W	
Scenario	**Entrants**	**Mio €**	**Rank**	**Mio €**	**Rank**	**Entrants**	**Mio €**	**Rank**	**Mio €**	**Rank**
P2P unbundling	3	243.1	2	279.2	2	4	466.9	1	490.3	2
GPON over P2P unbundling	3	245.6	1	283.6	1	3	434.0	2	493.8	1
WDM PON unbundling	4	240.5	3	270.8	3	4	431.2	3	473.9	3
GPON Bitstream Core	4	216.8	4	247.7	4.5	4	400.5	5	445.7	4.5
GPON Bitstream MPoP	3	208.6	5	245.4	4.5	4	416.0	4	445.1	4.5

In terms of total welfare, P2P architectures provide the best results, with GPON over P2P unbundling narrowly beating Ethernet P2P unbundling, while WDM PON ranks consistently third both for total welfare and consumer surplus, usually with a significant margin.[8] The two bitstream scenarios compete for last place.

We ran a number of sensitivities in addition to the base-case results reported in the table above including the quality of service deliverable by the various architectures, customers' willingness to pay for greater quality and the incumbency advantage. Considering the consistency of rankings for consumer surplus and total welfare across these sensitivities we found:

(i) WDM PON unbundling always comes up among the best;

(ii) P2P unbundling shows a variable ranking, but is usually in the first tier;

(iii) GPON over P2P unbundling is also quite variable but mostly ahead of P2P;

(iv) GPON with bitstream access at the core is as variable as P2P, but it shows up mostly in the second tier and would rank even worse under weak regulation; and

(v) GPON with bitstream access at the MPoP is always among the lowest-ranked.

In every scenario we modelled, the technologies suitable for unbundling ranked well above the bitstream-only options.

The additional cost involved in rolling out P2P is only about 10% higher than the one associated with closed GPON: technologies suitable for unbundling can achieve nearly the same coverage as closed GPON architectures.

Incumbent coverage of FTTH could reach up to 64% of the population with no noticeable difference between architectures suitable for unbundling and GPON.

We assume that the fixed network can reach a market share of up to 70% of the total potentially addressable market with the remainder representing DOCSIS 3.0, mobile broadband and non-subscribers. On this basis and assuming our ARPU projections, an incumbent operator can profitably cover a significant part of Euroland with FTTH - about 50% of the population could be covered with P2P or WDM PON while about 64% could be covered with GPON over P2P (or closed GPON). If WDM PON customer premises equipment (CPE) costs could be reduced to the level of GPON CPE, this technology could also cover around 64%. If ducts are available for re-use, coverage can generally

8 The margin is narrow for CS in the Hinterland model, because here WDM PON has 4 entrants, while the two P2P scenarios only have 3 entrants.

be extended one additional cluster (Less Suburban) with the greatest impact on the WDM PON case.

The cost comparison of our five scenarios has shown that overall GPON is the cheapest technology, followed by GPON over P2P, WDM PON and P2P.[9] A P2P fibre architecture requires only slightly higher costs than a closed GPON architecture in the range of 10%, reducing to around 7% if one takes account of the relative timing of investment between architectures. GPON over P2P generates savings compared to an Ethernet P2P architecture further reducing its investment gap with closed GPON.

This result can be understood because the network elements which cause the highest investment requirements, in-house cabling and drop cable, account for ~75% of total investment and these do not differ between any of the architectures.

Cost items like energy and floor space exhibit significant differences among architectures. Ethernet P2P causes nearly double as much energy cost at the MPoP as GPON and nearly 6 times higher energy costs than WDM PON (in terms of present value). P2P has more than 2.5 times higher floor space costs than closed GPON and nearly 90 times more than WDM PON. These apparently huge differences, however, only have a very limited impact on the overall cost performance of different architectures because the cost share of each of these factors is not more than 1%.

Proper pricing for access is essential.

In our basic models we assume that wholesale access charges are determined according to a Greenfield BU-LRIC cost standard. However, as the policy approach to wholesale charges as well as national specificities, topology, the speed of deployment and copper switch-off will all, of course, influence these wholesale prices which should not be simplistically interpreted as the ‘right’ price for fibre access.

Because of information asymmetries between the incumbent and the regulator, identifying the proper level of the LRIC in a newly emerging network may be a difficult task. Furthermore, there is currently a policy debate on explicitly deviating from LRIC to incentivize FTTH investment. Entrants may have to pay a mark-up on the LRIC based wholesale access charge. We have tested the impact of such policies on competition and welfare on the basis of our modelling approaches.

We find that, based on a given ARPU, increasing the wholesale prices moderately by 10% has a significant impact on the critical market shares and the competitive coverage with the strongest effects occurring in the P2P unbundling scenarios at the given ARPU. The competitive business model would become unviable except in the two most urban areas (18% population coverage). In the bitstream access scenarios the viability of

9 With the exception of the densest urban cluster where WDM PON and GPON over P2P switch ranks, this is consistent over the relevant clusters.

competition is removed from the Suburban area- some 11% of the total population. The general increase in critical market shares indicates a lower number of potential competitors and an increase in risk of insufficient market entry.

Under other assumptions WDM PON could be the best choice, if that technology becomes commercially available for the access network.

The ability to consolidate MDF locations should make WDM PON even more attractive to incumbents.

As WDM PON is expected to enable far longer line lengths and much higher splitting ratios, an incumbent rolling out WDM PON will be able to close many MDF locations and greatly aggregate demand in the remaining nodes. The incumbent might then be expected to realise profits when selling former MDF locations. Such profits have been integrated into our analysis by diminishing the discounted total expenses of rolling out WDM PON. With these profits incorporated into the analysis, WDM PON becomes the most attractive architecture in Cluster 1, becomes second in Cluster 2 and generally reduces the difference to GPON significantly. This may, however, strand the assets of entrants who have invested in active equipment at the MDF.

The relative performance of WDM PON is strongly influenced by the cost of customer premises equipment (CPE).

WDM PON viable market shares are actually lower than bitstream across the first 4 clusters but then jump significantly in Cluster 5 (Suburban). Should WDM PON vendors be able to reduce CPE prices to the level of GPON CPE the critical market shares for viability would be significantly reduced and coverage could be extended by one cluster to Cluster 6 - equivalent to the coverage achievable by GPON and at a slightly lower viable market share. Entrants could penetrate to Cluster 5 (Suburban) with viability at only 12% market share compared with 16% or 28% for GPON bitstream access at the core or MPoP respectively. Generally, WDM PON would then rank first as a technology. Getting WDM PON CPE costs down will require activity in the standards arena.

Notwithstanding these potential developments of WDM PON, the relative attractiveness of it against P2P is strongly influenced by assumptions made on consumers’ willingness to pay for additional quality, the advantages conferred to the incumbent by its brand (known as the incumbency premium) and the technical performance which may be achieved by WDM PON. If, by the time the network is fully rolled-out (after about 10 years) consumers ascribe a high value to ultra high speeds and strongly differentiated retail offerings, then the additional cost of P2P is a price worth paying. If, on the other hand, consumers ascribe only a small value to these attributes, or entrants cannot reach the market shares required for viability, then the savings achievable under WDM PON, while still allowing a form of unbundling, make WDM PON the best technology to maximize consumer surplus and total welfare.

1 Extended Summary

FTTH architectures

1. In this study we consider and evaluate NGA architectures which meet the foreseeable future bandwidth demand and allow for highest bandwidth and quality for end-users and which no longer rely on copper cable elements. These are FTTH architectures only. From all available FTTH architectures we concentrate on the two most relevant architectures in Europe, Ethernet Point-to-Point and GPON. In order to overcome some restrictions and weaknesses being discussed for GPON we also include into our considerations two (G)PON variants, one implementing GPON on top of a passive Point-to-Point fibre plant and a future version of PON, increasing the bandwidth and quality of the current PON systems by using WDM technology on a Point-to-Multipoint fibre topology.

2. We assume the incumbent to be the investor in the NGA network infrastructure. Competitors (new entrants) face the same (efficient) cost if they offer FTTH services on the basis of wholesale access to the incumbent's network, but may achieve a lower ARPU. If the NGA architecture is based on a Point-to-Point fibre plant we have modelled the competitors as using unbundled fibre loops as the wholesale access service. If the architecture is based on a Point-to-Multipoint fibre plant, we consider an active wholesale access at the MPoP or at the core network node locations. In total we consider the architectures and wholesale scenarios as presented in Table 1-1.

Table 1-1 Overview of the architecture scenarios considered

Scenario name	Incumbent architecture	Competitor (Entrant) wholesale base
P2P unbundling	Ethernet P2P	Fibre LLU at MPoP
GPON over P2P unbundling	GPON over P2P	Fibre LLU at MPoP
WDM PON unbundling	WDM PON	WDM unbundling at Core Nodes
GPON bitstream core	GPON	Bitstream access at Core Nodes
GPON bitstream MPoP	GPON	Bitstream access at the MPoP

3. A P2P FTTH fibre architecture deploys individual fibre access lines from the MPoP to each customer home. The complete fibre capacity is available for each customer in the subscriber access network since every customer has a dedicated fibre from his home to the MPoP. Because of the uncertainties of the future bandwidth needs of residential and business customers this Point-to-Point fibre plant appears to be the most future proof solution, since the use of the full optical spectrum per fibre is not restricted by any intermediate technology. MPoPs can serve more fibre links than the largest copper MDFs, which causes therefore no problem of manageabil-

ity. In this architecture the capacity of the fibre can easily and flexibly be expanded by dedicated port equipment. The architecture supports a high security standard.

4. A P2P architecture provides easy unbundled access to the individual fibre line at the MPoP. The competitor just has to install his own Optical Distribution Frame collocated at the incumbent's MPoP, where he then operates his own Ethernet Switch.

5. The GPON technology is designed for Point-to-Multipoint fibre plants. It concentrates the traffic of a significant number of customer access fibres at an intermediate optical splitter location (DP) onto a single backhaul fibre. Optical splitters may be cascaded in order to optimize the fibre count and to adapt it to the end customer distribution. Thus, the fibre plant strongly depends on the optical power budget and the maximum splitting factor. The fibres from the splitters are connected to the customer side of the ODF in the MPoP and patched there to the appropriate OLTs. The OLTs are connected to an Ethernet switch which is the interface to the concentration network. Especially during ramp-up when only few potential customers have become subscribers to the FTTH network this architecture still has considerable spare capacity. GPON systems offer a downstream bandwidth of 2.5 Gbps as shared capacity. In the case of 64 end customers per splitter thus the system supports an average capacity of 40 Mbps for each user. GPON architectures concentrate the traffic onto fewer electronic interfaces at the Central Office than Ethernet P2P. These active components are more complex and more expensive than P2P components, but fewer components are needed. Also the end-user devices are mo-re expensive.

6. GPON systems are more vulnerable to illegal interception, denial of service attacks and more difficult to repair because all users connected to one splitter share the same bandwidth. GPON architectures are well suited to asymmetric traffic, inasmuch upstream and downstream bandwidths differ due to the inherent upstream communication collision. A preponderance of downstream traffic over upstream has so far been the typical residential behavior. Insofar as customer demand moves more towards symmetric traffic patterns, the GPON architecture loses relative performance. The ability of GPON to serve end customers with individual services and bandwidth guarantees is restricted. An increase in bandwidth can be achieved by reducing the splitting factor (the number of customers per OLT) and/or by allocating fixed bandwidth through the OLT administration, or even supplying TDM based services. But the more bandwidth that is allocated to a particular customer, the less that is available to be shared by the others.

7. GPON, deployed with splitters in the field, can at present only be unbundled at the splitter locations close to the end customers. Fibre sub-loop unbundling is not considered in this study as it does not appear to support a sufficiently profitable competitor's business model.

8. Instead of unbundling we consider two bitstream access scenarios in the GPON case, bitstream access at the core network level and at the MPoP level for the competitors' wholesale access cases. The main difference between these scenarios is that the bitstream access at the core level includes the transport through the incumbent's concentration network while in the scenario bitstream access at the MPoP the competitor has to use his own concentration network and may obtain a transparent, non-overbooked bandwidth from the MPoP to his end customers, resulting in higher product quality and the ability of independent product design compared to GPON bitstream access at core nodes. But since the competitor still depends on the incumbent's active components, this quality improvement will not achieve the degree of unbundled fibre local loops.

9. GPON can also be implemented on top of a Point-to-Point fibre architecture by "moving the splitters back" into the central MPoP location and having dedicated fibres in both drop and feeder sections. We consider this combined P2P/GPON architecture because it has the potential to combine advantages of both worlds. All fibres are terminated on the customer sided ports of an ODF and are accessible per patch cables. So every customer still has a dedicated fibre line to the MPoP, thus opening all future fibre and optical spectrum uses one may imagine and also allowing individual use of a single fibre as described in the P2P scenario. Beside this additional option individual customer demand may be served out of the GPON features as described before, whereby the reduction of the splitting ratio could be achieved in an easy manner at the central site just introducing new splitters without affecting the fibre plant in the field. Locating the splitters at a central site allows a more efficient use of the splitters and the OLTs during the roll-out of the services (ramp-up). This generates not only positive cash flow effects but also reduces some risk of investment. The flexibility of the Point-to-Point fibre plant allows one to exchange the transmission systems smoothly over time, customer per customer, if that looks favourable, and thus reduces the supplier dependency of the operator.

10. The associated wholesale product we have considered in this study is an unbundled fibre loop. From a wholesale perspective GPON over P2P is identical with the Ethernet P2P case because it refers to the same P2P outside plant.

11. The fourth architecture we consider and assess is WDM PON. This technology would allow dedicated wavelengths for each customer, resulting in higher bandwidth compared to GPON. Each of these WDM PON wavelengths is announced to support 1 Gbps bandwidth, which can be administered by one or more WDM PON OLTs, operated by different carriers, thus allowing one to unbundle the wavelength. A single OLT will here support up to 1,000 wavelengths with 1 Gbps capacity each in a symmetric manner. The fibre plant may bridge a distance of up to 100 km allowing one to close down all the existing MDF locations except those few for the core network. With this type of WDM PON architecture we have a dramatic increase of dedicated bandwidth per end customer (from 40 Mbps to 1 Gbps) but the

bandwidth peak per customer is reduced to 1 Gbps compared to 2.5 Gbps in the shared GPON case.

12. WDM PON enables a specific unbundling option at the core locations. The associated wholesale access considered is an active line access at the core level, which we call "WDM PON unbundling".

13. Table 1-2 provides our assessment of the relative performance of the four fibre NGA architectures considered in this study on the basis of 10 key performance indicators. This assessment still is qualitatively. Insofar as the indicators relate to investment and cost they will be quantified in a cost modelling approach developed for this purpose. Thereby also the relative importance of the indicators can be and will be taken into account.

Table 1-2: Comparison of access architectures considered

	P2P	GPON over P2P	GPON	WDM PON
Fibre count drop / feeder	◑ / ○	◑ / ○	◑ / ●	◑ / ●
Bandwidth per customer / capability for symmetry	● / ●	◑ / ◑	◔ / ◑	◕ / ●
Max distance from MPoP to customer	10-40km	20km	20km	100km
Ability to cater to business customers	●	◕	◔	◑
Future-proof	●	●	◑	◑
Security	●	◑	◑	◕
Degree of vendor-independency	●	◔	◔	◔
Energy consumption MPoP	○	◕	◑	●
Fault identification and repair	●	◑	◔	◔
Floorspace demand at MPoP	○	◑	◕	●

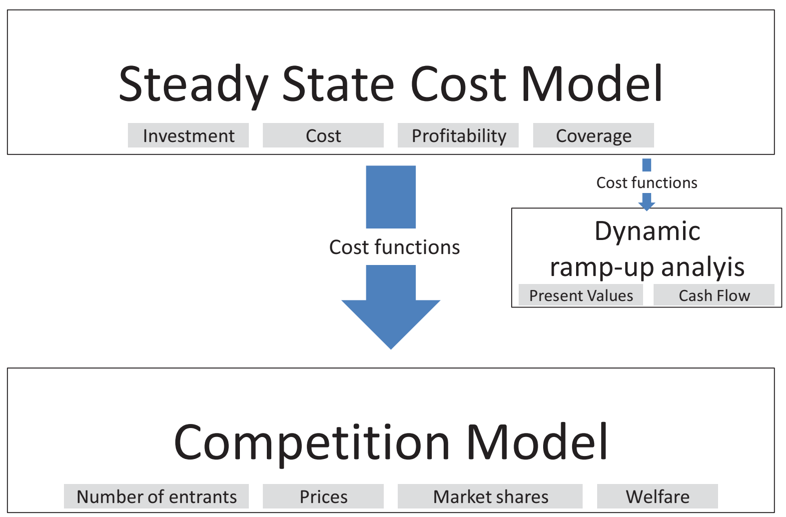
Relatively good ● Relatively poor ○

14. We have not considered and assessed FTTN/VDSL, Active Ethernet, Multi-fibre deployment, FTTB and EPON technologies in this study. These technologies either do not match the long-term capacity requirements of FTTH (FTTN, Active Ethernet, FTTB), are less flexible in customer individual solutions and not or only rarely used in Europe (EPON) or we have dealt with them already extensively elsewhere (Multi-fibre deployment).

Modelling approach

15. We have developed three partly interlinked modelling approaches to analyze the impact of different architectures and wholesale scenarios on investment, cost, profitability, reach, competition, market shares, pricing and welfare. We have used a steady state cost model that feeds cost functions into a strategic competition model. In addition, we have analyzed the impact of a ramp-up over time as an extension of the steady state model, the dynamic model. This model is not connected with the competition model. Figure 1-1 shows the relations between the three models and their primary outputs (grey).

Figure 1-1: Overview of modelling framework



16. Our basic modelling relies upon an engineering bottom-up cost modelling approach. We have modelled the total cost of the services considered under efficient conditions, taking into account the cost of all network elements needed to produce these services in the specific architecture deployed. This approach is coherent with a Long Run Incremental Cost approach as applied in regulatory economics.

17. Our model consists of a static and a dynamic approach. In the static model we compare the cost of a specific NGA deployment in a steady state. In the steady state the roll-out is completed and the FTTH network has (fully) substituted the copper access network. By increasing the market share in percent and comparing the resulting cost per customer with the fixed average revenues per customer we determine the point, where, if at all, the revenues equal the cost. This is the "critical market share" necessary to make the NGA business profitable and hence it deter-

mines the viability range of a network operator. Therefore we model the complete value chain of the operators. Contrary to the steady state model the dynamic approach considers the time path of investment according to a particular roll-out as well as the re-investment pattern.

18. According to the chosen LRIC approach we calculate the cost of each of the four architectures considered following a Greenfield approach. This means that the investor will construct a new, efficient state of the art network from the scratch, assuming that current existing infrastructure, if included in the new network, has to be considered at full current cost. However, in reality there often is available infrastructure from legacy networks which may be reused to generate investment savings. This possibility could have an impact on the investment decision. We analyze this aspect in a sensitivity calculation.

19. For purpose of this study we decided not to choose a dedicated European country but chose a settlement structure which is typical for European countries and designed the hypothetical country for approximately 22 million households or a population of around 40 Mio. inhabitants. This country is referred to as “Euroland”. We have defined 8 clusters, each having typical structural access network parameters derived out of detailed geo-modelling of access networks in several European countries on a nationwide basis. The geo-type characteristics rely on exact data from several countries. In that sense, “Euroland” is a generically representative European country. The clusters are composed in a way that they address similar numbers of potential subscribers.

20. To assess the relative performance of fibre technologies we modelled the total cost of providing NGA services. The access network is modelled in detail in a bottom-up approach. The cost model follows a Greenfield approach for all network elements. As a sensitity we also developed results of a Brownfield approach where the incumbent is able to save investment by using existing infrastructure without opportunity costs. Concentration and core network costs are approximated by a cost function consisting of fixed and variable costs. Besides scaling these cost functions they are the same for the incumbent and the entrant. Demand is represented by an ARPU per customer and month representing a relevant service customer type mix and amounts to 44.25 €. Due to brand and other competitive disadvantages entrants are assumed to achieve a 5% lower ARPU. Wholesale prices of the various access models are based on the LRIC of the network elements of the incumbent. They are calculated at a take-up rate of 70% of the FTTH network, a rate which is a bit less than the market share of the fixed network for all access lines today.

21. The different NGA architectures have a different time pattern of the investment regarding certain network elements. The steady state analysis is not able to cover this aspect. It may, however, have some impact on the relative (financial) performance of the architectures. We have therefore also developed a dynamic approach

which takes into consideration a ramp-up period to deploy the FTTH network. Besides a network deployment period this approach also takes into consideration that demand will be growing over time to reach the target level of a 70% take-up. The model takes a 20 year perspective and therefore also takes replacement investment of the electronic equipment into consideration.

Profitable coverage – Greenfield approach

22. We assume that the fixed network can reach a market share of up to 70% of the total potentially addressable market (access lines), an incumbent operator can profitably cover a significant part of Euroland with FTTH. The area of profitable coverage is relatively invariant of the FTTH architecture which is deployed:

- P2P and WDM PON can be profitably rolled out up to our suburban Cluster 5 or for 50.7% of the population.
- GPON over P2P and GPON can (theoretically) even be deployed up to our Less Suburban Cluster 6 corresponding to 64.4% of the population.

23. Even theoretically, a FTTH infrastructure can be replicated by a second investor only in the Dense Urban Cluster 1 or for 8.1% of the population. In all other viable areas the FTTH investor needs a critical market share of close to or above 50% to become profitable.

Profitable coverage – Brownfield approach

24. An incumbent usually can use existing network infrastructure to deploy a new fibre network. Potential savings due to existing infrastructure relate to trenches, ducts and manholes in all network segments. Potential investment or cost savings depend on the degree of ducting, the availability of (sufficient) spare capacity, the age structure of the passive network infrastructure and the degree of aerial deployment, where no savings through the use of already existing ducts can be achieved.

25. We assume that, where existing ducts are available, these ducts on average already have an average age of half of the equipment life time. Thus the use of existing ducts reduces the investment by (up to) 50%. Potential investment savings depend on the network segment and the architecture. We assume the following saving factors:

- up to 50% in the backhaul (up to 100% ducts usable),
- up to 50% in the feeder (up to 100% ducts usable),
- up to 25% in the drop segment (up to 50% ducts usable).

Potential savings differ by architecture only in the feeder segment, for which we assume

- 10% for P2P and GPON over P2P (many fibres in the feeder segment)
- 50% for GPON and WDM PON (strongly reduced fibre count in the feeder segment)
- In the drop segment potential savings increase with customer density (due to less aerial and more ducts in the dense clusters).

26. Lower investment requirements in a Brownfield approach enable incumbents to increase the profitable coverage with P2P and WDM PON up to the Less Suburban Cluster 6.
27. For all technologies total costs and critical market shares decrease. The strongest effects occur for the WDM PON architecture. Total network costs here decrease by 5% (Cluster 1) to 11% (Cluster 8). The lowest cost savings occur with P2P from 4% (Cluster 1) to 7% (Cluster 3). Cost savings for GPON are higher than for P2P but lower than for WDM PON, and range from 5% (Cluster 1) to 9% (Cluster 4).
28. The investment savings become more transparent by segment:
    - The effective reduction in the drop segment ranges from 7% to 20% depending on the cluster, and is similar for all architectures, since the architectures do not differ in this segment and the differences between the clusters depend on the different degrees of aerial cabling per cluster.
    - In the feeder segment, the savings for P2P are around 7% and for GPON around 40%, because the probability of finding sufficient empty duct space for the higher fibre count of P2P is lower.
    - The savings in the backhaul segment amount to around 40% for WDM PON, since all fibres fit into existing ducts.
29. Even if one assumes a more aggressive approach by doubling the investment cost savings, this would not expand the area of profitable coverage beyond Cluster 6 for any of the architectures.

Potential for competition

30. Competition cannot follow the incumbent in all areas of the FTTH roll-out. Independent of the network architecture and the access scenario considered, the viability of any competitive model ends at least one cluster less than the viability of the incumbent's roll-out (also the theoretic maximum for the competitors).

31. The critical market shares of the different scenarios indicate that in all architectures and competition scenarios potentially several competitors could survive in the mar-

ket. The highest potential number of competitors may occur in the case of GPON bitstream access and WDM PON wavelength unbundling at the core.

32. As expected, business models on the basis of unbundling require (significantly) higher critical market shares than business models based on bitstream access. The unbundling model requires already a critical market share of 24% in Cluster 3, while bitstream access is viable at 4% to 8% critical market share in the same cluster.

33. Because the cost curve of competitors is relatively flat in the relevant range, only slight changes in the relevant parameters (e.g. ARPU) have a strong impact on the profitability. In case of unbundling, for instance, the critical market share jumps from 10% in Cluster 2 to 24% in Cluster 3. The structure of the cost curves in the relevant range makes unbundling a riskier business model than bitstream access.

34. If the wholesale prices also reflect the investment savings of the incumbent then costs and critical market shares of competitors decrease in all competition scenarios. In addition, they can also expand competitive coverage by one cluster with the exception of the LLU scenarios.

35. We have calculated the impact of deviations from LRIC based wholesale prices on the structural conditions of competition. Even a moderate increase of the wholesale prices by 10% reduces the viability of competition and the competitive coverage in most cases. The most significant impacts occur in the LLU unbundling scenarios. Critical market shares of competitors in all scenarios increase significantly.

36. Similar effects occur if the wholesale prices are calculated at a 60% take-up rate of the FTTH network instead of 70%. Wholesale prices will then increase by 10% to 13%.

Investment and cost differences

37. GPON requires the lowest investment compared to all other architectures which we consider. This result holds for each cluster (subscriber density). WDM PON shows the second lowest investments. The investment deltas between P2P and GPON, however, remain moderate and range from 2% (Cluster 8) to 14% (Cluster 1).

38. GPON over P2P generates relevant savings compared to a P2P architecture and requires only moderately more investment compared to GPON.

39. The overall investment deltas between the architectures are relatively small because the network elements which cause the highest investment requirements, in-house cabling and drop cable, account for ~75% of total investment and do not differ between architectures.

40. In order to better understand the relation between the architectures, it is worthwhile to look at the investment deltas in the different network elements. The main reason for the advantage of GPON compared to P2P and GPON over P2P results from the lower investment in port electronics at the MPoP. Feeder investment can become up to double as much for P2P than for GPON. However, feeder investment differences become relatively small in less dense clusters as the additional fibres for P2P do not necessitate additional civil works but cables only. This difference is overcompensated by the use of splitters in the outside plant for GPON. WPN PON suffers from the highest investment in CPE. P2P requires more than two times higher floor-space investment at the MPoP than GPON and nearly 40 times more than WDM PON. These huge differences, however, only have a rather limited impact on the overall investment performance of technologies, because the investment share of this element amounts to less than 1%.

41. The relative performance of WDM PON is very much affected by the cost of customer premises equipment. Should WDM PON vendors be able to reduce CPE prices to the level of GPON CPE the viability of WDM PON could be extended by one cluster to Cluster 6. In addition the critical market shares for viability could be reduced. Generally, WDM PON would rank first as a technology.

42. The cost structure of a competitor in a FTTH network is strongly dominated by the wholesale price. In the bitstream scenarios the cost share of the wholesale price amounts to ~65% (20% market share, Cluster 3). The cost share of the wholesale provision amounts to 57% in case of unbundling.

Dynamic considerations of investment and cost

43. Moving from a static to a dynamic approach, the time path of investment according to a particular roll-out and the re-investment pattern has some impact on the relative investment and cost performance of the different architectures.

44. The overall picture of the relative performance only changes moderately: GPON remains the technology with the lowest investment. WDM PON, however, loses some attraction and becomes the most investment intensive technology. This follows mainly from the higher cost of CPE equipment in case of WDM PON.

45. The time path of the investment differs to some extent between the architectures: Although most of the investment is front-loaded for all architectures, GPON has a lower amount of investment which is driven by the actual number of subscribers. While Ethernet ports in P2P are subscriber driven, GPON’s investment in OLTs is not. The larger share of variable (subscriber driven) investment generates a slightly better risk profile for P2P compared to GPON.

46. Discounting future investment to a present value does not change the ranking between architectures, but the relative difference between P2P and GPON becomes smaller. It decreases from 10% to 7%. The same holds for WDM PON, which remains ranked as number three but the relative difference to GPON decreases to 5%.

47. Completing the picture by including all other network costs (including OPEX and common cost) besides investment, once again does not change the overall ranking of architectures: GPON remains the lowest cost technology, GPON over P2P comes next followed by WDM PON and P2P. The differences between technologies decrease if comparing total (discounted) expenses and investment. In relative terms, the difference in terms of present value of discounted expenses (Cluster 1 to 6) between GPON and GPON over P2P become negligible (~1%); P2P generates ~7% more expenses than GPON and WDM PON ~3% more.

48. Single cost items like energy and floor space exhibit significant differences among architectures.

    - P2P causes nearly double as much energy cost at the MPOP as GPON and nearly 6 times higher energy costs than WDM PON (in terms of present value)[10].
    - P2P has more than 2.5 times higher floor space costs than GPON and even nearly 90 times more than WDM PON.

    These huge differences, however, have only a very limited impact on the overall cost performance of architectures because the cost share of each of these factors is not more than 1%.

49. The incumbent might realize windfall profits when selling former MDF locations. Such windfall profits are not part of the decision relevant costs of a certain architecture. They have, however, to be taken into account in the decision making process of the investor. This is of particular relevance, if such windfall profits are different among architectures. Such windfall profits can conceptually consistently be integrated into our dynamic discounted cash flow analysis. They simply diminish the discounted total expenses of a particular architecture. In this model this is only relevant for the WDM PON case. On the basis of some plausible assumptions we assume a total net revenue of dismantling MDFs for the incumbent of 698 Mio. €, which are 279 Mio. € in present value given the assumed deployment path. These lump-sum profits have a relevant impact on the relative performance of WDM PON. WDM PON becomes the most attractive architecture in Cluster 1, becomes second in Cluster 2 and generally reduces the difference to GPON significantly.

10 CPE power consumption is not included, since we consider an operator's view.

The oligopoly modelling approach

50. The cost modelling results only generated a rough picture on the competitive conditions in the NGA market. It produced clear and definitive results on the replicability of FTTH fibre infrastructure. The critical market shares for viability indicated the potential number of competitors which could exist in the market on the basis of a certain business model. Furthermore, and most importantly, the cost modelling approach generated cost functions for the business models of the incumbent as the infrastructure investor and the access seeking competitors. These cost functions are developed for all architectural and all access scenarios we are considering in this study. The cost modelling approach, however, does not deal with the strategic interaction between the wholesale provider and the competitors. Only if that is taken into account, it becomes possible to predict the “real” market outcome in terms of prices, market shares, profits and the actual number of competitors in the market.

51. We have developed a strategic competition model which is capable to develop a steady-state model of competition in a FTTH oligopoly. The model is able to show the strategic interaction between the infrastructure provider and its competitors and allows comparing end user prices, consumer and producer surplus for all architectural and access scenarios. The focus will be on market outcomes for given investment decisions. The approach, however, will also allow us to quantify the gains from certain investment decisions. It can thus shed some light on investment incentives of the different market players. We can evaluate the effect of regulation on these gains from investment. The oligopoly model uses the output of the cost model, the cost functions of the various market players, as its basic and central input. Furthermore, the critical market shares are used to calibrate the initial number of operators in the oligopoly model.

52. Our modelling approach is based on the pyramid model, which is closely related to the spokes model: For each pair of services, there is a set of consumers who choose between these two products and these consumers are (uniformly) distributed in their willingness to pay for one service rather than the other. Graphically this leads to a pyramid with each service located at one of the tips of the pyramid. Our approach captures essential aspects of competition in FTTH markets, both on the wholesale and retail side. One firm, the “incumbent”, owns and invests in an FTTH access network, to which other firms (“entrants”) must obtain access in order to provide NGA-based services. Entrants are assumed to be symmetric and need to make own investments in order to use NGA access. We consider models both with and without a second vertically integrated broadband infrastructure (“cable”), to which no other firms have access. The services that firms offer are both “horizontally” and “vertically” differentiated. The former means that consumers do not react strongly to small price differences because individual preferences for firms’ brands

differ. In particular, assuming a uniform distribution of individual tastes in this horizontal dimension leads to linear demand functions. As a result of horizontal differentiation, the market is imperfectly competitive and firms will enjoy positive markups. Vertical differentiation expresses differences in service quality and goodwill or brand recognition as perceived by consumers, i.e., at equal prices a firm with higher service quality would attract more consumers. Service quality is assumed to affect all consumers similarly, i.e. we abstract from market segmentation in the service quality dimension.

53. To model that total FTTH subscription demand is variable, we considered two model variants. In both there is a group of “competitive” subscribers. Each competitive subscriber makes a first choice between two of the firms, and unless their offers are very unfavorable, he will choose one of the two. It is assumed that all pairs of preferred firms (before quality differences) are equally likely in the population, so that effectively each firm will compete with any other firm for consumers. Formally speaking, cross price elasticities are different from zero for all product pairs. Due to the assumption of uniform distributions of consumer tastes, the resulting demand function of each firm is linear in its own price and linear in the price of all other firms. This makes the analysis tractable and allows for explicit solutions. In spite of advances in empirical demand estimation that allow for more flexible demand specifications, the linear demand system remains popular in empirical research. Our underlying micro foundation permits us to compare markets with different numbers of firms in a meaningful way. If the firms on the market include the cable firm, our model has the feature that FTTH subscription demand is variable. However, total demand for subscription is fixed and assumed to be 100% of potential subscribers in the clusters considered. We call this the “No-Hinterland” model. In the absence of a non-FTTH-based competitor, we make subscription demand variable with the introduction of “captive” consumers who make a choice between one firm and not buying FTTH subscriptions at all (this is the “Hinterland” model). In line with the critical market share analysis we aim at FTTH subscriptions close to 70% of all potential subscribers in the clusters considered.

54. The access tariff paid by the entrants to the incumbent consists of a price per subscription and potentially also of a fixed fee. In this study we have considered only linear wholesale access tariffs based on the incumbent’s LRIC at a defined network load. In one variant of the model, we determined the linear access tariff such that at the resulting equilibrium quantity, the access payments exactly cover the total cost of providing FTTH access (interpreted as LRIC pricing).

55. We treated the incumbent as if he were under vertical accounting separation into a NetCo that supplies FTTH infrastructure access and an OpCo that sells FTTH end-user services. The incumbent’s NetCo sells access to other firms (“entrants”) and to the OpCo. This does not affect pricing behavior and overall profits but it provides for an automatic price-squeeze test.

56. Depending on the scenario considered, first, firms make certain investments in networks and access, which determine their service quality levels and operating cost. Second, they compete in subscription fees at the retail level. The resulting market outcome is modelled as the Nash equilibrium outcome of the resulting pricing game, from which subscriber numbers, profits, market shares, consumer surplus and total welfare are derived. In the model with entry and exit, we first allow for a non-specified process of entry and exit with the feature that all active entrants make profits and that the entry of an additional entrant would lead to losses of all active entrants. Here we postulate that entrants foresee the effect of entry on the pricing decisions and, thus, on market outcome. Formally, and in line with the literature on industrial organization, this means that we consider subgame perfect Nash equilibria of the two-stage game in which entrants first make their participation decision and then all active firms make pricing decisions.

57. Besides the cost functions for the various market players and scenarios the quality of service and willingness to pay assumptions of the various scenarios form another basic input of the competition model. Our assumptions on quality of service (QoS) and the end-users' willingness-to-pay (WtP) are provided in Table 1-3. The values are in Euro-equivalent per month.

Table 1-3: QoS and WtP assumptions for basic model

QoS Scenario	Incumbent QoS =WtP	Cable QoS = WtP	Entrant QoS	Entrant WtP
P2P unbundling	100	82	99	97
GPON over P2P unbundling	99	82	99	97
WDM PON unbundling	95	82	91	89
GPON bitstream core	90	82	85	83
GPON bitstream MPoP	90	82	87.5	85.5

The value of chosen QoS differences may appear large from today's perspective. However, it has to be kept in mind that we are considering steady state situations with full FTTH penetration around ten years from now. It can be expected that the share of customers with high-bandwidth demands and the prevalence of corresponding applications will be much higher than now. Thus, the premium for ultra-high bandwidth will also be much higher than now. In contrast, the incumbency premium will likely become smaller, as time goes by. This justifies the small incumbency premium of 2 Euros over entrants that we have chosen.

Results on end-user prices

58. There are three drivers of prices and price differences: Costs, WtP and competition (number of firms). In addition to the WtP shown above in Table 1-3 we, therefore, have to consider the relevant costs. Prices are directly driven by variable or, more

precisely, marginal costs (MC), not by fixed costs. Fixed costs only influence the level of profits and are, thus, important for entry and exit of firms (which again indirectly affect prices).

59. The equilibrium end-user prices for all scenarios are shown in Table 1-4. While the first two scenarios consistently lead to the highest prices, the order of prices overall differs between the Hinterland and the No-Hinterland model. Because of product differentiation the incumbent's price may be below the entrants' price (for instance, in the GPON over P2P scenario) if the incumbent's variable costs are sufficiently lower to offset for quality and goodwill differences which tends to lead to a higher price. In the No-Hinterland model the equilibrium number of firms is in two cases one higher than in the Hinterland model. In both these cases the order of prices between Hinterland and No-Hinterland model is affected by this difference.

Table 1-4: Marginal costs (MC) and prices (p) in Euro per month

			Hinterland			No-Hinterland			
Scenario	**$MC_{Iperceived}$**	**MC_E**	**n-1**	**p_I**	**p_E**	**n-2**	**p_I**	**p_E**	**p_C**
P2P unbundling	34.36	36.22	3	46.32	44.87	4	42.07	42.37	23.76
GPON over P2P unbundling	32.22	36.22	3	44.71	44.72	3	43.58	45.54	27.92
WDM PON unbundling	33.37	34.00	4	42.46	38.69	4	41.24	39.32	26.16
GPON bitstream core	31.99	32.62	4	41.58	37.44	4	40.10	37.63	28.28
GPON bitstream MPoP	31.53	32.16	3	43.04	40.52	4	38.76	37.67	27.15

Index I: Incumbent, E: Entrant, C: Cable; n: number of operators

60. Retail prices are quite sensitive to the number of firms in the market, if the number of firms is small. Retail prices decrease with the number of firms in the market for all market players. The absolute price differences between incumbent and entrants increase slightly and the relative differences increase significantly in the number of firms. This suggests that entry increases competition among entrants by more than competition between the incumbent and entrants. Competition by cable brings prices of entrants and the incumbent much closer than competition without cable.

Results on profits

61. Table 1-5 gives profits for the basic model for both the Hinterland and the No-Hinterland case. It should be noted that entrants' profits are always reported per entrant.

Table 1-5: Profits in Million Euro (per month)

	Hinterland			No-Hinterland			
Scenario	n-1	$prof_I$	$prof_E$	n-2	$prof_I$	$prof_E$	$prof_C$
P2P unbundling	3	24.83	3.74	4	18.78	0.45	2.81
GPON over P2P unbundling	3	27.89	3.38	3	26.91	6.55*)	13.22
WDM PON unbundling	4	13.05	1.83	4	17.91	2.92	13.09
GPON bitstream core	4	23.71	1.54	4	13.22	2.07	23.72
GPON bitstream MPoP	3	23.60	4.40*)	4	10.00	0.31	17.86

*) With 4 entrants there is a very small loss for each entrant.

Because of its higher retail prices and lower costs the incumbent can persistently earn higher profits than the entrants. This result holds even if one corrects for his larger market share. Profits of cable follow largely the quality differentials to FTTH. The greater the differential the lower is cable's profits.

62. The influence of the number of entrants on profits differs somewhat from the entry effect on prices. The reason lies in wholesale profits. In the Hinterland model wholesale profits (because of the associated increase in overall output) increase in the number of firms, thereby increasing the difference between entrants' profits per firm and the incumbent's overall profits. In the No-Hinterland case the incumbent's wholesale profits are, because of the intervening effect of cable output, first increasing and then decreasing in the number of firms, resulting in a closing of the gap between entrants' profits per firm and the incumbent's overall profits. All firms experience a decline in profits per firm, as the number of firms increases. However, this happens at a declining rate, suggesting in particular that profits per entrant do not change dramatically around the free-entry equilibrium if the number of firms is fairly large.

Results on market shares

63. Table 1-6 provides market shares in the basic model. It should be noted that entrants' market shares are always per entrant.

Table 1-6: Market shares 's' in percent

	Hinterland			No-Hinterland			
Scenario	n-1	s_I	s_E	n-2	s_I	s_E	s_C
P2P unbundling	3	40.7	19.8	4	23.4	13.5	22.5
GPON over P2P unbundling	3	42.1	19.3	3	26.3	16.5	24.2
WDM PON unbundling	4	41.4	14.7	4	24.5	12.1	27.1
GPON bitstream core	4	43.4	14.1	4	24.8	11.0	31.1
GPON bitstream MPoP	3	41.5	19.5	4	22.6	12.1	28.9

In both models the incumbent's market share stays in a narrow range through all scenarios, although it varies more in the No-Hinterland model than in the Hinterland model. In the No-Hinterland model the market share of cable varies substantially. It closely follows quality differences between cable and FTTH and is lowest where the quality differential to FTTH is greatest.

Results on consumer surplus (CS) and welfare (W)

64. Table 1-7 summarizes our basic model results for CS and W. It also puts the results on prices, profits and market shares in perspective. In this context it needs to be noted that CS is largely driven by the price/valuation relationships between the different technologies and firms rather than by the overall quantity of output, which is fixed in the No-Hinterland model and varies only for each firm's backyard in the Hinterland model.

Table 1-7: Basic model results on consumer surplus and welfare per month

Scenario	Hinterland					No-Hinterland				
	n-1	CS		W		n-2	CS		W	
		Mio €	Rank	Mio €	Rank		Mio €	Rank	Mio €	Rank
P2P unbundling	3	243.1	2	279.2	2	4	466.9	1	490.3	2
GPON over P2P unbundling	3	245.6	1	283.6	1	3	434.0	2	493.8	1
WDM PON unbundling	4	240.5	3	270.8	3	4	431.2	3	473.9	3
GPON bitstream core	4	216.8	4	247.7	4.5	4	400.5	5	445.7	4.5
GPON bitstream MPoP	3	208.6	5	245.4	4.5	4	416.0	4	445.1	4.5

65. The ranking of CS in the Hinterland model is very close between the first three scenarios (with a 2% difference between GPON over P2P unbundling as the first and WDM PON unbundling as the third). In contrast, the difference between WDM PON unbundling as the third and the GPON bitstream scenarios is much larger (about 10%), while the latter two are almost equal. As explained below, the CS rankings are somewhat different in the No-Hinterland model and, except for the very close GPON over P2P unbundling and WDM PON unbundling cases in places 2 and 3, they are rather evenly spread.

66. In terms of W GPON over P2P unbundling ranks consistently first and narrowly beats P2P unbundling, while WDM PON unbundling is consistently third both for W and CS, usually with a significant margin. The margin is narrow for CS in the Hinterland model, because here WDM PON unbundling has 4 entrants, while the two P2P topologies only have 3 entrants. The two GPON bitstream scenarios are in a dead heat for last place in terms of W.

67. In contrast to CS, W is not much affected by entry, once the number of firms reaches 4 (No-Hinterland model) or 5 (Hinterland model). Thus, as a result of different numbers of entrants, the same rankings of W are as unsurprising as are different rankings of CS. While W first increases in the number of firms, this ebbs off very quickly and possibly starts to decrease. In contrast, CS continues to increase fairly strongly in the number of firms.

Level of wholesale charge

68. In our basic models we generally assume that wholesale access charges are determined according to the LRIC cost standard. Because of information asymmetries between the incumbent and the regulator identifying the proper level of the LRIC in a newly emerging network may be a difficult task. Furthermore, there is currently a policy debate on explicitly deviating from LRIC to incentivize FTTH investment. Under such concepts entrants have to pay a mark-up on the LRIC based wholesale access charge. We have tested the impact of such policies on competition and welfare on the basis of our modelling approaches.

69. Increasing the wholesale prices moderately by 10% has a significant impact on the critical market shares and the competitive coverage at the given ARPU. Only in the WDM PON scenario the profitable coverage of the competition model remains unaffected. The strongest effects occur in the P2P unbundling and GPON over P2P unbundling scenarios. The competitive business model here is only viable in Cluster 1 and 2. In the bitstream access scenarios the viability of competition is reduced from Cluster 5 to Cluster 4. The general increase in critical market shares indicates potentially a lower number of potential competitors and an increase in risk of market entry.

70. The oligopoly model shows less significant effects than the cost model. First of all, a percentage mark-up on access charges leads to an almost parallel increase of all retail prices (incumbent, entrants and cable). Therefore, the incumbent’s wholesale profits increase strongly and linearly. In contrast, the entrants profits and the incumbent’s downstream profits decrease very slightly with the mark-up. Cable’s profits are favourably affected. The market share of the incumbent remains more or less constant and the market share of cable increases at the expense of the share of entrants.

71. Welfare shows only a weak decline due to the mark-ups. Consumer surplus, however, shows a strong decline due to an increase in the access mark-up. Insofar as the number of competitors remains unaffected, the oligopoly model only shows limited effects on competition.

The effects of averaging

72. The cost modelling approach generally considers the investment decisions of the incumbent in a cluster-specific way. The investor decides for each individual cluster whether there is viability of investment on the basis of a given ARPU per customer. The profit maximizing firm will invest until the APRU exceeds costs in the marginal cluster. The infra-marginal clusters will generate a rent to the investor which may be used to expand coverage up to the cluster where the average cost over all profitable clusters still exceed ARPUs. We do not consider this case in this context.

73. In the competition model we have chosen a different approach. Our analysis here aggregates all variables and all results over the four densest population clusters of Euroland. This is based on the critical market share results of the cost model, which suggested that entrants and incumbents would be viable for all scenarios up to Cluster 4. This does not mean, however, that the viability of all firms, which was the basis of the free-entry equilibria presented so far, also holds for Cluster 4 in isolation. It may be doubtful because access charges, costs and end-user pricing have all been based on an aggregate (or average) of all four clusters. Cluster 4 as the marginal cluster with the lowest population density has higher fixed costs per user for all types of firms than the average of Clusters 1 to 4.

74. As a separate market, Cluster 4 would have about 24% the size of all four clusters. Under the averaged access charge for all four clusters we get the same prices as before, but in the Hinterland model profits of the incumbent are only about 10% of the aggregate profits and profits of the entrants are only 18%. However, Cluster 4 remains profitable in isolation so that the equilibrium number of firms is reemphasized. One drawback for the incumbent is that wholesale access becomes a major loss maker and offering wholesale access therefore is not incentive compatible. In contrast, incumbent’s profits are only 6% of aggregate Clusters 1-4 profits and profits of entrants turn slightly negative in the No-Hinterland model. Thus, entrants may refrain from entering Cluster 4 in this case. Under cluster-specific wholesale access charges instead of an average access charge end-user prices increase but that only helps the incumbent, while entrants’ profits/losses deteriorate.

75. Profits in the marginal Cluster 4 are substantially lower than average profits for all Clusters 1-4. Because of large losses from selling wholesale access profits overall can turn negative for the incumbent and slightly negative for entrants, suggesting that the incumbent may refrain from entering Cluster 4 and fewer competitors may enter the marginal cluster than the others. This latter effect on competitors becomes stronger if one uses cluster-specific entry charges or if the incumbent also enters Cluster 5.

Sensitivity of Greenfield approach

76. We have also studied the impacts of the lower investment costs of the Brownfield assumptions as presented in para. 24 to 29 on competition and welfare. The cost change from a Greenfield to a Brownfield model only concerns the capital costs of FTTH for the incumbent. Since this does not affect LRIC and therefore LRIC access charges are unchanged, the effect of the Brownfield model leaves end-user prices and market shares unchanged. Only the incumbent's profit is increased by the cost saving. This is a well-known result from the theoretical literature. The only effect of moving from Greenfield to Brownfield is that the incumbent's wholesale profits increase precisely by the cost difference between the Greenfield and Brownfield models.

77. If access charges are reduced by the cost savings of the incumbent end-user prices are reduced, market shares change little, profits of the incumbent are slightly reduced but those of entrants increase (compared to the Greenfield approach). If wholesale access charges are adjusted downward by the cost savings the end-user prices are lowered and profits for entrants increase. The incumbent's profits are substantially lower than under LRIC access charges but still somewhat higher than under the Greenfield costs. Welfare increases almost exactly by the cost savings. Most of this increase benefits consumer surplus but some also goes to profits.

Sensitivity on QoS and WtP assumptions

78. We have run several sensitivities to identify the impact of our QoS and willingness to pay assumptions on the results. Changes in the WtP assumptions can have substantial effects on the model results:

- A smaller spread between the different WtP for incumbents, entrants and cable shows that end-user prices, profits and market shares of the incumbent all generally decrease, while these variables increase for the entrants.
- Increasing the goodwill advantages of the incumbent increases end-user prices, profits and market shares of the incumbent at the expense of those of entrants. This result shows that the incumbent can have strong incentives to deteriorate the quality of the wholesale product provided to entrants.
- An improved WtP for WDM PON leads to entry of an additional firm, implying substantially lower prices and profits.
- An increase in the incumbency advantage leaves the rankings with respect to CS and W largely intact. CS and W generally decrease because of the lower WtP for entrants and cable services.
- An improved WtP for WDM PON changes the ranking of the scenario by moving it ahead of P2P unbundling and GPON over P2P unbundling.

2 Competitive models in fibre deployment

2.1 Introduction

The task of the competition model is to develop a steady-state model of competition in an FTTH oligopoly to show and to allow comparing end-user prices, consumer surplus and producer surplus (for both network owner and other firms). The following five scenarios of NGA technology and associated wholesale access seekers are considered (the costs of these have been derived from the cost model).[11]

1. (Ethernet) P2P unbundling: The incumbent builds a passive P2P plant and operates dedicated Ethernet P2P access lines. The competitors buy unbundled access at the MPoP level. In addition to the unbundling charge they have to collocate at the MPoP, invest in a small ODF of their own and Ethernet Switches as well as bear the cost of concentration and core network.

2. GPON over P2P unbundling: The incumbent builds a passive P2P plant but contrary to the previous scenario deploys GPON active electronics and splitters at the MPoP for his own operations. Competitors buy unbundled access in the same fashion as in the first scenario.

3. WDM PON unbundling: The incumbent builds a passive Point-to-Multipoint plant that has cascaded splitters at the distribution point and MDF level. The majority of MDF locations is closed and about 500.000 lines are concentrated in MPoPs with WDM PON technology. Competitors buy “unbundled wavelength access” to individual customers. Because of the high level of concentration realised through MDF dismantling competitors only add their own core network; no further concentration is required.

4. GPON bitstream access

    a. at the core network level: The incumbent builds a passive Point-to-Multipoint plant with passive splitters at the distribution point and operates active GPON electronics at the MPoP. He provides bitstream access to competitors at the core level so the bitstream includes a transport service through the incumbent’s concentration network. Competitors collocate at the incumbent’s first level core location nodes and add their own core network.

11 One has to differentiate between topologies (Point-to-Point, Point-to-Multipoint) and the active layer 2 technologies used to light the fibres (Ethernet, GPON). Throughout most parts of this study we use the term P2P to refer to the combination of Ethernet technology and P2P topology. In some case we may want to exclusively refer to the topology. In this case we would e.g. speak of P2P topologies which would include the first two scenarios.

b. at the MPoP level: The incumbent builds a passive Point-to-Multipoint plant with passive splitters at the distribution point and operates active GPON electronics at the MPoP. He provides bitstream access to competitors at the MPoP level so competitors have to provide their own concentration and core network.

Accordingly, scenarios differ by FTTH access technologies and by the mode of access provided to competitors (= entrants). Table 2-1 describes the scenarios in terms of the value added supplied by the incumbent to entrants. The scenarios are described in detail in section 2.3.

Table 2-1: Costs borne as access charge (ULL, bitstream access charge) by entrants by scenario (shaded)

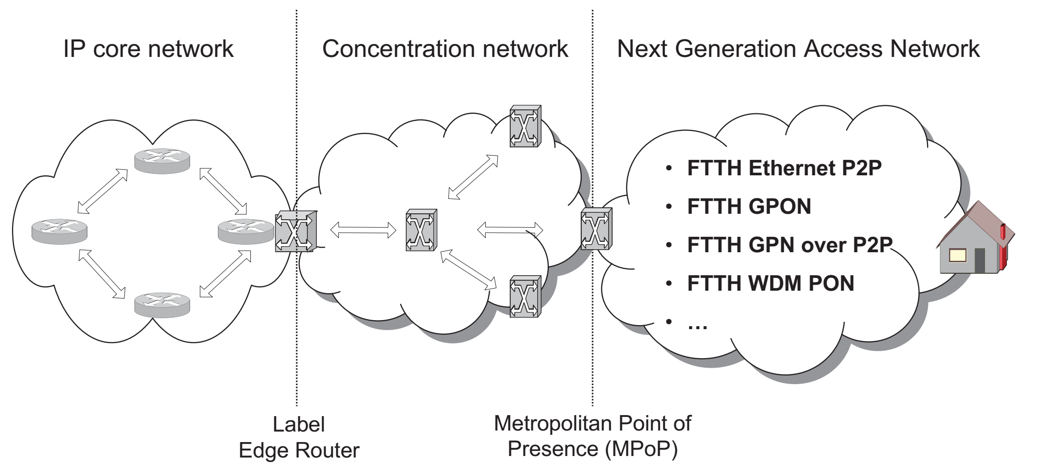
Entrant costs scenario	FTTH access network	MPoP electronics	Concentration network	Core network	Retail
P2P unbundling					
GPON over P2P unbundling					
WDM PON unbundling					
GPON bitstream core					
GPON bitstream MPoP					

Since we regard subscriptions as the units of sales, ULL and bitstream access in our approach only differ by costs, wholesale prices and QoS, but not by units of measurement. This allows us to use the same formal model for all scenarios; we only need to adjust parameter values appropriately.

2.2 The overall NGN/NGA architecture

Next Generation Networks allow one to transport many different application contents over one universal IP-protocol based electronic communication network. Such content may be data, voice-telephony or TV/video etc. The new approach of NGN networks is that all this content is transported and switched within one single network, while in the past different networks of different technologies have been used at the switching level. The universal transport protocol used is the Internet Protocol (IP). Integrating all electronic communication content into one single network and taking into account the increasing demand of electronic communication/usage of electronic applications requires overcoming bandwidth bottlenecks in the access networks. The new access networks are therefore based on fibre access lines, which either shorten the existing copper lines or even replace them totally in the FTTH architectures.

Figure 2-1: NGN/NGA general architecture



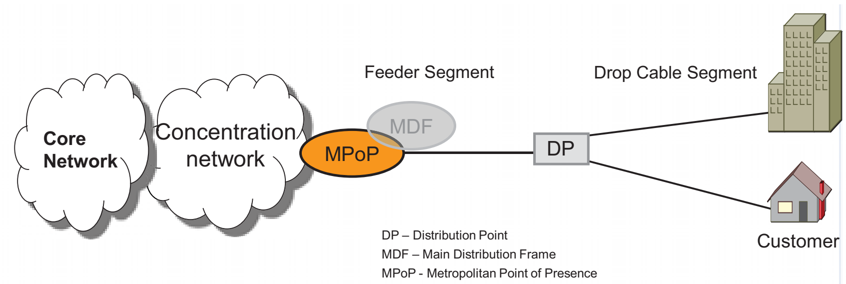
The overall NGN/NGA architecture has three major segments, the IP core network, the nowadays typically Ethernet based concentration network and the access network. In the IP core network the IP-traffic is switched between end users or connected to the application servers located in the core layer locations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

Regarding access network topology we use the terms of the European Commission's NGA recommendation.[12] It defines the Metropolitan Point of Presence (MPoP) as equivalent to the Main Distribution Frame (MDF). The MPoP is the last location where, depending on the NGA architectures and looking from the end user, an Ethernet Switch of the concentration network is located. The Distribution Point is an intermediate node in the NGA, from which fibres from the MPoP can be divided/accessed before running them to the customer building (or in the case of FTTC from which access is realised through copper sub loops). The segment from MPoP to Distribution Point is called Feeder (Cable) Segment. The segment from Distribution Point to the customer location we call Drop (Cable) Segment[13]. There may be fewer MPoPs than MDFs, since fibre overcomes the line length restrictions of copper connections. Thus MPoPs may be a

12 European Commission (2010).
13 The EU NGA Recommendation (2010) calls this network segment terminating segment also, but for reasons of consistency with recent WIK studies we continue to use the term drop cable segment in this study. Both terminologies characterise the same network element.

subset of the existing MDFs. In this case we will use the term “backhaul” to refer to the segment between an abandoned MDF location and the new MPoP.

Figure 2-2: Network topology: Terms and definitions



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

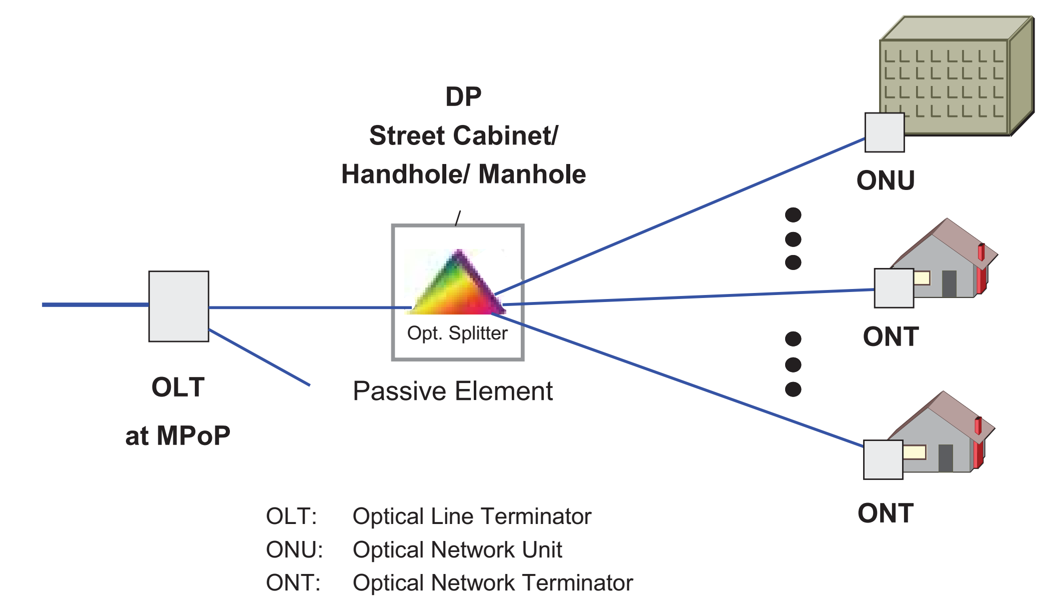
FTTC requires the lowest number of new fibre lines. The number of fibres depends on the degree of concentration a DSLAM in the DP (street cabinet) provides, e.g. on the amount of user interfaces a single DSLAM offers. Typical values are below 1000 users per DSLAM. Fibres are then only installed in the feeder segment.

FTTB requires one fibre per building in the feeder and in the drop cable segment. Thus the degree of fibre concentration is driven by the number of homes per building, or by the number of FTTB-terminating systems (called ONU, Optical Network Unit) in the case of large multi dwelling units, depending on the system’s user port capacity. A typical figure for the latter may be 8.

FTTH Point-to-Point (P2P) requires one fibre per home in both, the feeder and the drop cable segment, and in the inhouse cable segment, too. Thus FTTH is the architecture with the highest fibre count in the feeder cable segment, which may cause cost differences.

Point-to-Multipoint Passive Optical Network (PON) technology concentrates the optical signals of several fibres onto one single fibre by a passive component called splitter (Figure 2-3). This architecture thus reduces the number of fibres in the feeder segment compared to the Point-to-Point fibre architecture described above. The degree of fibre reduction depends on the splitting factor a splitter supports[14]. Only one fibre per splitter is needed between MPoP and splitter location (e.g. a DP). However, one fibre per home (FTTH) or per building (FTTB) is still required in the drop segment. Accordingly the drop cable segment in PON architecture has the same fibre count as a P2P architecture.

Figure 2-3: Point-to-Multipoint fibre architecture



Due to the fact that multiple end customers can send their upstream information at the same time some administration is necessary in order to manage conflicts and also in order to manage the downstream traffic. The systems used for this are the Optical Line Terminators (OLT) at the central site and Optical Network Units (ONU) for several end customers (e.g. FTTB) or Optical Network Terminators (ONT) for one single end customer (e.g. FTTH). All customers connected to the same splitter share the same communication channel and its bandwidth. There are many different PON systems. The

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

most commonly one used in Europe, GPON, is considered in this study and our models. PON systems (MPoP equipment and customer modems) have to interact and be compatible; in order to fully support all functionalities PON components often have to be from the same supplier.

Another, more advanced Point-to-Multipoint fibre technology is under development, which allows one to use different colours (optical wavelengths) of the optical signal to address different customers over a single fibre. The technology of using different colours to separate individual communication streams on a single fibre is called Wave Division Multiplex (WDM). While the fibre plant does not differ compared to PON, the WDM-splitters need not necessarily distribute all colours to all end customers, but may be configured to provide individual colours to each of the end customers.[15] Each end customer may then use its own colour beam individually, not sharing its bandwidth with the neighbours at the same splitter.

Wholesale access for competing operators may occur for all NGA architectures in two different manners, by accessing the physical infrastructure to the end customers or by obtaining access to a bitstream which is managed by the wholeseller.

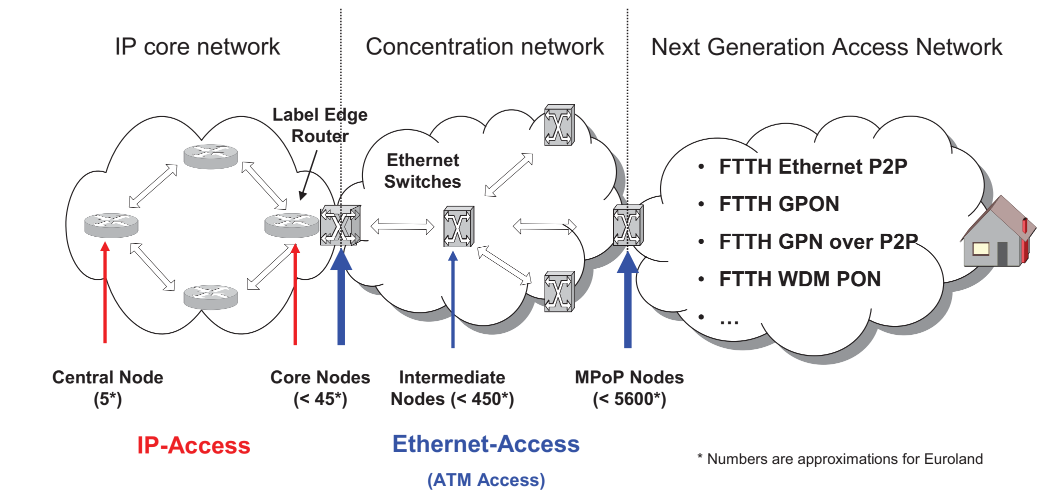
In FTTH architectures based on a Point-to-Point fibre plant, a physical access to the fibre access lines occurs at the MPoP, where all access lines are concentrated at the Optical Distribution Frame (ODF) and where the competitors may collocate their own equipment. This is very closely comparable to the well-known copper Local Loop Unbundling with all its proven processes and skills. In Point-to-Multipoint fibre plants the fibre star point is at the splitter site, thus the competitors have to collocate there – with accessible cabinets and Optical Street Distribution Frames (OSDF), making these locations significantly more expensive. In cases of cascaded splitters it is the splitter location closest to the end customer locations where unbundling would take place. The closer the splitter location to the end customer, the more locations are needed and the more expensive the own infrastructure of the competitors will become. In addition, the less customers are concentrated per splitter and the less customers a competitor can therefore acquire per location, the less attractive it is for competitors to collocate there. The dispute of the optimal splitter location is well known from the French discussion about the optimal mutualisation point. Studies by WIK-Consult and others have demonstrated the unattractiveness of Sub-loop Unbundling at the DP[16] compared to Local Loop Unbundling at the MPoP. In our ongoing considerations we will therefore not consider the physical unbundling at the DP.

For all NGA architectures there are many points for active electronic interfaces to access connections to the end customers (Figure 2-4) at all network node locations of the concentration and core network. At the concentration network the interfaces are typical-

15 This in general improves the optical budget and the length over which the signals can be transmitted.
16 See e.g. Elixmann/Ilic/Neumann/Plückebaum (2008), Ilic/Neumann/Plückebaum (2009), Ilic/Neumann/Plückebaum (2010), Analysys (2007).

ly based on the Ethernet protocol, and the state of the art equipment also consists of Ethernet switches[17]. In the core network IP routers operate offering IP interfaces for wholesale access. [18]

Figure 2-4: Access point options for wholesale bitstream access (WBA)



A bitstream access at the core network nodes aggregates many customers at one Point of Interconnection (PoI), whose traffic may be influenced by the traffic of the other customers of the wholesale operator and by the traffic of the other customers on the network. The closer the PoI is relative to the end customers, the less customers are aggregated and the less the traffic is influenced by the wholeseller's own operations and network management.

Beside that a PoI at the MPoP level may also allow for bundled interfaces for a group of end customers without any overbooking/concentrating the end customers' access bandwidth, thus forming a so called Virtual Unbundled Local Access (VULA).[19] Such concepts are well known from the bundled local loop access lines in the FTTC/OPAL[20] areas of Germany since 1998. While the OPAL bundled access uses ITU-T V 5.1[21] like interfaces, the VULA is based on Ethernet. In these access concepts the competitor still relies on some last active access nodes of the wholeseller, which have to be config-

17 The older ATM equipment is also mentioned in Figure 2-4.
18 With FTTC architectures and DSLAMs at the DP one could also in theory imagine a bitstream access at the DP site, requiring the competitors to collocate there, which we do not consider under the same reasoning as for the physical unbundling approaches.
19 See article 7 notification responses of the EU Commission to UK (EU Commission (2010b)) and Austria (press release IP 10/10/760) as well as the decisions of the Austrian Telekom-Control-Kommission TKK (2010a) und TKK (2010b), all from summer 2010.
20 Optical Access Line.
21 PSTN E1 interfaces with 30 user and 2 control channels with 64 kbit/s each.

ured, operated and repaired by him and still form a procedural hurdle for a clear and transparent network provisioning and operation of the competitor. Even with future WDM PON, where the customer access connections may be handed over to the competitor as colour beams on a single fibre, the competitors' network quality will depend on the wholeseller's quality to provide and operate the WDM access nodes. Thus, even the so called Lambda[22] or Wavelength Unbundling is a low layer but active wholesale access.[23]

Nevertheless, in Point-to-Multipoint fibre plants the VULA may be the highest quality wholesale customer access a competitor can buy. Compared to unbundled fibres customer access bandwidth above the wholesale bandwidth or own products based itself on WDM technology could not be offered by a competitor using WBA, VULA or Wavelength Unbundling.[24]

2.3 Technologies/architectures considered[25]

Constructing new broadband access networks should be done in a way which will satisfy the end customer demand for almost the estimated life time of the components, e.g. the fibre lines. This is significantly long and will exceed 20 years. Thus the architectures considered should at least cover future demand right now or should have a proven migration path for significant bandwidth upgrade.

The future bandwidth needs of a residential customer at the upper end are uncertain (50 or more than 100 Mbps symmetrical, or even more could be conceivable). For business and even more for wholesale customers we already now see high bandwidth demand, which cannot be satisfied by all NGA architectures. So already today mobile base stations could require more than 100 Mbps backhaul line capacity and an increasing number of business and wholesale customers need direct fibre access and exploit a major share of the optical frequency spectrum (e.g. with CWDM, Coarse WDM or even DWDM (Dense WDM)). The ideal future NGA architecture can cover all customer access demand or at least allows one to do so with small enhancements.

In this study we therefore consider those NGA architectures which allow for highest bandwidth and quality for the end customers and which do no longer rely on copper cable elements. These are FTTH architectures only. From all FTTH architectures we concentrate on the two most relevant architectures in Europe, Ethernet Point-to-Point

22 Lambda stands for wavelength of light and is equivalent to light of a dedicated colour.
23 We do not enter into the discussion if VULA and wavelength unbundling should be considered in the market 4 or 5. From the point of network operation and related product quality it is only relevant that there is active equipment in the customer access line – in the value chain – which is not operated by the competitor and thus influences/hinders transparent customer provisioning and network operation, restricts product definition and requires process interfaces in a degree, which would not be needed if only physical wholesale products would be used in the value chain.
24 It is of course questionable if such products are relevant today or in the future, throughout the lifetime of the NGA architecture.
25 In Annex 2 we describe those technologies which we do not consider in this study.

and GPON. In order to overcome some restrictions and weaknesses being discussed for GPON we also include into our considerations two GPON variants, one implementing GPON electronics on top of a passive Point-to-Point fibre plant and a future version of PON, increasing the bandwidth and quality of the nowadays PON systems by using WDM technology on a Point-to-Multipoint fibre topology. All architectures considered will be described with their relevant characteristics for product definition and cost in the next sections.

In the discussion on the relative performance of Ethernet P2P and GPON technology arguments about different OPEX, especially concerning space requirement and power consumption, have been exchanged. Therefore we model the space requirement and the power consumption of the architectures considered explicitly in a bottom-up manner. For the size of an MPoP we assume, that the equipment to serve fibre lines for 100% of the homes passed has to be hosted. For Point-to-Multipoint topologies all fibres are connected to OLTs, in the case of P2P topologies the floorspace dimensioning for active equipment is based on 70% take-up[26] (see sections 3.1.1 on the fixed network market reach and 3.1.6.2 on floorspace issues).

In our model we assume that the incumbent is the investor of the NGA network infrastructure. Competitors (new entrants) face the same (efficient) cost if they provide access on the basis of wholesale access to the incumbent's network, but may achieve a lower ARPU. If the NGA architecture is based on a Point-to-Point fibre plant we consider the competitors to use unbundled fibre loops as wholesale access service in this study. If the architecture is based on a Point-to-Multipoint fibre plant, we consider an active wholesale access at the MPoP or at the core network node locations.

In total we consider the following architectures (Table 2-2). Details of the architectures are explained in the next subsections in the order Ethernet P2P, GPON, GPON over P2P as a special implementation and WDM PON.

Table 2-2: Overview of the architecture scenarios considered

Scenario	Incumbent architecture	Competitor (Entrant) wholesale base
P2P unbundling	Ethernet P2P	Fibre LLU at MPoP
GPON over P2P unbundling	GPON over P2P	Fibre LLU at MPoP
WDM PON unbundling	WDM PON	WDM unbundling at Core Nodes
GPON bitstream core	GPON	Bitstream access at Core Nodes
GPON bitstream MPoP	GPON	Bitstream access at the MPoP

26 We expect a long-term market of the FTTH network of all potential access lines in the competition against cable, mobile and non-users.

2.3.1 P2P

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

The maximum length a fibre local loop may have is determined by the optical budget of the fibre connection and the power of the interface cards at the MPoP and end customer location (respectively their lasers and receivers). Without intermediate repeaters today's interface cards may reach up to 40 - 80 km. But the longer the distance bridged, the more expensive the interfaces will become. In NGA networks we talk about mass market deployments, thus expensive interface cards could have a significant impact on total cost. In our model assumptions for Ethernet P2P we therefore take the same line length assumptions as for the copper access network.

Another discussion covers the manageability of larger fibre network starpoints, so that an upper limit regarding the fibre count at the MPoP might exist. Today large copper MDFs serve more than 35,000 copper pairs. With fibre an end customer connection in Point-to-Point fibre plants needs only a single fibre instead of a copper pair and each fibre requires less space (has a much smaller diameter) than a copper wire. The Optical Distribution Frame may be larger than the copper equivalent, so the ODF may still be a little bit larger per fibre, but due to technical innovations this may change over time. Overall, a fibre MPoP will be able to serve more fibre links than the largest copper MDFs today. Therefore, we are convinced that with our model approach of assuming the existing copper MDF locations to be the proper scorched nodes of the new NGA network, where all existing spare ducts may be used, we are conservative and do not raise fibre management problems.

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

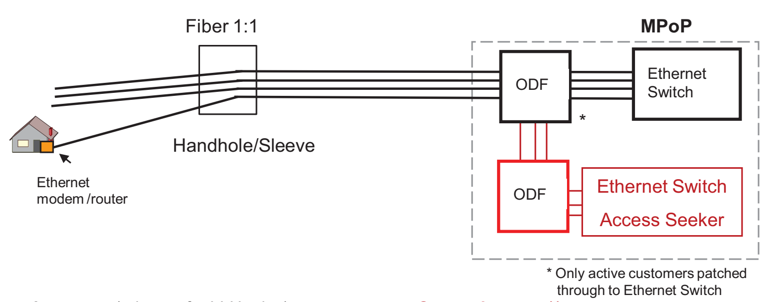
If more than one Ethernet switch is needed to connect the active customers additional switches are considered in a cascaded and hierarchical manner. The last network sided switch then is the border to the upper concentration network. The network sided interface cards are already part of the concentration network. They are considered separately in the respective cost calculations in order to adapt to the wholesale cost calculations (see below).

For competitors using wholesale access we have considered a fibre unbundling scenario for the P2P architecture in which a competitor rents the unbundled fibre loop, places an additional Optical Distribution Frame of his own at rented collocation space in the MPoP where he operates his own Ethernet Switch. The competitor's ODF is connected via a dedicated connection cable to dedicated customer sided ports of the incumbent's main ODF. The costs of all these elements are part of the competitor's total cost. In addition, the competitor has to bear the cost of the concentration and core network himself.

Figure 2-5 not only describes the P2P topology in general and which cost elements are considered in the incumbent's total cost, but also details which cost items become part of the fibre LLU price (underscored cost positions) and which elements and costs of the access network the competitor has to bear directly (red).

We treat the incumbent deploying a P2P network and offering fibre unbundling to competitors as our first scenario.

Figure 2-5: Scenario P2P with fibre LLU



Incumbent cost (relevant for LLU price)

- CPE
- Access Network incl. Inhouse cabling
- ODF + Patch cabling + floorspace
- Ethernet Switch + floorspace + energy
- Network sided Ethernet port (1 per MPoP)

- Concentration Network
- Core Network

Competitor cost**

- CPE
- LLU charge
- Competitor's ODF & Patch cabling + floorspace
- Ethernet Switch + floorspace + energy
- Network sided Ethernet port (1 per MPoP)

- Concentration Network
- Core Network

** Assumption: Unbundler operates Ethernet P2P network

2.3.2 GPON

The GPON technology is designed to deal ideally with Point-to-Multipoint fibre plants. It concentrates the traffic of a significant number of customer access fibres at an intermediate optical splitter location (DP) onto a single backhaul fibre. Optical splitters may be cascaded in order to optimize the fiber count and to adapt it to the end customer distribution. But each splitter adds some additional attenuation by getting spliced into the cable and because it has to distribute the power of the downstream signal to all fibres connected. Thus the fibre plant strongly depends on the optical power budget and the maximum splitting factor. ITU-T G.984 standardises GPON in its limitation of 20 km reach at a 1:32 maximum splitting factor. New standards and better interfaces allow a splitting factor of up to 64 or even 128. For our models we assume a splitting factor of 1:64 under any circumstances in a single step, without any cascades.

Already in order to enable the use of existing spare ducts we assume DP locations and sizes comparable to an efficient copper plant. These may host several splitters, according to fibre count.

In our incumbent model the fibre plant is deployed to all homes (100% homes passed). This assumption corresponds to an efficient fibre deployment strategy. The fibres are connected to splitters filling them up to 90% of their capacity, keeping spares for future use and additional capacity. The fibres from the splitters are connected to the client side of the ODF in the MPoP, patched over there to the appropriate OLTs. The OLTs are connected to an Ethernet switch which is the interface to the concentration network. Especially during ramp-up when only few potential customers have already become subscribers to the FTTH network this architecture still has considerable spare capacity, which will be reduced as the take-up increases.

Keeping the copper MDF locations as scorched nodes where the existing duct plant concentrates we are confident that fibre management problems at the MPoP sites due to the number of fibres will never occur, since the fibre count in the feeder cable segment is reduced by the splitting factor compared to a P2P approach. The fibre count in the drop cable segment between (the last) splitter and the end customer premise will be the same as in the P2P case.

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

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

GPON with its central administration of sending rights in the OLT in principle allows one to allocate a fixed bandwidth or more dynamic bandwidth for an end customer and thus enables to serve end customers in an individual manner. But this is limited to the degree the other customers are not harmed or restricted in their principle capacity demand. Reducing the amount of customers connected to a splitter is another method to increase bandwidth per customer, and of course both methods may be combined. But reducing the amount of customers for a splitter requires a change in the fibre plant. Since customer demand cannot be planned in advance, some spare splitters could be foreseen during fibre roll out for future use.

All fibres will be driven by the same interface cards, so individual solutions to single, dedicated (business or wholesale) customers going beyond Ethernet interfaces above 1 Gbps or requiring access to the optical spectrum (WDM band) cannot be supported by GPON, but may require additional fibres in the feeder and drop cable segment.[27] Additional spare splitters or fibres are not considered in our model assumptions, because we did only model pure architectures and no hybrid solutions.

Each ONU/ONT has to listen to the downstream messages of all connected customers and filter them for its own end-user. The downstream messages are encrypted, but may be listened to by all neighbours at the same splitter. This inherently makes the system more vulnerable to illegal interception and/or generates higher costs for encryption to secure communications. The upstream messages between end customer and OLT are not encrypted and may be reflected by imperfect splices in the feeder cable, thus enabling clear text interception with very sensitive (special) receivers. Denial of service attacks may be started with a strong optical beam ignoring the OLT’s administration, or by affecting the OLT’s administration messages, and there is also a certain risk that faults in one ONU/ONT may affect all the other endpoints of the same splitter/OLT. Determination of fault locations in such a spread environment is harder to achieve than in a P2P system where only single lines fail under these circumstances. Thus we assume GPON systems to be more vulnerable to illegal interception, denial of service attacks and un-

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

der certain fault conditions more time consuming to repair. We will consider this aspect in our assumptions about quality differences in our competition model (section 2.6.1.3).

GPON architectures concentrate the traffic onto fewer electronic interfaces at the Central Office. These active components are more complex and more expensive than P2P components. The same holds true for end user devices. As long as a GPON architecture cannot make use of the concentration of the splitters, because users have not yet subscribed or infill homes[28] are not yet constructed, many splitter locations in an OLT are likely to stand empty for a significant period of time. This situation could be improved with intermediate distribution frames at splitter locations. Nevertheless, this complexity does not occur with P2P architectures, where ports are only installed and operated to connect active customers.

GPON architectures are well suited to asymmetric traffic, inasmuch upstream and downstream bandwidth differs due to the inherent upstream communication collision. A preponderance of downstream traffic over upstream has so far been a typical residential communication behaviour, and GPON is well suited to residential customers who have substantial downstream and limited upstream communication demand. However, already today business customer demand is symmetrical. And even for residential customers, there is a strong progressive trend towards more symmetric broadband communication (e.g. video conferences/telephony, gaming, Peer-to-Peer[29] communication). Therefore, one might question whether the GPON architectures are really future proof in the long-term concerning traffic patterns, given that fibre-based infrastructures could have economic lifetimes of as much as 40 years.

If GPON had to deal with a bandwidth demand increase by a factor of 10, then the planned GPON evolution to 10G-PON would not suffice; however, one can be confident that new GPON technologies will appear, or that the installed Point-to-Multipoint fibre plant may be used to migrate to WDM PON.[30] Migration to systems where the optical frequencies used overlap each other (e.g. GPON and DWDM) require the complete exchange of the components in the fibre strings (tree) of a splitter/OLT in one step with all ONU connected (e.g. 64) or a redesign of the fibre plant. Migration to technologies requiring a Point-to-Point fibre plant would require additional ducts and fibres in the feeder cable segment, thus should be avoided if possible.

GPON, deployed with splitters in the field, can at present only be unbundled at the splitter locations closest to the end customers. Fibre sub-loop unbundling is not considered in this study as it does not appear to be a sufficiently profitable wholesale product. In-

28 Homes which may be constructed later.

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

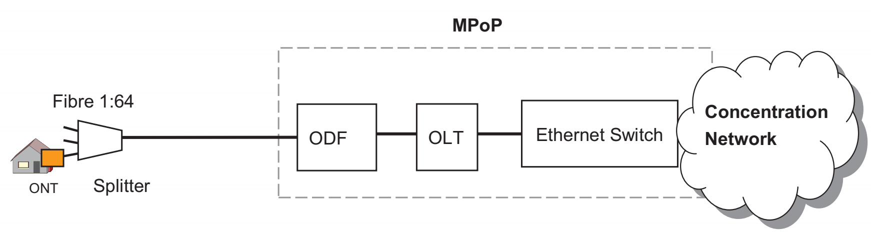
30 For migration from GPON to 10GPON the optical windows of the frequency plan are synchronized and allow for overlay installations and smooth migration. With XG-PON2 of FSAN (Full Service Access Network, the member companies drive standards into products and contribute to the standardization process via ITU-T) 10GPON will offer 10 Gbps symmetrical shared bandwidth. From 10GPON to WDM PON overlay and frequency plans are not coordinated and will cause conflicts (Figure 2-9).

stead we consider two bitstream access scenarios in the GPON case, bitstream access at the core network level and at the MPoP level for the competitors’ wholesale access cases. The main difference between the two scenarios is that bitstream access at the core level includes the transport through the incumbent’s concentration network while in the other bitstream scenario the competitor has to use his own concentration network and may obtain a transparent, non-overbooked bandwidth from the MPoP to his end customers, resulting in higher product quality and the ability of independent product design compared to the GPON bitstream core scenario. But since the competitor still depends on the incumbent’s active components this quality improvement will not achieve the degree of unbundled fibre local loops.

Since the incumbent benefits more from economies of scale his unit cost of the concentration network transport will be lower than that of the competitor, thus the competitor in the GPON bitstream core scenario may benefit from the lower cost in the wholesale price.

Figure 2-6 and Figure 2-7 show the GPON architecture and detail cost components for the two scenarios. The underlined cost components once again are the input for the wholesale price calculation, while the components in black build the total cost of the incumbent and those in red the total cost of the competitor.

Figure 2-6: Scenario GPON with bitstream access at the core level



Incumbent cost (relevant for bitstream price)

- •CPE
- •Access Network incl. inhouse cabling
- •ODF + Patch cabling + floorspace
- •OLT + floorspace + energy
- •Ethernet Switch + floorspace + energy
- •Concentration Network

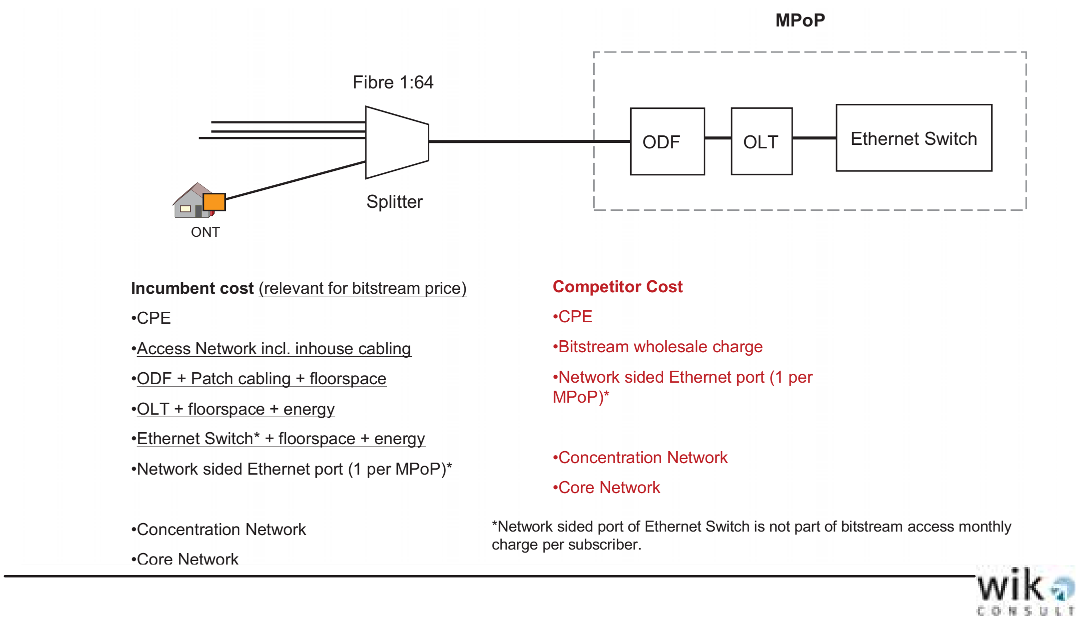
- •Core Network

Competitor cost

- •CPE
- •Bitstream wholesale charge
- •Network sided Ethernet port (1 per MPoP)

- •Core network

Figure 2-7: Scenario GPON with bitstream access at the MPoP level



Most GPON systems allow one to distribute a separate cable-TV signal (RF signal)[31] as a separate wavelength in a broadcast manner from OLT to ONU/ONT. This signal is terminated on a coax plug and can be fed into the existing cable-TV cabling at the end customer homes. If enough bandwidth is set aside for the RF signal (e.g. 2.5 GHz bandwidth of this additional RF signal) the RF channel may be shared between several cable-TV signals (e.g. 3 x 800 MHz) and thus is open for unbundling and wholesale offers also. This feature adds new options of market approaches which would increase the complexity of modelling and result interpretation. We exclude a detailed analysis of the additional TV capabilities of GPON, only taking into account that IPTV is considered. Because there also exists Ethernet P2P equipment offering a RF colour on the same fibre used for the Ethernet signal with no significant additional cost, these RF-TV features will not cause any differences between the architectures we compare, hence this feature may be neglected without distorting results.

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

31 RF – Radio Frequency.

may be broadcasted at the same time. Thus, we qualify the IPTV capability of GPON to be poorer than in the other architectures considered in this study.

2.3.3 GPON over a passive P2P plant

GPON can also be implemented on top of a Point-to-Point fibre architecture by "moving the splitters back" into the central MPoP location and having dedicated fibres in both drop and feeder section. Like in the first scenario the fibre count in the feeder and drop cable segment is the same, thus this GPON architecture does not have the fibre savings in the feeder segment as described before.

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

Locating the splitters at a central site allows a more efficient use of the splitters and the OLTs during the roll out of the services (ramp-up). This not only generates positive cash flow effects but also reduces some risk of investment. Only active subscribers would be patched from the main ODF via a network sided ODF port onto a splitter and from there to the OLT. This assures a very high degree of splitter and OLT efficiency (contrary to the standard GPON case with splitters in the field, OLTs will have a very high utilisation rate because only active subscribers are patched through).[32]

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

There is also no change concerning the exchangeability and interoperability of GPON OLTs and ONU/ONT. But the flexibility of the Point-to-Point fibre plant allows one to exchange the transmission systems smoothly over time, one customer at a time, if that

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

looks favourable, and thus reduces the supplier dependency of the operator. This economic value per se[33] is neither quantified nor considered in our model assumptions.

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

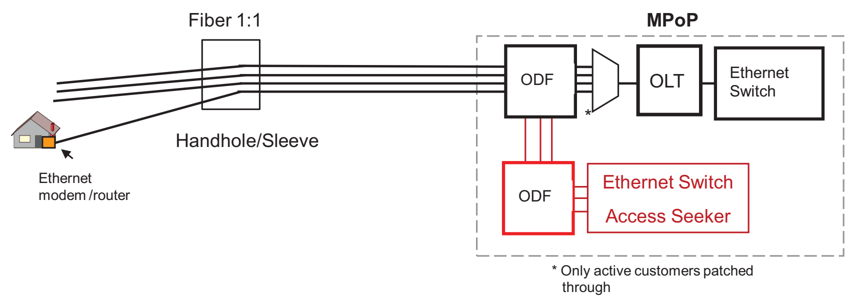
The space and the associated cost required at the MPoP sites will be higher than with GPON with distributed splitters (described in the previous section 2.3.2), because the ODF network and customer sided port counts are significantly higher (by the splitting factor) and the splitters themselves must be located at the MPoP sites, too. This will be considered in our bottom-up space demand model for the MPoPs. On the other hand, the distributed splitters and their associated cost in the field will be saved.

The demand of electrical power consumption during ramp-up will be lower in GPON with centralized splitters, since the OLTs will only be installed according to demand and subscriber increase. We will consider this also in our bottom-up MPoP OPEX modelling. The ramp-up effect however only will become visible in our dynamic modelling (section 3.1.8).

The associated wholesale product we have considered in this study is an unbundled fibre loop. From a wholesale perspective the scenario GPON over P2P unbundling is identical with the scenario P2P unbundling because it refers to the same P2P outside plant.

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

Figure 2-8: Scenario GPON over P2P with fibre LLU



Incumbent cost (relevant for LLU price)

- CPE
- Access Network incl. inhouse cabling
- ODF + Patch cabling + floorspace
- Splitter + OLT + floorspace + Energy
- Ethernet Switch + floorspace + Energy
- Network sided Ethernet port (1 per MPoP)

- Concentration Network
- Core Network

Competitor Cost

- CPE
- LLU charge
- Competitor's ODF & Patch cabling + floorspace
- Ethernet Switch + floorspace + energy
- Network sided Ethernet port (1 per MPoP)

- Concentration Network
- Core Network

Concerning outband RF-TV signal transmission there is no difference between the two GPON approaches. RF, however, is not considered in the modelling.

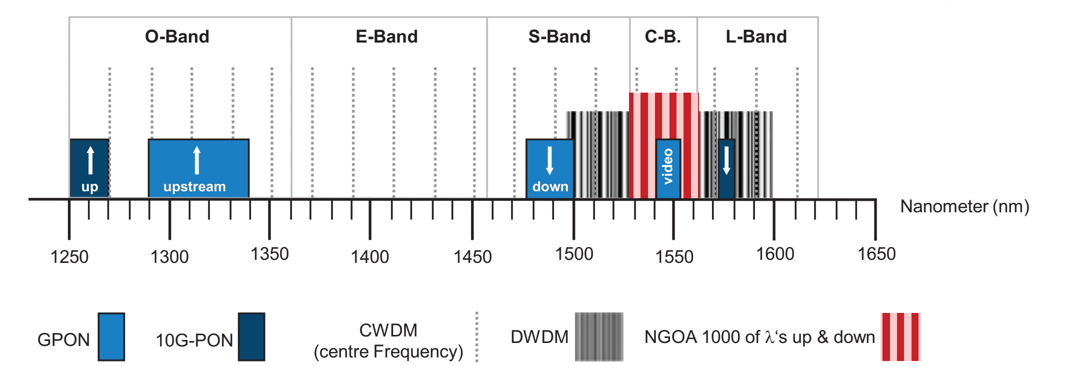
2.3.4 WDM PON

Using one optical fibre for several customers can be done in technologically different ways. GPON technologies use the same single optical beams and assign transmission rights to end users by a central administration (the OLT at the central site), so that each user can send his upstream information exclusively and without interference to other users in the same system in different time slots (TDM, Time Division Multiplex). WDM (Wave Division Multiplex) systems, however, use different optical beams of different wavelengths (different colours) to separate the transmitted information from each other. Hence, WDM is essentially a means of capacity expansion through reusing the physical medium optical fibre with more than just one wavelength.

GPON already multiplexes two (three when additionally considering analogue (RF) TV) wavelengths on the fibre. The Coarse WDM standard enables 18 separately distinguishable wavelengths and the Dense WDM standard enables 162 wavelengths with a much smaller channel width. GPON and C/DWDM as such cannot coexist on the same fibre (at least not without sacrificing some of the defined WDM wavelengths, see Figure 2-9). The more wavelengths are enabled, the smaller the spacing between two wavelengths becomes. Smaller channel width and spacing mean that lasers must be increasingly accurate. This is what has made the use of DWDM in the access network up to now so expensive.

System development proceeds and DWDM cost have significantly decreased over the last decade and will continue to decrease further on. Already today there are DWDM PON systems in the market that allow using up to 80 different colours of the DWDM grid in order to address customers individually[34] – or as customers grouped to an GPON overlay network. The WDM splitters allocate the individual colours to the appropriate fibre access lines connected to the splitters. Each colour is capable of transporting a 10 Gbps Ethernet signal. Tuneable transponders allow one to use "grey light" standard end customer equipment. In multi-dwelling buildings this large capacity may be shared in a FTTB manner by an Ethernet aggregation switch in the basement. At the central site the OLT routes the optical beams to different directions and thus allow one to unbundled single optical beams. Overall this DWDM based approach is not well suited to address the mass market already now, because it is oversized and still is rather expensive, so better suits for business customers and large multi-dwellings in a FTTB manner.

Figure 2-9: Use of the optical wavelength grid



Source: WIK/Schuster[35]

Recent research by Nokia Siemens Networks and other companies organized in the Open Lambda Initiative aims at enabling an enormous increase of wavelengths on the same fibre by facilitating technological progress in signal processing, tuneable lasers and photonic integration. This would allow high wavelength density and requires high receiver sensitivity, thereby enabling approximately one thousand individual wavelengths in the C-Band of the spectrum alone (Next Generation Optical Access – NGOA), just affecting the GPON downstream channel bandwidth, being above and below the RF video wavelength of the GPON standard and above and below the 10G-

34 E.g. ADVA Systems, Munich, Germany.
35 Schuster (2010), modified by WIK.

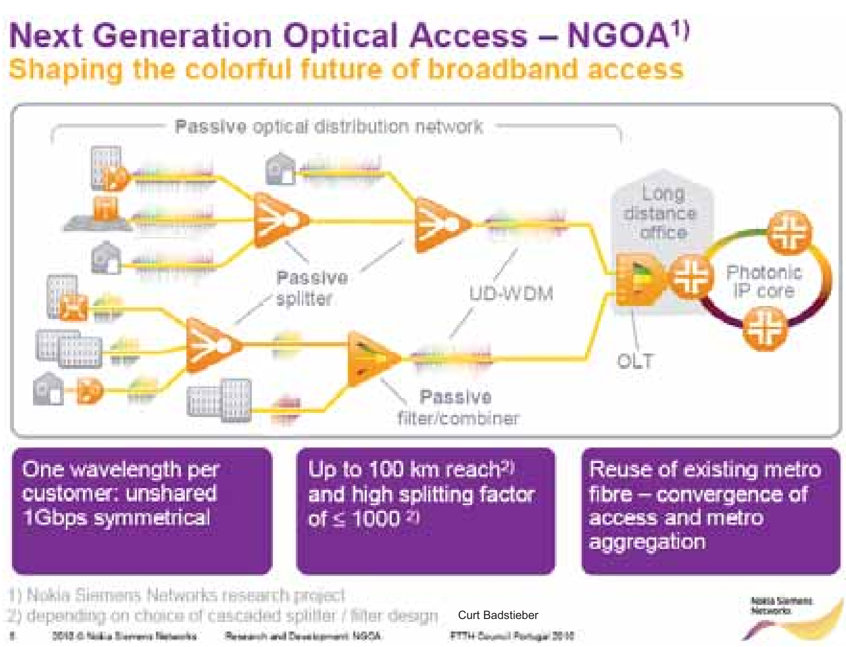
PON downstream channel wavelength). In this way, only coexistence between GPON and 10G GPON would be enabled. At the moment we see no option for coexistence between GPON and NGOA.

Such a WDM PON technology (Figure 2-10) would allow dedicated wavelengths for each customer, resulting in higher bandwidth compared to GPON. Each of these WDM PON wavelengths is announced to support 1 Gbps bandwidth, which can be administered by one or more WDM PON OLTs, operated by different carriers, thus allowing one to unbundle the wavelength.

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

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

Figure 2-10: Outlook: WDM PON in future use



Source: Badstieber (2010)

Nevertheless we have considered a WDM PON technology such as the one proposed by the Open Lambda Initiative as a very forward looking technology option in this study.[36]

We assume that a single OLT supports up to 1000 wavelengths with 1 Gbps capacity each in a symmetric manner. The fibre plant may bridge a distance of up to 100 km. This allows one to close all of the existing MDF locations except those used for the core network, which consists of 45 locations in our model country Euroland (see section 3.1.2). The MDF will be replaced by larger manholes which host additional splitters (1:16) in order to further concentrate the fibres. Up to 1000 drop cable access lines would then be concentrated per backhaul fibre between the old MDF and the remaining MPoP at the core layer nodes. Up to the old MDF locations we assume the fibre plant to be the same compared to GPON (with splitters in the field), from there to the MPoP the existing concentration network will be replaced by backhaul fibres, hence by a passive optical network.[37]

Furthermore, we make advanced assumptions for the cost of the WDM PON equipment by assuming it will be produced in large numbers of components, thus costing more than GPON components. The OLT we assume to be 5 times more expensive than a GPON OLT, the ONT 1.5 times more expensive than a GPON ONT. The difference is caused by the higher complexity and bandwidth of the systems.[38] The central systems functionality of WDM PON at the MPoP is comparable to the GPON technology. The backhaul cables are terminated to an ODF, which allows one to patch the splitter chain to any OLT port. The OLTs are connected to high power Ethernet switches aggregating the traffic to the core routers. The space required in the MPoP and the electrical power consumption will be calculated bottom up like in all other calculations.

With this type of WDM PON architecture we have a dramatic increase of dedicated bandwidth per end customer (from 40 Mbps to 1 Gbps) but the bandwidth peak per customer is reduced to 1 Gbps compared to 2.5 Gbps in the shared GPON case. This solution only allows one to serve the end customers individually in the bandwidth frame the optical beam offers (1 Gbps). Higher bandwidth can only be offered by bundling colours. Dark fibre optical frequency bands for dedicated customers cannot be served and require additional fibres in the backhaul, feeder and drop segment. Supplier dependency and inflexibility for future system upgrade may remain the same since the system bases also on a Point-to-Multipoint fibre plant.

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36 Therefore our results may have some uncertainty.

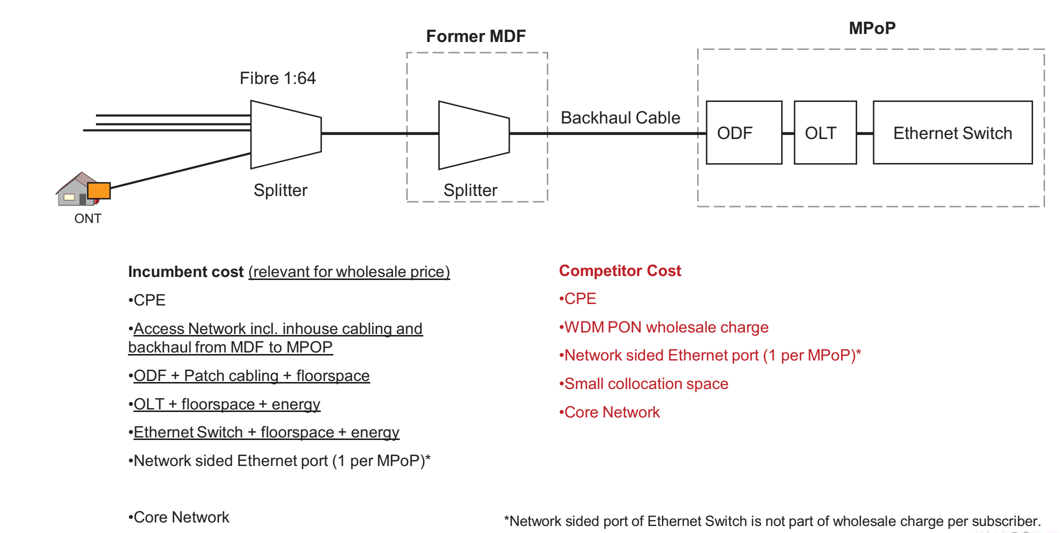
37 With 45 MPoPs the 22 million potential subscribers give on average 490,000 potential subscribers per MPoP. With a splitting ratio of 1:1000 only 490 fibres have to be concentrated at the MPoP, thus there is no question of fibre manageability. 45 circles with a radius of 50 km (100 km divided by 2 for fibre routing deviations) may certainly cover the whole Euroland. Therefore, we believe our assumptions to be reasonable.

38 The WDM PON OLT has 400 times more capacity (1000/2.5) than a GPON OLT and a much higher complexity of the optical systems, the WDM PON ONT has to deal with the much more complex wavelength grid at comparable speeds. For the WDM PON ONT price we also conducted sensitivities.

We assume that the disadvantages of the GPON security and availability constraints will not exist in the WDM PON architecture, which does not use broadcast for individual communication and only transmits the end user information over the end users access line.

Accordingly, the associated wholesale access considered is an active line access at the core level, which we call "WDM PON unbundling". The underlined cost components in Figure 2-11 once again are the input for the wholesale price calculation, while the components in black build the total cost of the incumbent and those in red the total cost of the competitor.

Figure 2-11: Scenario WDM PON with unbundling at the core level



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

2.3.5 Comparison of technologies considered

The following table provides a comparison of all solutions considered. Generally Point-to-Point outside plants (deployed in the case of P2P and GPON over P2P) are better suited for higher and symmetrical bandwidth and therefore also better able to cater to business users. P2P outside plants are more future proof because they can be flexibly upgraded according to the demand of future customers. In addition, P2P allows the operator to source from multiple equipment vendors much more easily than all PON variants. PON variants (GPON over P2P, GPON and WDM PON) on the other hand require fewer fibres in the feeder segment and save on MPoP footprint and potentially on energy consumption. Our cost modelling analysis will specifically address the latter aspects to analyze the cost advantages in this respect. Most of the other qualitative differentiating factors (performance, ability for unbundling, scalability, fault identification, security, etc.) are not part of the quantitative analysis.

Table 2-3: Comparison of access solutions considered

	P2P	**GPON over P2P**	**GPON**	**WDM PON**
Fibre count drop / feeder	◑ / ○	◑ / ○	◑ / ●	◑ / ●
Bandwidth per customer / capability for symmetry	● / ●	◑ / ◑	◔ / ◑	◕ / ●
Max distance from MPoP to customer	**10-40km**	**20km**	**20km**	**100km**
Ability to cater to business customers	●	◕	◔	◑
Future-proof	●	●	◑	◑
Security	●	◑	◑	◕
Degree of vendor-independency	●	◔	◔	◔
Energy consumption MPoP	○	◕	◑	●
Fault identification and repair	●	◑	◔	◔
Floorspace demand at MPoP	○	◑	◕	●

Relatively good ● **Relatively poor** ○

Source: WIK-Consult

2.4 Competitive models not considered

There are two models or scenario variants which are close to the scenarios considered, for which we have decided not to analyse in the competition model.

The first variant would be in the wholesale entrant sphere, an entrant using **bitstream** instead of unbundling fibre loops of the existing **Point-to-Point** fibre plant of the P2P and GPON over P2P architectures. This variant would not add significant findings, and would not contribute to the discussion of architectural differences, since the bitstream has most of the quality disadvantages a bitstream access product produced by GPON also has. Both strongly depend on the wholesale providers performance and service quality.

The second variant will show an **entrant who replicates the incumbent's NGA** infrastructure to the end customers' homes. As we will show in chapter 3 infrastructure replicability is only (theoretically) viable in Cluster 1 of Euroland, we do not believe this approach to have major relevance, but including it would bring major complexity into the competitive model. The coverage of the other scenarios at least reaches Cluster 4 and the cost curve would differ compared to the other entrants. Therefore we have excluded this variant.

In addition to these 2 variants there is another case we have neither modelled in the steady state model and its dynamic extension nor in the competition model: This is the case of **sub-loop unbundling** at the DP in order to obtain access to unbundled fibre lines in the Point-to-Point drop fibre plants. These architectures require a competitor's infrastructure not only to the MPoP, but in addition to the DPs in the field. So the feeder fibre lines have to be replicated by the competitors. This reduces profitability compared to all scenarios considered (ULL and bitstream) and is the reason why we did not include this case into our considerations.

2.5 Critical market shares for competitive models

The cost model determines which take-up rate an operator needs to realise in order to bring his total cost below revenues per user. These critical market shares (see section 3.2.1) also formed the basis of determining the number of firms in the initial competitive model design. Since critical market shares of competitors have shown to be relatively high except in the first two clusters it became apparent that the number of firms in the competitive model would very likely be in the single-digit range. Later calibration of the model then confirmed this expectation. As a result, we are looking at about 4-6 firms competing in the free entry equilibrium.

In the cost model the ARPU is fixed and market shares are only referenced to in order to compare ARPU with cost. In the competitive model however, price is a function of competition and so is the effective market share in the equilibrium.

2.6 Competitive and regulatory interaction in an oligopoly environment

2.6.1 Modelling approach

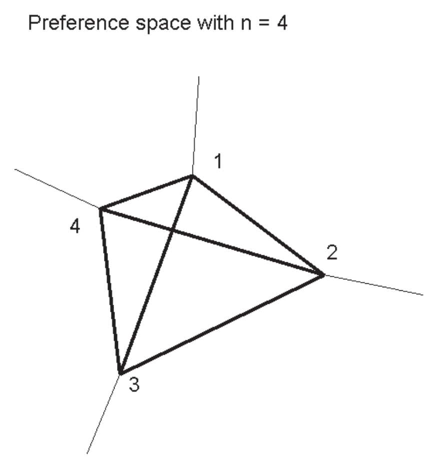
2.6.1.1 The theoretical model

Our modelling approach is based on the pyramid model, which is closely related to the spokes model:[39] For each pair of services, there is a set of consumers who choose between these two products and these consumers are (uniformly) distributed in their

39 The pyramid model was first developed by von Ungern-Sternberg (1991), while the spokes model originates from Chen and Riordan (2007).

willingness to pay for one service rather than the other. Graphically this leads to a pyramid, as illustrated in Figure 2-12, with each service located at one of the tips of the pyramid. In addition, there may be "Hinterland" consumers who consider only one of the services, represented as the thin lines emanating from the tips.

Figure 2-12: Preference space



An alternative would be the Salop model, which is widely used in the industrial organization literature.[40] A major disadvantage of the Salop model is that it imposes a very particular substitution pattern across products: A service is a substitute only to its two neighboring services implying that cross price elasticities to other services are equal to zero. Our modelling approach allows for positive cross price elasticities between any pair of services.

Another frequently used model is the logit model.[41] Our approach and the logit model have in common that all cross price elasticities are strictly positive. While our approach is in general very flexible, our chosen implementation and the logit model have in common that a given number of available services are affected symmetrically by the introduction of an additional service. In terms of implementation, an advantage of the present framework leads to linear demand functions and, thus, explicit solutions. This is not the case for the logit model.

Infrastructure. Our approach captures essential aspects of competition in FTTH markets, both on the wholesale and retail side. One firm, the "incumbent", owns and invests in an FTTH access network, to which other firms ("entrants") must obtain access in or-

40 See Salop (1979).
41 For an extensive treatment, see Anderson, de Palma and Thisse (1992).

der to provide NGA-based services. Entrants are assumed to be symmetric and need to make own investments in order to use NGA access. We consider models both with and without a second vertically integrated broadband infrastructure (“cable”), to which no other firms have access.

Demand. The services that firms offer are both “horizontally” and “vertically” differentiated. The former means that consumers do not react strongly to small price differences because individual preferences for firms’ brands differ. In particular, assuming a uniform distribution of individual tastes in this horizontal dimension leads to linear demand functions. As a result of horizontal differentiation, the market is imperfectly competitive and firms will enjoy positive mark-ups. Vertical differentiation expresses differences in service quality and goodwill or brand recognition as perceived by consumers, i.e., at equal prices a firm with higher service quality would attract more consumers. Service quality is assumed to affect all consumers similarly, i.e. we abstract from market segmentation in the service quality dimension.

To model that total FTTH subscription demand is variable, we consider two model variants. In both there is a group of “competitive” subscribers. Each competitive subscriber makes a first choice between two of the firms, and unless their offers are very unfavorable, he will choose one of the two. It is assumed that all pairs of preferred firms (before quality differences) are equally likely in the population, so that effectively each firm will compete with any other firm for consumers. Formally speaking, cross price elasticities are different from zero for all product pairs. Due to the assumption of uniform distributions of consumer tastes, the resulting demand function of each firm is linear in its own price and linear in the price of all other firms. This makes the analysis tractable and allows for explicit solutions. In spite of advances in empirical demand estimation that allow for more flexible demand specifications, the linear demand system remains popular in empirical research. Our underlying micro foundation permits us to compare markets with different numbers of firms in a meaningful way.

If the firms on the market include the cable firm, our model has the feature that FTTH subscription demand is variable. However, total demand for subscription is fixed and assumed to be 100% of potential subscribers in the clusters considered. For reasons that become clear in a moment, we call this the “No-Hinterland” model. In the absence of a non-FTTH-based competitor, we make subscription demand variable with the introduction of “captive” consumers who make a choice between one firm and not buying FTTH subscriptions at all (this is the “Hinterland” model). Here we aim at FTTH subscriptions close to 70% of all potential subscribers in the clusters considered.

All subscribers then either buy one subscription or none, where competitive subscribers will always buy one subscription. Not buying leads to a surplus normalized to zero, while the choice between the two preferred options is based on the comparison between prices, quality of service and the relative preference for the two brands.

Cost structure. We consider market outcomes on a monthly basis, so investment cost for providing or using NGA have been translated into a monthly value over the life time of the infrastructure. Each firm also bears downstream costs which consist of a fixed part and a variable part as a function of number of subscribers. For the latter, the model allows for either increasing or decreasing marginal cost. In the actual model runs we have only used constant marginal costs, though.

The access tariff paid by the entrants to the incumbent consists of a price per subscription and potentially also of a fixed fee. In this study we are considering only linear wholesale access tariffs based on the incumbent's LRIC at a defined network load. In one variant of the model, we determine the linear access tariff such that at the resulting equilibrium quantity, the access payments exactly cover the total cost of providing FTTH access (interpreted as LRIC pricing).

We treat the incumbent as if he were under vertical accounting separation into a NetCo that supplies FTTH infrastructure access and an OpCo that sells FTTH end-user services. The incumbent's NetCo sells access to other firms ("entrants") and to the OpCo. This does not affect pricing behavior and overall profits but it provides for an automatic price-squeeze test.[42]

All cost components consist of fixed costs and constant variable costs, but we could also include a quadratic term to model non-constant variable cost.

Incumbent:

- Costs of wholesale products for the whole FTTH output
- Opportunity costs of wholesale products for own end-user sales
- Downstream network (concentration and core network) and retail costs for own end-user sales.

Competitors/entrants:

- Price of wholesale products purchased
- Downstream network (concentration and core network) and retail costs for end-user sales.
    - Entrants/competitors are modelled on a scorched node basis, where nodes are determined by the incumbent's network architecture.
    - Entrants fully penetrate each modelled cluster.

42 In our model runs price squeeze has never been an issue.

Cable TV/DOCSIS3

- Total costs of own end-user sales

The price of wholesale products is assumed to be based on the long-run incremental costs (LRIC) of the access service, which in turn contain the fixed and variable costs incurred by the incumbent for the FTTH access product. Here the variable costs include wholesale sale costs. These wholesale sale costs are saved when the incumbent provides the access product internally to himself. A linear wholesale charge is then the total LRIC divided by the FTTH access quantity (including access used internally by the incumbent). On top of this, there may be a multiplicative mark-up on the pure LRIC to arrive at the wholesale charge.

Equilibrium. Depending on the scenario considered, first, firms make certain investments in networks and access, which determine their service quality levels and operating cost. Second, they compete in subscription fees at the retail level. The resulting market outcome is modelled as the Nash equilibrium outcome of the resulting pricing game, from which subscriber numbers, profits, market shares, consumer surplus and total welfare are derived.[43] In the model with entry and exit, we first allow for a non-specified process of entry and exit with the feature that all active entrants make profits and that the entry of an additional entrant would lead to losses of all active entrants. Here we postulate that entrants correctly foresee the effect of entry (and the associated investment decisions) on the pricing decisions and, thus, on market outcome. Formally, and in line with the literature on industrial organization, the stronger notion of subgame perfect Nash equilibrium is used. This means that we consider subgame perfect Nash equilibria of the two-stage game in which entrants first make their participation decision and then all active firms make pricing decisions.

2.6.1.2 The quantitative model

More detailed and formal descriptions of the competitive model are provided in Annex 4. In the market for broadband, n firms (the incumbent, entrants and potentially a cable company) compete for N_c “competitive” consumers and possibly N_e “Hinterland” consumers. Each firm provides a quality level S_i. The intensity of preferences of consumers between services supplied by firms i and j are measured by σ_{ij}, and λ_i is the intensity of preferences in the Hinterland of firm i.

After investments have been made, firms compete in subscription prices. Market outcomes are given by the Nash equilibrium of this pricing game between firms.

Providing FTTH access involves a marginal cost of c_0 and a fixed cost of K_0. Firm i’s downstream costs of providing retail services consist of a marginal cost c_i and a fixed

43 The Nash equilibrium is the standard solution concept used in the literature. It assures that firm decisions are mutually consistent.

cost K_i. Downstream firms pay an access tariff consisting of a per-subscriber price a and (potentially) a fixed fee A. Only the incumbent receives wholesale payments ($\gamma_1 = 1$ and $\gamma_i = 0$ for the other firms), but all firms apart from the cable company use the incumbent's FTTH access ($\delta_i = 0$ for cable, and $\delta_i = 1$ for all other firms)

Model output variables. The following variables are determined at the equilibrium outcome:

- p = final output subscription price
- n = the equilibrium number of firms. While the number of firms is actually an input into the quantitative model, we determine the free-entry equilibrium number by running the model with an increasing number of entrants, until under n firms entrants are profitable while under (n+1) firms entrants expect to make losses.
- prof = profits per month per firm
- WhProf = wholesale profits of incumbent. These include profits from the sale of the incumbent's Netco to the incumbent's Opco.
- s = market share per firm
- sum(q) = market output
- CS = consumer surplus per month. It has to be noted that total output (including cable) does not vary in the No-Hinterland model, whereas in the Hinterland model it does not vary for competitive subscribers but does vary for Hinterland subscribers.
- W = welfare per month = CS + sum(prof). Aside from market expansion effects in the Hinterland markets the main welfare effects stem from cost and WtP differences of the various technologies and suppliers. Among others, welfare is affected by changes in the market shares of the different technologies and by changes in the market shares of the different providers using the same technology. With endogenous entry, also the duplication of fixed costs affects the welfare analysis.

2.6.1.3 QoS and willingness to pay in the basic model

Our assumptions on quality of service (QoS) and the end-users' willingness-to-pay (WtP) are provided in Table 2-4. The values are in Euro-equivalent per month.

Table 2-4: QoS and WtP assumptions for basic model

QoS, Scenario	Incumbent QoS =WtP	Cable QoS = WtP	Entrant QoS	Entrant WtP
P2P unbundling	100	82	99	97
GPON over P2P unbundling	99	82	99	97
WDM PON unbun-dling	95	82	91	89
GPON bitstream core	90	82	85	83
GPON bitstream MPoP	90	82	87.5	85.5

The value of chosen QoS differences may appear large from today's perspective. However, it has to be kept in mind that we are considering steady state situations with full FTTH penetration around ten years from now. It can be expected that the share of customers with high-bandwidth demands and the prevalence of corresponding applications will be much higher than now. Thus, the premium for ultra-high bandwidth will also be much higher than now.

In contrast, the incumbency premium will likely become smaller, as time goes by. This justifies the small incumbency premium of 2 € over entrants that we have chosen.

Quality differences between architectures refer to incumbents, entrants and cable and are explained as follows.

Incumbent:

- **1) P2P Ethernet:** This is the base case with best quality (QoS = 100). Each customer can be served with individual bandwidth up to 10 Gbps according to demand.
- **2) GPON over P2P:** In this case users share down- and upstream capacity and influence each other. However, the operator can scale the degree of sharing very flexibly by controlling split factors. Compared to P2P Ethernet this is poorer for IPTV and more sensitive to security and availability for end-users. Due to P2P fibres individual services for dedicated customers up to 10 Gbps or in the optical spectrum in separate technology are possible (-> QoS = 99).
- **3) WDM PON:** In this case users share down- and upstream lines on a per color base, resulting in about 1 Gbps per customer. Compared to P2P Ethernet this is poorer for IPTV and is sensitive to security. The shared fibre is inflexible for dramatic bandwidth upgrades so that there can be no 10 Gbps lines or WDM use (-> QoS = 95).

- **4) GPON:** In this case users share down- and upstream capacity and influence each other. Any bandwidth guarantee per customer is limited (< 40 Mbit/s) or dependent on statistical behavior. Compared to P2P Ethernet this is poorer for IPTV and is sensitive to security. The shared fibre is inflexible for dramatic bandwidth upgrades (-> QoS = 90).

Entrant:

- **1) Unbundling of P2P Ethernet:** This is the base case with best quality for entrants enabling ULL for entrants, but because the value chain is partially predetermined by the incumbent and because entrants depend on the incumbent for service and repairs, slightly poorer quality may result. Each customer can be served with individual bandwidth up to 10 Gbps according to demand (-> QoS = 99).[44]

- **2) Unbundling of GPON over P2P:** This case allows ULL for entrants with advantages as above (-> QoS = 99).

- **3) Unbundling of WDM PON:** In this case the value chain is strongly dependent on the incumbent, but the bandwidth guarantee is rather high (~1 Gbit/s per customer). The service is sensitive to security. The shared fibre is inflexible for dramatic bandwidth upgrades. So, there can be no 10 Gbps lines, dark fibre or WDM use (-> QoS = 91).

- **4) Bitstream access of GPON:** Value chain in this case is strongly dependant on the incumbent. Any bandwidth guarantee per customer is limited (< 40 Mbps) or dependent on statistical behavior. The handover at core locations is poorer than at MPoPs (bitstream core -> QoS = 85, bitstream MPoP -> QoS = 87.5).

Cable:

- Cable is a shared technology that is inferior to FTTH in all the above versions and compared to incumbents and entrants.

Scope of results

- We have done model runs based on the final cost model outputs.

- This resulted in runs for all scenarios for the aggregate of Clusters 1 through 4. We have done this for both the Hinterland model and the No-Hinterland model. This way we can generate comparable results for all scenarios and for both models. In addition we have done selective model runs for GPON bitstream core

44 Nevertheless, we assume that wholesale services are provided under non-discriminatory conditions. This means under a perfect regulatory regime. Imperfect regulation would imply larger quality differences between incumbent and entrants, See Footnote 52 below for incentives of the incumbent to deteriorate quality of wholesale access.

for Clusters 1 through 5, because the critical market share analysis[45] indicated that competitive entry in Cluster 5 was feasible for the GPON bitstream core scenario.

- The remaining discretionary data inputs (horizontal differentiation and size of Hinterland) were calibrated to be compatible with the assumed ARPUs, with plausible quality differences and with plausible market shares. We have kept these parameters constant across scenarios and only adapted them to different market sizes. Reduced product differentiation would have led to fiercer competition, resulting in a smaller equilibrium number of firms.

2.6.2 Basic model results

In this section we provide results on prices, profits, market shares, consumer surplus and welfare for all scenarios over the first four clusters. These basic model runs have all been performed under strong regulation and do not differentiate between weak and strong regulation. Weak regulation with mark-ups on wholesale access prices is taken up in section 2.6.2.5. Section 2.6.2.6 endogenizes the access charges based on actual equilibrium access quantities. Section 2.6.2.7 considers the marginal Cluster 4 in isolation, in order to find out if investment in that cluster is profitable for the incumbent and/or entrants under the basic model assumptions. Last, we include Cluster 5 for the GPON bitstream core scenario in section 2.6.2.8.

The cost data and wholesale charges for the different scenarios are generally taken from the results of the cost model. Except when noted differently the costs and wholesale charges are generally the aggregate numbers for the first four clusters. The cost data for cable were assumed by us to reflect reasonable estimates.

2.6.2.1 Results on end-user prices

There are three drivers of prices and price differences: Costs, WtP and competition (number of firms). In addition to the WtP shown above in Table 2-4 we, therefore, have to consider the relevant costs. Prices are directly driven by variable or, more precisely, marginal costs (MC), not by fixed costs. Fixed costs only influence the level of profits and are, thus, important for entry and exit of firms (which again indirectly affect prices).[46]

In Table 2-5 below MC_C and MC_E are the actual marginal costs incurred by cable and entrants and are directly relevant for their retail pricing; the values for MC_C have been assigned by us and the values of MC_E have been determined from cost model results. For the incumbent, MC_{I_actual} are the sum of MC of access and downstream services,

45 The concept of critical market shares is developed in section 3.2.
46 The aggregate fixed costs of cable for the first four clusters are assumed to be 20 Mio € per month.

while $MC_{I\_perceived}$ are the sum of wholesale access charges and downstream costs. In contrast to MC_{I_actual} the $MC_{I\_perceived}$ are directly relevant for the incumbent's end-user pricing because selling wholesale rather than retail is the next best use of the incumbent's FTTH infrastructure. Prices above $MC_{I\ perceived}$ also fulfill the condition of being margin squeeze free. The marginal cost of the entrants MC_E are the sum of the wholesale access charges and the (variable) downstream costs.

Table 2-5: Marginal costs in Euro per month

Scenario	MC_C	$MC_{I\ actual}$	$MC_{I\ perceived}$	MC_E
P2P unbundling	12.00	20.18	34.36	36.22
GPON over P2P unbundling	12.00	18.05	32.22	36.22
WDM PON unbundling	12.00	18.36	33.37	34.00
GPON bitstream core	12.00	16.46	31.99	32.62
GPON bitstream MPoP	12.00	16.46	31.53	32.16

Source: WIK estimates

The equilibrium end-user prices for all scenarios are shown in Table 2-6. While the first two scenarios consistently lead to the highest prices, the order of prices overall differs between the Hinterland and the No-Hinterland model. Because of product differentiation the incumbent's price may be below the entrants' price (for instance, in case of GPON over P2P unbundling) if the incumbent's variable costs are sufficiently lower to offset for quality and goodwill differences which tends to lead to a higher price. In the No-Hinterland model the equilibrium number of firms is in two cases (P2P unbundling and GPON bitstream MPoP) one higher than in the Hinterland model. In both these cases the order of prices between Hinterland and No-Hinterland model is affected by this difference. Figure 2-13 and Figure 2-14 below illustrate the effect of the number of firms, 'n', on prices.

Table 2-6: Marginal costs and prices in Euro per month

			Hinterland			No-Hinterland			
Scenario	$MC_{Iperceived}$	MC_E	n-1	p_I	p_E	n-2	p_I	p_E	p_C
P2P unbundling	34.36	36.22	3	46.32	44.87	4	42.07	42.37	23.76
GPON over P2P unbundling	32.22	36.22	3	44.71	44.72	3	43.58	45.54	27.92
WDM PON unbundling	33.37	34.00	4	42.46	38.69	4	41.24	39.32	26.16
GPON bitstream core	31.99	32.62	4	41.58	37.44	4	40.10	37.63	28.28
GPON bitstream MPoP	31.53	32.16	3	43.04	40.52	4	38.76	37.67	27.15

Figure 2-13: Prices and number of firms Scenario GPON bitstream core, Hinterland

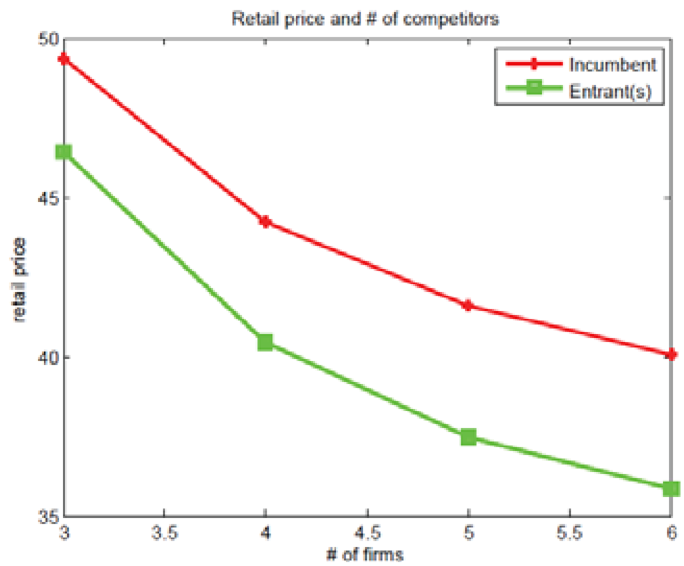
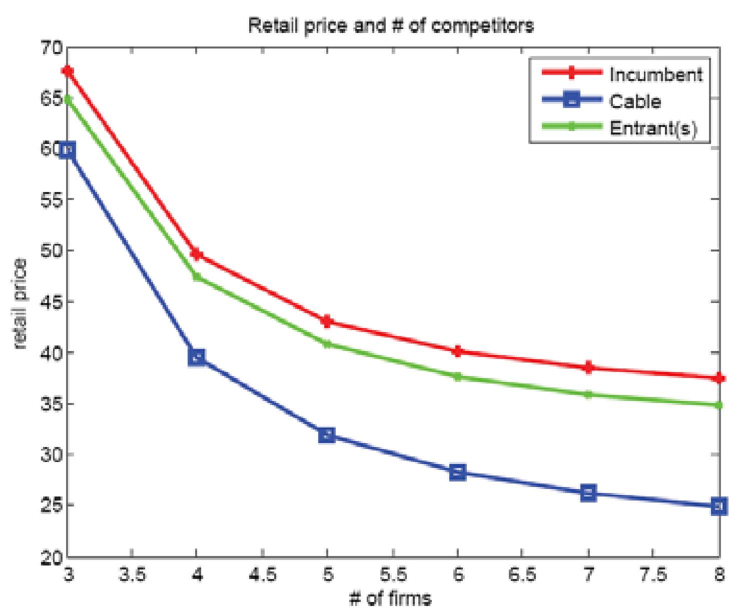


Figure 2-14: Prices and number of firms Scenario GPON bitstream core, No-Hinterland



The above illustrations in Figure 2-13 and Figure 2-14 for GPON bitstream core are derived by running the model with varying numbers of firms while keeping all other input variables of the model constant (and thus treat entry and exit as exogenous). The results are representative for all scenarios. The curves are always downward-sloping and convex. Retail prices are thus quite sensitive to the number of firms in the market, if the number of firms is small. Note that under the basic parameterization in all scenarios only 3 or 4 entrants survive in equilibrium.

The absolute price differences between incumbent and entrants increase slightly and the relative differences increase significantly in the number of firms. This suggests that entry increases competition among entrants by more than competition between the incumbent and entrants. Competition by cable brings prices of entrants and the incumbent much closer together than competition without cable.

Since the Hinterland model has one less firm than the No-Hinterland model, a direct comparison between both models would be for 3-7 firms in the Hinterland model and for 4-8 firms in the No-Hinterland model. In these ranges the two models yield quite similar results.

Table 2-7 shows the case of 5 firms in the Hinterland model and 6 firms in the No-Hinterland model, leading to 4 entrants in each case. Both models give the same rankings of the scenarios for prices of incumbents and entrants. However, on average prices are a little higher in the Hinterland model than in the No-Hinterland model. Prices of incumbents are always higher while prices of entrants are always lower in the Hinterland model than in the No-Hinterland model.

Table 2-7: Prices in Euro per month in case of 4 entrants for all scenarios

	Hinterland				No-Hinterland					
Scenario	p_I	**Rank**	p_E	Rank	p_I	**Rank**	p_E	Rank	p_C	Rank
P2P unbundling	43.78	1	41.64	1	42.07	1	42.37	1	23.76	5
GPON over P2P unbundling	41.78	3.5	41.51	2	40.38	3.5	42.17	2	24.11	4
WDM PON unbundling	42.46	2	38.69	3	41.24	2	39.32	3	26.16	3
GPON bitstream core	41.58	3.5	37.44	4.5	40.10	3.5	37.63	4.5	28.28	1
GPON bitstream MPoP	40.29	5	37.42	4.5	38.76	5	37.67	4.5	27.15	2

Table 2-7 clearly shows that the ranking of scenarios by the end-user price of cable differs substantially from the rankings of scenarios by the end-user prices of the incumbent and entrants. This holds because cable has in all scenarios distinctly lower marginal costs than the incumbent and entrants, while the difference in customer valuations between cable and the incumbent's and entrants' services varies substantially by scenarios. End-user prices for cable therefore vary inversely to the relative difference in WtP between cable and FTTH services.

The rankings of the scenarios in terms of the incumbent's and entrants' end-user prices are not all the same except for P2P unbundling which has always the highest and GPON bitstream MPoP which has always the lowest prices. GPON over P2P unbundling and WDM PON unbundling are very close to each other below P2P unbundling, and GPON bitstream core is somewhat above GPON bitstream MPoP.

If one therefore keeps the number of firms constant the equilibrium results would show P2P unbundling to have the highest prices followed by GPON over P2P unbundling and WDM PON unbundling. GPON bitstream core would be next and GPON bitstream MPoP last. The price rankings follow quite closely those of marginal costs, and any deviations are explained by higher or lower customer valuations of the services.

2.6.2.2 Results on profits

Table 2-8 gives profits for the basic model for both the Hinterland and the No-Hinterland case. It should be noted that entrants' profits are always reported per entrant.

Table 2-8: Profits in Million Euro (per month)

	Hinterland			No-Hinterland			
Scenario	n-1	$prof_I$	$prof_E$	n-2	$prof_I$	$prof_E$	$prof_C$
P2P unbundling	3	24.83	3.74	4	18.78	0.45	2.81
GPON over P2P unbundling	3	27.89	3.38	3	26.91	6.55*)	13.22
WDM PON unbundling	4	13.05	1.83	4	17.91	2.92	13.09
GPON bitstream core	4	23.71	1.54	4	13.22	2.07	23.72
GPON bitstream MPoP	3	23.60	4.40*)	4	10.00	0.31	17.86

*) with 4 entrants there is a very small loss for each entrant.

Because of the additional competition of cable in the Hinterland model, profits are not directly comparable between the Hinterland model and the No-Hinterland model.

In the Hinterland model entrants' profits are substantially higher in the three-entrant markets (P2P unbundling, GPON over P2P unbundling and GPON bitstream MPoP) than in the four-entrant markets (GPON bitstream core and WDM PON unbundling). Only in the WDM PON unbundling scenario seem the profits of the incumbent to be impacted by the number of competitors in the Hinterland model. As Figure 2-15 and Figure 2-16 show, this is mostly driven by additional competition.

In the No-Hinterland markets entrants' profits are much lower in those markets, whereas the Hinterland model has one less entrant in equilibrium. The reason is that there is a knife-edge entry of one more firm in the No-Hinterland model in those scenarios (P2P unbundling and GPON bitstream MPoP). Had fixed costs been just a little higher there would not have occurred this extra entry.

As has been the case with end-user prices, profits of cable services follow largely the quality differentials to FTTH in the various scenarios. The greater the differential the lower is cable's profits.

As Figure 2-15 and Figure 2-13 show, the influence of the number of entrants on profits differs somewhat from the entry effect on prices. The reason lies in wholesale profits. In the Hinterland model wholesale profits (because of the associated increase in overall output) increase in the number of firms, thereby increasing the difference between entrants' profits per firm and the incumbent's overall profits. In the No-Hinterland case the incumbent's wholesale profits are, because of the intervening effect of cable output, first increasing and then decreasing in the number of firms, resulting in a closing of the gap between entrants' profits per firm and the incumbent's overall profits.

Figure 2-15: Profits and number of competitors – GPON bitstream core, Hinterland

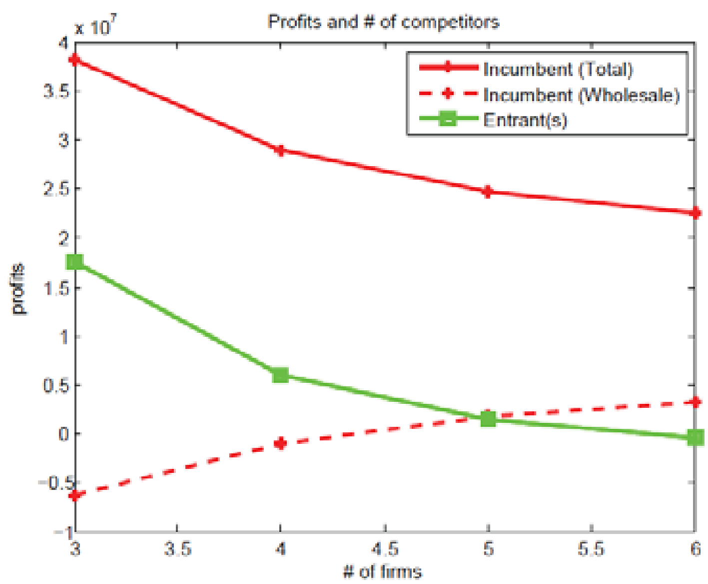
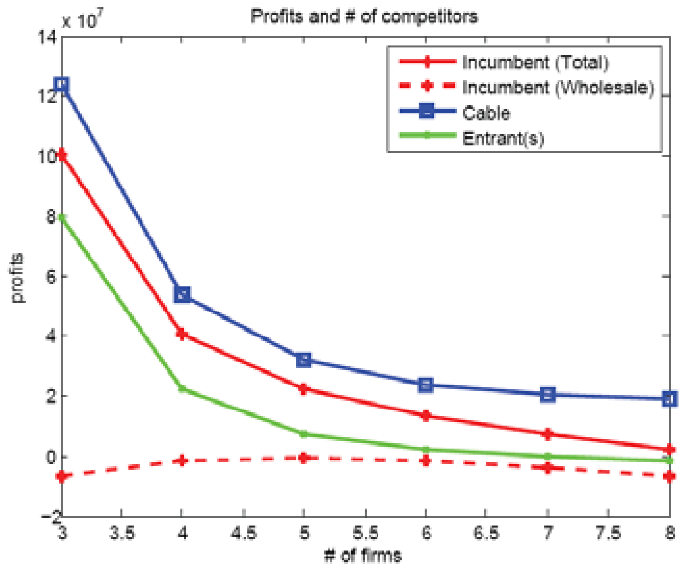


Figure 2-16: Profits and number of competitors - GPON bitstream core, No-Hinterland



Because of the increase in FTTH market output[47] that is associated with entry the wholesale profits increase with entry, although at a decreasing rate.

Otherwise, all firms experience a decline in profits per firm, as the number of firms increases. However, this happens at a declining rate, suggesting in particular that profits per entrant do not change dramatically around the free-entry equilibrium if the number of firms is fairly large. However, in the range of our equilibria (4-5 firms in the Hinterland model and 5-6 firms in the No-Hinterland model) profits do change substantially with entry.

2.6.2.3 Results on market shares and number of firms

Table 2-9 provides market shares in the basic model. It should be noted that entrants' market shares are always per entrant.

47 We are referring here to a relative shift of market shares between cable and the FTTH network.

Table 2-9: Market shares ‘s’ in percent

	Hinterland			No-Hinterland			
Scenario	n-1	s_I	s_E	n-2	s_I	s_E	s_C
P2P unbundling	3	40.7	19.8	4	23.4	13.5	22.5
GPON over P2P unbundling	3	42.1	19.3	3	26.3	16.5	24.2
WDM PON unbundling	4	41.4	14.7	4	24.5	12.1	27.1
GPON bitstream core	4	43.4	14.1	4	24.8	11.0	31.1
GPON bitstream MPoP	3	41.5	19.5	4	22.6	12.1	28.9

Even if one fully corrects for the presence of cable the incumbent’s market share in the No-Hinterland model is consistently smaller than in the Hinterland model.

In both models the incumbent’s market share stays in a narrow range through all scenarios, although it varies more in the No-Hinterland model than in the Hinterland model.

In the No-Hinterland model the market share of cable varies substantially. It closely follows quality differences between cable and FTTH and is lowest where the quality differential to FTTH is greatest.

As Figure 2-17 and Figure 2-18 show, the market shares sometimes react in a non-monotonic fashion to market entry. It is, in particular, noteworthy that, in the Hinterland case, the market share of the incumbent *increases* at some point as entry increases further. This appears to be restricted to the GPON bitstream core scenario, while in other scenarios the incumbent’s market share only tapers off as more firms enter.

Figure 2-17: Market shares and number of competitors – GPON bitstream core, Hinterland

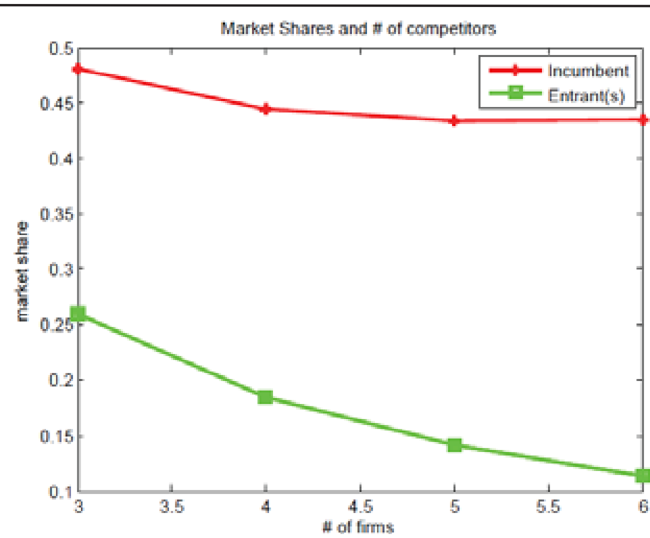
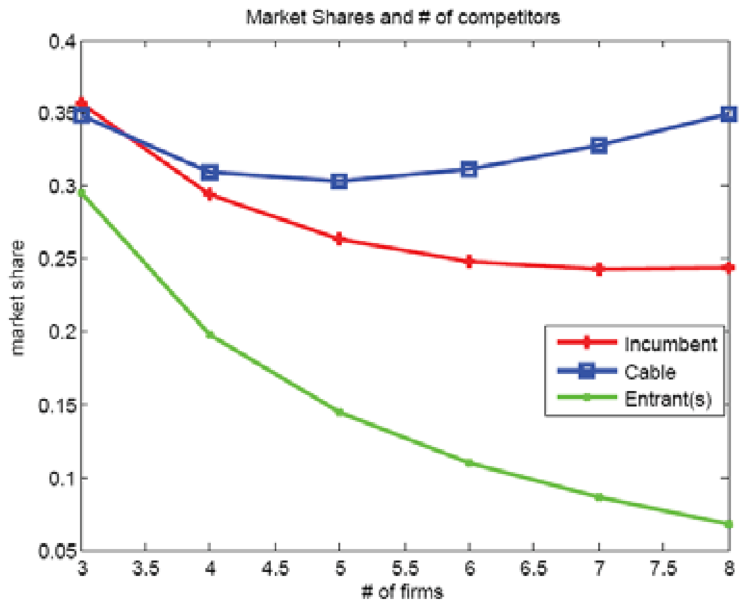


Figure 2-18: Market shares and number of competitors - GPON bitstream core, No-Hinterland



In the No-Hinterland case cable experiences at some point a market share increase as the number of entrants increases further.

Under the basic parameterization in all scenarios only 3 or 4 entrants survive in equilibrium. While we had expected this for all the other scenarios, it has come as a surprise for GPON bitstream core, where our expectation based on the critical market shares was for a higher number of entrants. The main reason is that, already with a small number of entrants, the low WtP for GPON leads to prices below the general ARPU assumed for the critical market share analysis. Further entry then leads to even lower prices and lower quantities per entrant, resulting in overall losses for all entrants.

2.6.2.4 Results on consumer surplus (CS) and welfare (W)

Table 2-10 summarizes our basic model results for CS and W. It also puts the results on prices, profits and market shares in perspective. In this context it needs to be noted that CS is largely driven by the price/valuation relationships between the different technologies and firms rather than by the overall quantity of output, which is fixed in the No-Hinterland model and varies only for each firm's backyard in the Hinterland model.

Table 2-10: Basic model results on consumer surplus and welfare per month

Scenario	Hinterland					No-Hinterland				
	n-1	CS		W		n-2	CS		W	
		Mio €	Rank	Mio €	Rank		Mio €	Rank	Mio €	Rank
P2P unbundling	3	243.1	2	279.2	2	4	466.9	1	490.3	2
GPON over P2P unbundling	3	245.6	1	283.6	1	3	434.0	2	493.8	1
WDM PON unbundling	4	240.5	3	270.8	3	4	431.2	3	473.9	3
GPON bitstream core	4	216.8	4	247.7	4.5	4	400.5	5	445.7	4.5
GPON bitstream MPoP	3	208.6	5	245.4	4.5	4	416.0	4	445.1	4.5

The ranking of CS in the Hinterland model is very close between the first three scenarios (with a 2% difference between GPON over P2P unbundling as the first and WDM PON unbundling as the third). In contrast, the difference between WDM PON unbundling as the third and the two GPON bitstream scenarios is much larger (about 10%), while GPON bitstream core and GPON bitstream MPoP are almost equal. As explained below, the CS rankings are somewhat different in the No-Hinterland model and, except for the very close GPON over P2P unbundling and WDM PON unbundling scenarios in places 2 and 3, they are rather evenly spread.

In contrast to the case of CS, the rankings of W are similar between the Hinterland and the No-Hinterland model and so are the differences between Scenarios. There is a roughly 4% difference between the first (GPON over P2P unbundling) and the third (WDM PON unbundling) and a 7%-8% difference between third and $4^{th}/5^{th}$ place.

The difference in CS and W between Hinterland and No-Hinterland is greater than the simple addition of the cable market. A direct comparison of absolute values between the two models is therefore not appropriate.

In terms of W GPON over P2P unbundling ranks consistently first and narrowly beats P2P unbundling, while WDM PON unbundling is consistently third both for W and CS, usually with a significant margin. The margin is narrow for CS in the Hinterland model, because here WDM PON unbundling has 4 entrants, while P2P unbundling and GPON over P2P unbundling only have 3 entrants.

The two GPON bitstream scenarios are in a dead heat for last place in terms of W.

In terms of CS the ranking between the P2P topologies and between the GPON bitstream scenarios is reversed for the Hinterland and No-Hinterland model. In the No-Hinterland model there are only three entrants under GPON over P2P unbundling and four entrants under P2P unbundling. Vice versa, in the Hinterland model there are only 3 entrants under GPON bitstream MPoP and 4 entrants under GPON bitstream core. This leads to higher prices and lower CS for GPON over P2P unbundling than P2P unbundling and for GPON bitstream MPoP than GPON bitstream core.

Figure 2-19 and Figure 2-20 show that, in contrast to CS, W is not much affected by entry, once the number of firms reaches 4 (No-Hinterland model) or 5 (Hinterland model). Thus, as a result of different numbers of entrants, the same rankings of scenarios in terms of W are as unsurprising as are different rankings of scenarios in terms of CS. The small effect of entry beyond 4 or 5 firms on W seems to be the result of the stable market share of the incumbent. In the No-Hinterland case, the resulting cable's gain in market share relative to the entrants appears to be welfare neutral taking all other effects into account.

Figure 2-19: Welfare per month and number of competitors – GPON bitstream core, Hinterland

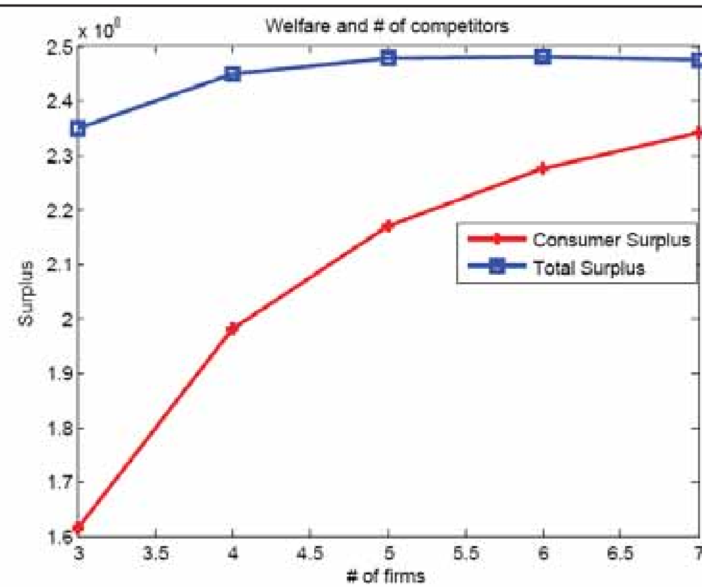
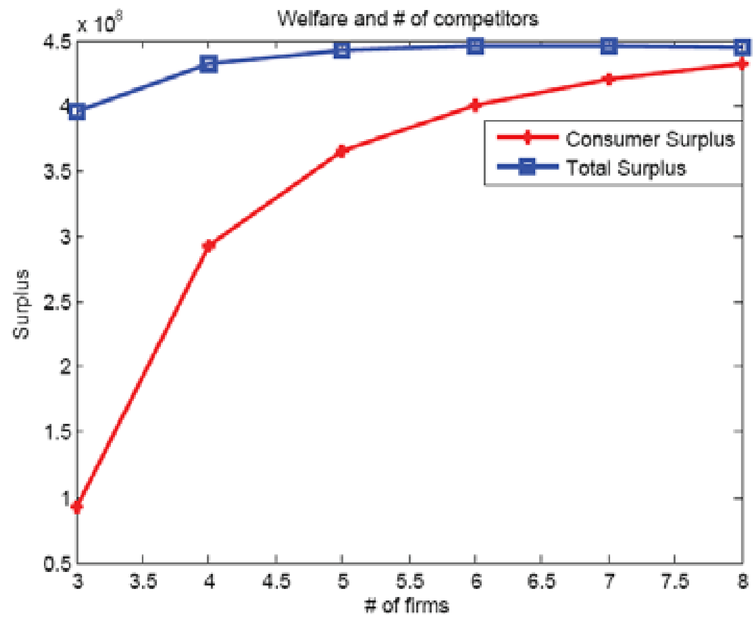


Figure 2-20: Welfare per month and number of competitors - GPON bitstream core, No-Hinterland



While W first increases in the number of firms, this ebbs off very quickly and possibly starts to decrease. In contrast, CS continues to increase fairly strongly in the number of firms.

Since the number of firms in equilibrium in some cases appears to be quite sensitive to small changes in model parameters (and therefore different between the Hinterland and the No-Hinterland model), the results on welfare should be considered more stable than the results on consumer surplus.

2.6.2.5 Access mark-up for the GPON bitstream core scenario

The GPON bitstream core scenario included “weak regulation” in its original definition. This has not been part of the basic model runs presented so far and will be done in the current section. In this context weak regulation shall mean that entrants have to pay a mark-up on the LRIC-based wholesale access charge. In the following we show the effects of such a mark-up of 0%-20% on prices, profits, market shares, CS and W.

While the presentation of results is restricted to GPON bitstream core, the results would be similar across all scenarios.

As expected and as shown in Figure 2-21 and Figure 2-22 a percentage mark-up on access charges leads to an almost parallel increase of all retail prices (incumbent, entrants and cable).

Figure 2-21: Prices and access mark-up - GPON bitstream core, Hinterland

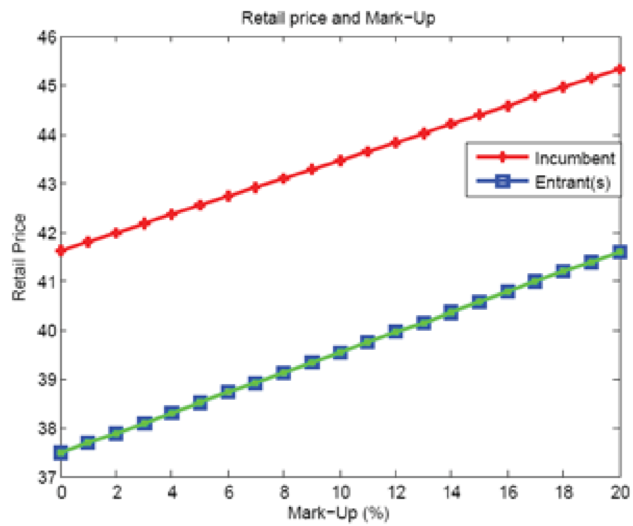
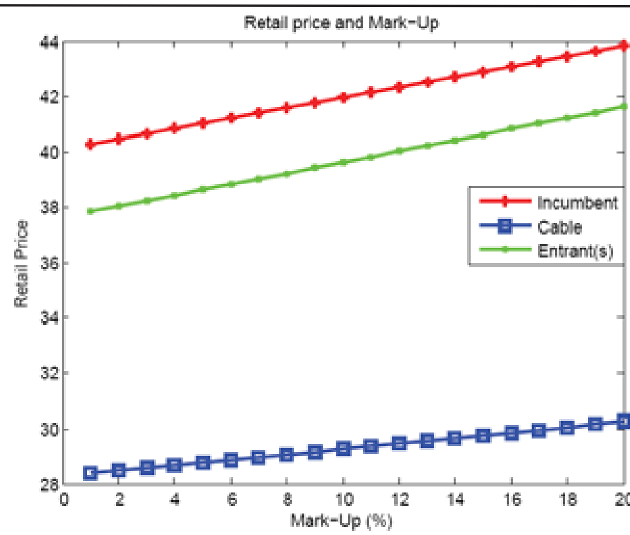


Figure 2-22: Prices and access mark-up - GPON bitstream core, No-Hinterland



As becomes clear from Figure 2-23 and Figure 2-24 the incumbent's wholesale profits increase strongly and linearly with an access mark-up. In contrast, the entrants' profits and the incumbent's downstream profits decrease very slightly with the mark-up. Cable's profits are again favorably affected by the mark-up, although not quite as much as the incumbent's overall profits.

Figure 2-23: Profits per month and access mark-up - GPON bitstream core, Hinterland

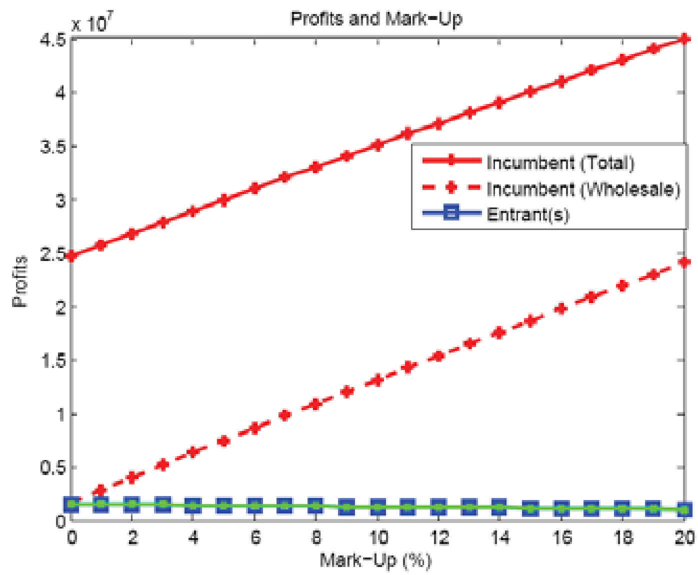


Figure 2-24: Profits per month and access mark-up - Scenario Bitstream access to GPON at core nodes, No-Hinterland

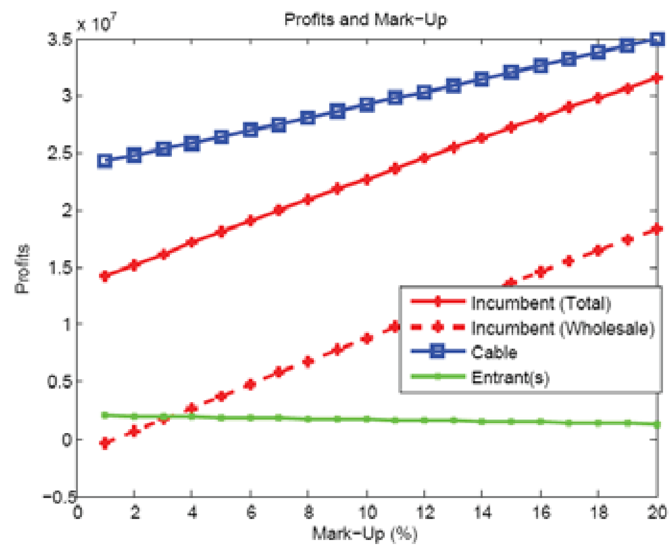


Figure 2-25 shows the incumbent's market share in the Hinterland model to increase slightly against entrants as a result of increased access charge mark-ups. In contrast, in the No-Hinterland model higher access charge mark-ups reduce the market share of entrants, hold the incumbent's market share constant and increase the market share of cable.

Figure 2-25: Market shares and access mark-up - GPON bitstream core, Hinterland

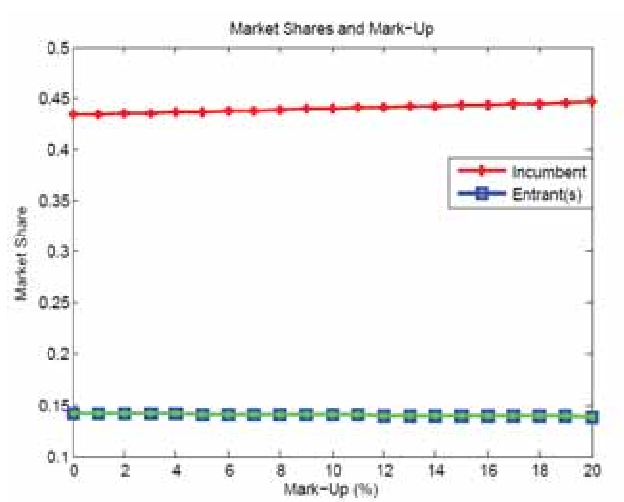


Figure 2-26: Market shares and access mark-up - GPON bitstream core, No-Hinterland

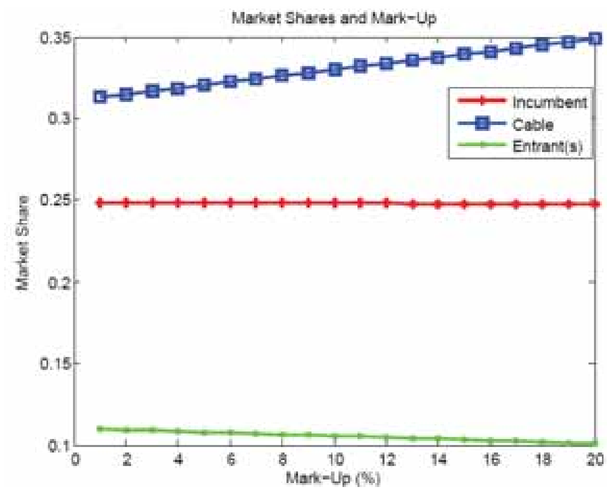


Figure 2-27 and Figure 2-28 show the relationship between access charge mark-ups and consumer surplus and welfare.

Figure 2-27: Welfare per month and access mark-up - GPON bitstream core, Hinterland

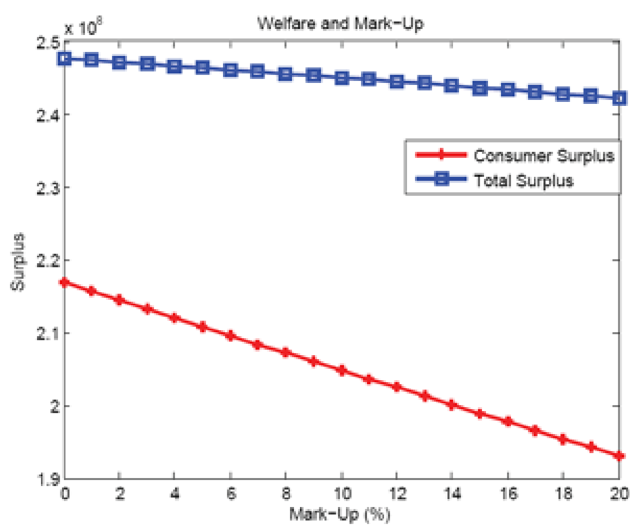
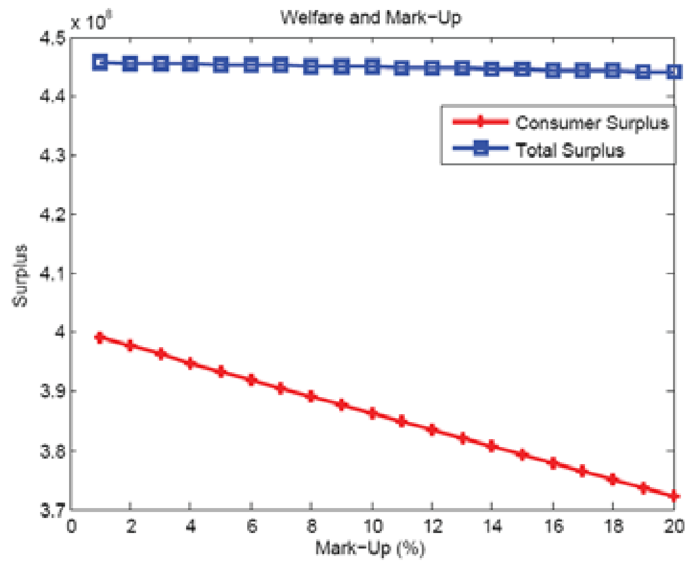


Figure 2-28: Welfare per month and access mark-up - GPON bitstream core, No-Hinterland



Both models show a weak decline in W and a strong decline in CS in an increase in access charge mark-up. Since incumbents' profits strongly increase and entrants' profits weakly decrease in the mark-up, such a mark-up may encourage incumbents' infrastructure investments. However, in our analysis so far incumbents' aggregate profits appear to be sufficient without mark-ups.

If we take weak regulation for the GPON bitstream core scenario to mean a 10% mark-up on LRIC wholesale access charges then weak regulation changes the rankings of the scenarios as follows. End-user prices are increased compared to the basic model run from 41.61€ to 43.46€ for the incumbent and from 37.48€ to 39.54€ for the entrants in the Hinterland model and from 40.10€ to 42.06€ for the incumbent and from 37.63€ to 39.82€ for the entrants in the No-Hinterland model. In both cases the incumbent's price ranking would move from lowest price (place 5) to highest price (place 1) for the incumbent and from place 5 to place 3 for the entrants. The incumbent's profits would increase by about 50% in both models, while the entrants' profits would decrease by about 15%. CS would decrease from 216.8 Mio € to 204.8 Mio € in the Hinterland model and from 400.5 Mio € to 384.5 Mio € in the No-Hinterland model. It would move the GPON bitstream core scenario from place 4 to place 5 in the Hinterland model and would reemphasize place 5 in the No-Hinterland model. In contrast, W would change very little, from 247.7 Mio € to 245.1 Mio € in the Hinterland model and from 445.7 Mio € to 444.3 Mio € in the No-Hinterland model. This would have no effect on the W-rankings. The results on wholesale access charge mark-ups in the competition models may appear to contrast with those of the critical market share analysis in the cost model (section 0).This is, because *critical market shares* of competitors increase in the cost model but *equilibrium market shares* remain relatively stable in the competition model. The current competition model assumes that demands for FTTH services are downward-sloping. Thus, an increased mark-up can be translated into a higher end-user price without too much loss in sales. In the cost model analysis the ARPU is taken as given and therefore implicitly assumes a horizontal demand curve at a price equal to the assumed ARPU. However, as long as the critical market shares determined in the cost model (which constitute minimum market shares for viability) remain below or at the level of the actual market shares in the competition model, there is no contradiction.[48]

2.6.2.6 Endogenous wholesale access charges

The wholesale access charges in our analysis are based on LRIC, which in turn is based on projected FTTH output quantities. In equilibrium the FTTH output quantities may differ from those projected quantities, requiring an adaptation of ‘a’ to the resulting new LRIC.

Annex 3 describes the formal method for calculating such adaptations for both the Hinterland model and the No-Hinterland model. This is done by solving for the LRIC corresponding to the actual equilibrium quantities of each case. We have done the calculations of endogenous access charges for all scenarios. As can be seen in Table 2-11 and Table 2-12 for the No-Hinterland case of the P2P unbundling scenario, the effect of endogenizing ‘a’ can be substantial. It is, however, strongest for P2P unbundling and GPON over P2P unbundling, where it leads to a substantial decrease in retail prices.[49]

In the P2P unbundling scenario, since the market share of cable with 22% is substantially below the 30% that we assumed for the LRIC calculation, the endogenized LRIC for access charges, based on 78% market share for FTTH, gives a reduction in the wholesale ULL charge from a = 21.14 to a = 19.82, corresponding to the exact equilibrium market share. As a result, all end-user prices are reduced, wholesale profits vanish (by construction) with a strong negative effect on the incumbent’s overall profits. Cable’s profits also decrease, while entrants’ profits rise moderately (not enough to spur further entry). Consumer surplus rises moderately and welfare only by a minimal amount.

48 In addition, we have to keep in mind that market share's in the cost model are cluster-specific while market shares of the competition model are mostly based on an aggregated analysis of clusters 1-4.

49 In the first two scenarios in the No-Hinterland model the difference between exogenous and endogenous a is above 1.30 €, whereas for all other scenarios it is below 0.70 € and, in the cases of the bitstream access scenarios goes in the other direction.

Table 2-11: Basic model results P2P unbundling, No-Hinterland

	a = given = 21.14			
	General	Incumbent	Cable	Each Entrant
N	6			
P		42.07	23.76	42.37
Prof		18.78 Mio	2.81 Mio	0.45 Mio
WhProf		9.23 Mio		
S		0.23	0.22	0.14
sum(q)	8.64 Mio			
W	490 Mio			
CS	467 Mio			

Table 2-12: Model results with endogenous ‘a’, No-Hinterland, P2P unbundling

	a = endogenous = 19.82			
	General	Incumbent	Cable	Each Entrant
A				
N	6			
P		40.71	23.04	40.92
Prof		10.06 Mio	0.11 Mio	0. 81 Mio
WhProf		0		
S		0.23	0.21	0.14
sum(q)	8.64 Mio			
W	491 Mio			
CS	478 Mio			

2.6.2.7 Looking at Cluster 4 in isolation

Our analysis so far aggregates all variables and all results over the four densest population clusters of Euroland. This is based on the critical market share results of the cost model, which suggested that entrants and incumbents would be viable for all scenarios up to Cluster 4. This does not mean, however, that the viability of all firms, which was the basis of the free-entry equilibria presented so far, also holds for Cluster 4 in isolation. It may be doubtful because access charges, costs and end-user pricing have all been based on an aggregate (or average) of all four clusters. Cluster 4 as the marginal cluster with the lowest population density has higher fixed costs per user for all types of firms than the average of Clusters 1 to 4.

We have therefore, for P2P unbundling, separately calculated the relevant outcomes for Cluster 4 alone with a wholesale access charge based on

- the average of all four clusters: a = LRIC(Clusters 1-4) = 21.14
- the marginal Cluster 4: a = LRIC(Cluster 4) = 23.41
- the average of five clusters: a = LRIC(Clusters 1-5) = 22.85

The last case reflects the fact that, according to the cost model results, the incumbent would be viable in Cluster 5 as well as in Clusters 1-4. If the incumbent, in addition to Clusters 1-4, also penetrates Cluster 5 the LRIC relevant for wholesale access charges would therefore be based on the average LRIC of Clusters 1-5. This would follow currently used regulatory practice.

Table 2-13: Basic model results: Cluster 4 - P2P unbundling, Hinterland Model

Average access charge over 4 clusters: a = 21.14			
		Incumbent	Each Entrant
n	4		
p		46.32	44.87
Prof		2.52 Mio	0.69 Mio
WhProf		-3.02 Mio	
Cluster-specific access charge: a = 23.41			
n	4		
p		48.15	46.93
Prof		5.13 Mio	0.57 Mio
WhProf		-0.11 Mio	
Average charge Cluster 1-5: a = 22.85			
n	4		
p		47.70	46.43
Prof		4.50 Mio	0.60 Mio
WhProf		-0.81 Mio	

Table 2-14: Basic model results: Cluster 4 - P2P unbundling, No-Hinterland Model

Average access charge over 4 clusters: a = 21.14				
		Incumbent	**Cable**	**Each Entrant**
N	6			
P		42.07	23.76	42.37
Prof		1.08 Mio	0.67 Mio	-0.09 Mio
WhProf		-1.07 Mio		
Cluster-specific access charge: a = 23.41				
N	6			
P		44.01	24.77	44.42
Prof		3.88 Mio	1.65 Mio	-0.21 Mio
WhProf		1.90 Mio		
Average charge Cluster 1-5: a = 22.85				
N	6			
P		43.53	24.52	43.92
Prof		3.20 Mio	1.40 Mio	-0.18 Mio
WhProf		1.18 Mio		

When interpreting the results on Cluster 4 presented in Table 2-13 and Table 2-14, one has to keep in mind that Cluster 4 has 2,062,480 potential end-users compared to 8,636,068 potential users for all four clusters. Thus, as a separate market, Cluster 4 would have about 24% the size of all four clusters. Under the averaged access charge for all four clusters we get the same prices as before, but in the Hinterland model profits of the incumbent are only about 10% of the aggregate profits and profits of the entrants are only 18%. However, Cluster 4 remains profitable in isolation so that the equilibrium number of firms is reemphasized. One drawback for the incumbent is that wholesale access becomes a major loss maker and offering wholesale access therefore is not incentive compatible.

In contrast, incumbent's profits are only 6% of aggregate Clusters 1-4 profits and profits of entrants turn slightly negative in the No-Hinterland model. Thus, entrants may refrain from entering Cluster 4 in this case. Under cluster-specific wholesale access charges (a = 23.41) end-user prices increase but that only helps the incumbent, while entrants' profits/losses deteriorate. This pattern also holds for the not illustrated case of GPON over P2P unbundling.

Furthermore (not illustrated here), in the GPON bitstream scenarios and WDM PON unbundling the incumbent makes a loss on account of the larger wholesale loss associ-ated with the smaller market share of FTTH relative to cable. Since only in the GPON bitstream core scenario the market share of FTTH is below the 30% assumed for the LRIC calculation relevant for determining the access charge, incumbent losses may turn up for all scenarios under endogenous access charges. This does not hold for the Hinterland model of P2P unbundling, where endogenous access charges of a = 20.94 lead to a slight reduction in the Cluster 4 incumbent's profit to 2.29 Mio € and an increase in each entrant's profits to 0.70 Mio €. However, in the No-Hinterland model with an endogenous access charge of a = 19.82 the incumbent generates an overall loss of 0.63 Mio € (resulting from a wholesale loss of 2.89 Mio €) and the entrants make a small loss of 0.02 Mio € each.

If the incumbent also serves Cluster 5 the resulting averaged wholesale access charge (a = LRIC(Clusters 1-5) = 22.85) leads to a result that lies between the result under a = 21.14 and under a = 23.41.

2.6.2.8 Cluster 5 results for the GPON bitstream core scenario

One of the results of the critical market share analysis has been that in the GPON bitstream core case both the incumbent and entrants could profitably operate in Cluster 5 as well as in Clusters 1-4. We have therefore done basic model runs of the GPON bitstream core scenario for the aggregate of Clusters 1-5 and of Cluster 5 in isolation. The access charge in this case is a = 23.77.

Table 2-15: Basic model run, Hinterland, GPON bitstream core, Clusters 1-5

	General	Incumbent	Each Entrant
n	5		
p		43.06	39.09
prof		28.91 Mio	1.84 Mio
WhProf		0.35 Mio	
s		0.44	0.14
sum(q)	7.79 Mio		
W	303 Mio		
CS	267 Mio		

Table 2-15 shows that both for incumbent and for the same number of entrants profits are higher for Clusters 1-5 than they were for the Clusters 1-4 case.[50] This results in spite of the higher Cluster 5 costs, because the higher access charge of a = 23.77 over the Cluster 1-4 access charge of a = 22.05 drove up end-user prices.

Table 2-16 provides the results for Cluster 5 in isolation, and it is quite surprising. Although adding Cluster 5 to Clusters 1-4 increases profits for both the incumbent and the entrants, Cluster 5 in isolation is a big loss maker for the incumbent, but provides decent profits for the entrants (considering that Cluster 5 has only about 22% the inhabit-

50 Profits are not higher in proportion to increased market size, though. However, since these profits are above the calculated rate of return on equity, their absolute size would be relevant for infrastructure investment.

ants of Clusters 1-5 together). The reason is that the incumbent's FTTH infrastructure access costs in Cluster 5 are 29.82 compared to the wholesale access charge of a = 23.77. As a result, the incumbent generates a wholesale loss of over 10 Mio €. Thus, the incumbent could have incentives not to invest in Cluster 5 if wholesale access seekers also enter. But nevertheless the incumbent would be better off than if he had only invested in Clusters 1-4.

Table 2-16: Basic model run, Hinterland, GPON bitstream core, Cluster 5 in isolation

	General	Incumbent	Each Entrant
N	5		
P		43.06	39.09
Prof		-3.91 Mio	0.50 Mio
WhProf		-10.32 Mio	
S		0.44	0.14
sum(q)	1.73 Mio		
W	57 Mio		
CS	59 Mio		

In Table 2-17 and Table 2-18 we show the same exercises for the No-Hinterland model. Compared to the Cluster 1-4 case the incumbent's profits are now about even for the aggregate of Clusters 1-5, while those of cable and entrants jump ahead. The reason is that the increased market price gives cable a boost, both in price-cost mark-up and in market share against FTTH. As a result, the incumbent suffers a substantial wholesale loss that negatively affects its overall profits.

Table 2-17: Basic model run, No-Hinterland, GPON bitstream core, Clusters 1-5

	General	Incumbent	Cable	Each Entrant
N	6			
P		41.65	29.14	39.38
Prof		13.44 Mio	33.25 Mio	2.56 Mio
WhProf		-5.24 Mio		
S		0.25	0.33	0.11
sum(q)	11.10 Mio			
W	555 Mio			
CS	498 Mio			

Table 2-18 shows that, again, Cluster 5 in isolation generates a huge wholesale loss for the incumbent, and that translates into a large overall loss as well.

Table 2-18: Basic model run, No-Hinterland, GPON bitstream core, Cluster 5 in isolation

	General	Incumbent	Cable	Each Entrant
n	6			
p		41.65	29.14	39.38
prof		-7.34 Mio	4.80 Mio	0. 66 Mio
WhProf		-11.56 Mio		
s		0.25	0.33	0.11
sum(q)	2.46 Mio			
W	110.55 Mio			
CS	110.44 Mio			

2.6.2.9 Basic model results: Conclusions

Although the two P2P topologies consistently show the highest prices, they also have highest levels of CS and W in the basic model runs. They are followed fairly closely by WDM PON and more distantly by the GPON bitstream scenarios. GPON bitstream core falls back even further if, for this scenario, strong regulation is replaced by weak regulation.

Sometimes the ranking of CS and W between scenarios do not coincide, mainly because of differences in the equilibrium number of firms. Since consumer surplus can be very sensitive to small parameter changes, the results on W are likely more robust than those on CS.

While CS always increases in the equilibrium number of firms, W is almost constant at the equilibrium levels reached in our model runs.

Under the basic parameterization in all scenarios only 3 or 4 entrants survive in equilibrium. This is the result of a combination of high cost and high WtP for some scenarios (notably P2P unbundling and GPON over P2P unbundling) and low cost and low WtP for others (notably GPON bitstream core and GPON bitstream MPoP). Independent of entry, the incumbent’s market share does not differ much across scenarios.

Because of lower costs incumbents are consistently profitable in the basic model runs, where entrants are profitable.

A percentage mark-up on the LRIC-based access charge leads to a corresponding increase in end-user prices of almost the same magnitude as the mark-up; entrants’ market share decreases and entrants’ profits decrease slightly, while the incumbent’s profits increase substantially.

Endogenizing the wholesale access charge strengthens the results of the basic model runs.

Profits in the marginal Cluster 4 are substantially lower than average profits for all Clusters 1-4. Because of large losses from selling wholesale access profits overall can turn negative for the incumbent and slightly negative for entrants, suggesting that the incumbent may refrain from entering Cluster 4 and fewer competitors may enter the marginal cluster than the others. This latter effect on competitors becomes stronger if one uses cluster-specific entry charges or if the incumbents also enters Cluster 5.

A competition analysis of Clusters 1-5 for GPON bitstream core showed that entering Cluster 5 would be profitable for entrants both on an aggregate basis and for Cluster 5 in isolation. However, such entry has ambiguous effects on the incumbent. The incumbent would have higher profits than if both he and the entrants would only enter Clusters 1-4. Yet, Cluster 5 in isolation would be a large loss maker. The reason is that overall prices increase through this expanded penetration, but it generates a large wholesale loss in Cluster 5.

The likely effect of wholesale access regulation on the incumbent’s FTTH investment is therefore ambiguous, if applied a wholesale cost average. There seems to be no investment problem for an aggregate number of clusters. The incumbent’s profits are sufficient for aggregate investments. However, there can be problems in the marginal clusters, where the incumbent’s overall profits may turn negative on account of large wholesale losses. This would not happen if wholesale access charges were cluster-specific. But such differentiated charges could severely cut competitor entry in less densely populated clusters.

The main explanation for the welfare ranking for the Scenarios is the following: The rankings in terms of costs are almost exactly the reverse of the rankings of the scenarios in terms of consumer valuations. However, the cost differences are smaller than the valuation differences. As a result P2P unbundling and GPON over P2P unbundling rank ahead of WDM PON unbundling, which in turn beats the GPON bitstream scenarios.

2.6.3 Sensitivity analysis

In the following we show a few sensitivity analyses

- on cost assumptions, by contrasting a *Brownfield* approach with the *Greenfield* approach of the basic model
- on WtP for incumbent, entrant and cable services for all scenarios.

2.6.3.1 Greenfield vs. Brownfield results

Table 2-19, Table 2-20 and Table 2-21 contrast three cases. Table 2-19 shows the basic Greenfield results for WDM PON unbundling, while Table 2-20 gives Brownfield results based on LRIC cost calculations. Table 2-21 moves to stronger access charge regulation based on Brownfield costs. The cost change from Greenfield to Brownfield model only concerns the capital costs of FTTH access.

Since this does not affect LRIC and therefore LRIC access charges are unchanged, the effect of the Brownfield model leaves end-user prices and market shares unchanged. Only the incumbent's profit is increased by the cost saving. This is a well-known result from the theoretical literature.

However, if access charges are reduced by the cost savings end-user prices are reduced, market shares change little, profits of incumbent are slightly reduced but those of entrants increase (compared to the Greenfield approach).

Table 2-19: Basic Greenfield model results for WDM PON unbundling, Hinterland model, a = 21.24

	General	Incumbent	Each Entrant
n	5		
p		42.46	38.69
prof		23.05 Mio	1.83 Mio
WhProf		1.33 Mio	
s		0.414	0.147
sum(q)	6.24 Mio		
W	271 Mio		
CS	240 Mio		

Table 2-20: Brownfield model results for WDM PON unbundling, Hinterland model, a = 21.24

Brownfield, a = 21.43			
	General	**Incumbent**	**Each Entrant**
n	5		
p		42.46	38.69
prof		39.76 Mio	1.80 Mio
WhProf		18.03 Mio	
s		0.414	0.147

Comparing Table 2-19 and Table 2-20 shows that the only effect of moving from Greenfield to Brownfield is that the incumbent's wholesale profits increase precisely by the cost difference between the Greenfield and Brownfield models. However, if wholesale access charges are adjusted downward by the cost savings from a = 21.24 to a = 18.48 the end-user prices are lowered and profits for entrants increase (s. Table 2-21). The incumbent's profits are substantially lower than under LRIC access charges but still somewhat higher than under the Greenfield costs. Welfare increases almost exactly by the cost savings. Most of this increase benefits CS but some also goes to profits.

Table 2-21: Brownfield model results for WDM PON unbundling, Hinterland model, a = 18.48

Brownfield a = 18.48			
N	5		
P		40.32	36.32
Prof		26.72 Mio	2.12 Mio
WhProf		3.86 Mio	
S		0.408	0.148
sum(q)	6.37 Mio		
W	290 Mio		
CS	255 Mio		

As will be shown in section 3.2.3.3 below, a switch from PSTN to WDM PON can generate substantial liquidity for an incumbent from selling MDF locations in real estate transactions. This money would not have been available under continued use as MDF and therefore provides an additional profit potential generated by the switch to WDM PON. Since the net revenues from such real estate sales (exhibited in Table 3-34 below) only save capital costs, they can be treated almost exactly in the same way as the savings of the Brownfield over the Greenfield approach. For the clusters 1-4 modelled for our competitive analysis they would represent about 1.6% savings[51] over the Greenfield FTTH capital requirements or an increase of about 13% relative to the Brownfield cost savings for those four clusters. Without an adjustment of wholesale access charges the incumbent's profit under the WDM PON unbundling scenario would therefore increase by about an additional 2.2 Mio € per month. Alternatively, there could be an additional 0.40€ downward adjustment in the wholesale access charge to about a = 18.10€. This in turn would lead to a downward adjustment of end-user prices by about 0.30€ for both incumbent and entrants and to slight increases in profits for both types of firms compared to the Brownfield approach without sale of MDF locations.

Different from the Brownfield approach, however, is the welfare treatment of the savings from selling MDF locations. To the extent that the incumbent only exchanges one asset

51 We are using approximate figures here because of the inexact possibilities for discounting. The competitive model operates in a steady state about 10+ years from now. The savings may have to be brought up to that value, using the WACC, but that is not the way other costs are treated for steady state purposes. So, we have treated the savings like the other costs.

(real estate) against another (money) such a sale would be welfare neutral. The incumbent should have valued the opportunity cost of the real estate already under the PSTN regime. One can argue that dismantling the MDF has freed up the real estate and therefore created additional value, but that has also been associated with dismantling costs. So it is hard to squeeze extra welfare out of this transaction.

2.6.3.2 QoS and WtP assumptions

The following sensitivity analysis of our WtP assumptions is contrasting the basic Model (I) with three alternatives:

- **Model II.** An increase in the goodwill advantage of incumbents vis-à-vis entrants and cable by 3 € for all scenarios (from 2 € to 5 €). For our basic model we had assumed a small goodwill advantage of 2 € because we are modelling steady state competition ten years from now, when both incumbents and entrants are established FTTH suppliers. The reason for this sensitivity then is that today's goodwill advantage of incumbents appears to be larger than assumed in the basic model.

- **Model III.** A reduction in the spread between the different WtP for incumbents, entrants and cable for all scenarios by 50%. In our basic model we had assumed a fairly large spread between technologies based on expected ultra-high bandwidth requirements by a large fraction of users. Again, such large differentiation in WtP is not generally observable today.

- **Model IV.** First a reduction in the spread by 50% and then an increase in the goodwill advantage by 3 €. This model combines the properties of Models II and III.

- **Model V.** In addition, for WDM PON unbundling alone, we adapted the WtP closely to that of the GPON over P2P scenario. This model reflects uncertainties about the quality properties of WDM PON.

Table 2-22: WtP assumptions for sensitivity analysis

Scenario	I. Basic model			II. Increased incumbency advantage			III. Smaller spread			IV. Increased incumbency advantage and smaller spread		
	SI	SE	SC	SI	SE	SC	SI	SE	SC	SI	SE	SC
P2P unbundling	100	97	82	100	94	79	100	98.5	91	100	95.5	88
GPON over P2P unbundling	99	97	82	99	94	79	99.5	98.5	91	99.5	95.5	88
WDM PON unbundling	95	89	82	95	86	79	97.5	94.5	91	97.5	91.5	88
WDM PON unbundling alternative	99	95	82									
GPON bitstream core	90	83	82	90	80	79	95	91.5	91	95	88.5	88
GPON bitstream MPoP	90	85.5	82	90	82.5	79	95	92.75	91	95	89.75	88

We first present sensitivities for three scenarios, P2P unbundling, GPON bitstream core and WDM PON unbundling. The reason for this selection is that P2P unbundling benefits most from the high spread of the basic Model I. GPON bitstream core suffers most under the high spread. In contrast, in the basic Model I, WDM PON unbundling lies in between those scenarios and is closest in ranking to the two P2P topology scenarios. Also, only WDM PON unbundling is affected by the Model V changes.

Table 2-23 to Table 2-25, for the Hinterland case of each of the selected scenarios, compares the outcomes of the different models in terms of the equilibrium number of firms, prices, profits and market shares.

Table 2-23: Sensitivity to WtP assumptions - P2P unbundling, Hinterland Model

	WtP	n	p_I	p_E	$prof_I$ Mio €	$prof_E$ Mio €	s_I	s_E
I. Basic model	SI = 100 SE = 97	4	46.32	44.87	24.82	3.74	0.41	0.20
II. Increased incumbency advantage	SI = 100 SE = 94	4	47.35	44.30	29.05	2.43	0.44	0.19
III. Smaller spread	SI = 100 SE = 98.5	4	45.80	45.16	22.84	4.43	0.39	0.20
IV. Increased incumbency advantage and smaller spread	SI = 100 SE = 95.5	4	46.83	44.59	26.89	3.07	0.42	0.19

Table 2-24: Sensitivity to WtP assumptions – GPON bitstream core, Hinterland Model

	WtP	n	p_I	p_E	$prof_I$ Mio €	$prof_E$ Mio €	s_I	s_E
I. Basic model	SI = 90 SE = 83	5	41.61	37.48	24.67	1.54	0.43	0.14
II. Increased incumbency advantage	SI = 100 SE = 80	5	42.72	37.03	29.48	0.80	0.48	0.13
III. Smaller spread	SI = 95 SE = 91.5	6	38.92	36.36	19.72	0.35	0.36	0.16
IV. Increased incumbency advantage and smaller spread	SI = 95 SE = 88.5	5	41.71	37.69	26.79	1.91	0.42	0.14

Table 2-25: Sensitivity to WtP assumptions - WDM PON unbundling, Hinterland Model

	WtP	n	p_I	p_E	$prof_I$ Mio €	$prof_E$ Mio €	s_I	s_E
I. Basic model	SI = 95, SE = 89	5	42.46	38.69	23.05	1.83	0.41	0.15
II. Increased incumbency advantage	SI = 95, SE = 86	5	43.48	38.24	27.83	1.06	0.46	0.14
III. Smaller spread	SI = 97.5, SE = 94.5	6	39.76	37.39	17.07	0.33	0.36	0.13
IV. Increased incumbency advantage and smaller spread	SI = 97.5, SE = 91.5	5	42.59	38.75	24.34	1.95	0.41	0.15
V. Increased WtP for WDM PON	SI = 99, SE = 95	6	40.21	37.30	19.14	0.17	0.37	0.13

In comparison to the basic Model I we find the following for the Hinterland model:

In Model II (increased incumbency advantage) end-user prices, profits and market shares of the incumbent all increase at the expense of those of entrants.[52]

In cases where the number of firms stays the same, Model III (smaller spread) end-user prices, profits and market shares of the incumbent all generally decrease, while these variables increase for the entrants. However, in the GPON bitstream core and WDM PON unbundling scenarios the number of firms increases by one, leading to lower prices and profits for both types of firms. Such entry further erodes the incumbent's market share.

Model IV (increased incumbency advantage and smaller spread), as the intermediate case, shows almost the same prices, profits and market shares as Model I.

52 This result shows that the incumbent can have strong incentives to deteriorate the quality of the wholesale product provided to entrants.

Model V (improved WtP for WDM PON) for WDM PON unbundling leads to entry of an additional firm, implying substantially lower prices and profits. Market shares are quite similar to Model III.

Table 2-26 to Table 2-28, for the Hinterland case of each of the selected scenarios, compares the outcomes of the different models in terms of the equilibrium number of firms, prices, profits and market shares.

Table 2-26: Sensitivity to WtP assumptions - P2P unbundling, No-Hinterland Model

	WtP	n	p_I	p_E	p_C	$prof_I$ Mio €	$prof_E$ Mio €	$prof_C$ Mio €	s_I	s_E	s_C
I. Basic model	SI = 100 SE = 97 SC = 82	6	42.07	42.37	23.76	18.78	0.45	2.81	0.23	0.14	0.22
II. Increased incumbency advantage	SI = 100 SE = 94 SC = 79	5	46.62	45.40	27.26	32.00	6.17	10.52	0.28	0.16	0.23
III. Smaller spread	SI = 100 SE = 98.5 SC = 91	5	43.98	45.24	31.16	14.22	5.70	28.07	0.23	0.16	0.29
IV. Increased incumbency advantage and smaller spread	SI = 100 SE = 95.5 SC = 88	5	45.29	44.86	30.82	19.82	4.69	26.41	0.26	0.15	0.29

Table 2-27: Sensitivity to WtP assumptions – GPON bitstream core, No-Hinterland Model

	WtP	n	p_I	p_E	p_C	$prof_I$ Mio €	$prof_E$ Mio €	$prof_C$ Mio €	s_I	s_E	s_C
I. Basic model	SI = 90, SE = 83, SC = 82	6	40.10	37.63	28.28	13.22	2.07	23.72	0.25	0.11	0.31
II. Increased incumbency advantage	SI = 100, SE = 80, SC = 79	6	41.44	37.32	28.00	19.47	1.50	22.26	0.28	0.10	0.31
III. Smaller Spread	SI = 95, SE = 91.5, SC = 91	7	36.86	36.16	26.73	0.25*)	23.15	0.15	0.20	0.09	0.34
IV. Increased incumbency advantage and smaller spread	SI = 95, SE = 88.5, SC = 88	6	39.84	37.64	28.55	11.53	2.09	25.21	0.24	0.11	0.32

*) Large market share of cable leads to large wholesale loss. Endogenous ‘a’ would fix that.

Table 2-28: Sensitivity to WtP assumptions - WDM PON unbundling, No-Hinterland Model

	WtP	n	p_I	p_E	p_C	$prof_I$ Mio €	$prof_E$ Mio €	$prof_C$ Mio €	s_I	s_E	s_C
I. Basic model	SI = 95 SE = 89 SC = 82	6	41.24	39.32	26.16	17.91	2.92	13.09	0.24	0.12	0.27
II. Increased incumbency advantage	SI = 95 SE = 86 SC = 79	6	42.59	39.01	25.89	24.07	0.23	11.83	0.28	0.11	0.27
III. Smaller Spread	SI = 97.5 SE = 94.5 SC = 91	7	37.97	37.53	25.93	2.34	0.29	18.60	0.19	0.10	0.32
IV. Increased incumbency advantage and smaller spread	SI = 97.5 SE = 91.5 SC = 88	6	40.99	39.04	27.77	13.03	2.34	21.06	0.24	0.12	0.30
V. Increased WtP for WDM PON	SI = 99 SE = 95 SC = 82	7	39.01	38.09	21.42	18.84	1.30	-2.35	0.22	0.11	0.22

In comparison to the basic Model I we find the following for the No-Hinterland model:

In cases where the equilibrium number of firms stays the same, Model II end-user prices, profits and market shares of the incumbent all increase at the expense of entrants, while the results for cable are generally unchanged. In the first scenario the number of firms is decreased by one, leading to higher prices and profits for all firms. In this case the market share of the incumbent and cable increase at the expense of entrants.

Model III (smaller spread) shows very differentiated results, depending on whether the number of entrants decreases, (P2P unbundling) or increases (GPON bitstream core and WDM PON unbundling).

In the P2P unbundling scenario the number of firms decreases by one, leading to higher prices for all firms. Profits of cable and entrants increase, while those of the incumbent drop. In this case the market share of the incumbent remains the same, while cable increases at the expense of entrants.

In GPON bitstream core and WDM PON unbundling the number of firms increases by one, leading to lower prices and profits for incumbents and entrants, while those of cable increase substantially. Such entry erodes the incumbent's market share in favor of cable.

With the exception of P2P unbundling Model IV (increased incumbency advantage and smaller spread), as the intermediate case between Models II and III, shows almost the same prices, profits and market shares as Model I. In the P2P unbundling scenario

Model IV has one less firm than Model I, leading to higher prices and profits for all firms. The incumbent and cable gain market shares at the expense of entrants.

Model V (improved WtP for WDM PON) leads to entry of an additional firm, implying substantially lower prices and profits. The incumbent and cable lose market shares.

Table 2-29 to Table 2-32 relate the WtP assumptions of Models I-V to the CS and W outcomes across all scenarios.

Table 2-29: Sensitivity to W and CS to WtP assumptions Hinterland Model, in Mio Euro

	P2P unbundling		GPON over P2P unbundling		GPON bit-stream core		GPON bit-stream MPoP		WDM PON unbundling	
	CS	W	CS	W	CS	W	CS	W	CS	W
Basic model	243	279	246	284	217	248	209	245	240	271
WDM PON alternative									281	301
Increased incum-bency advantage	233	269	236	274	206	239	199	236	230	262
Smaller spread	248	284	252	290	268	289	263	283	277	296
Increased incum-bency advantage and smaller spread	238	274	241	280	231	273	231	273	253	286

Table 2-30: Sensitivity to W and CS to WtP assumptions Hinterland Model, ranking

	P2P unbundling		GPON over P2P unbundling		GPON bitstream core		GPON bit-stream MPoP		WDM PON unbundling	
	CS	W	CS	W	CS	W	CS	W	CS	W
Basic model	2	2	1	1	4	4.5	5	4.5	3	3
WDM PON alternative	3	3	2	2	4	4.5	5	4.5	1	1
Increased incumbency advantage	2	2	1	1	4	4.5	5	4.5	3	3
Smaller spread	5	4.5	4	2	2	3	3	4.5	1	1
Increased incumbency advantage and smaller spread	3	4	2	2	4.5	4	4.5	4	1	1

Table 2-31: Sensitivity to W and CS to WtP assumptions No-Hinterland Model, in Mio Euro

	P2P unbundling		GPON over P2P unbundling		GPON bit-stream core		GPON bit-stream MPoP		WDM PON unbun-dling	
	CS	W	CS	W	CS	W	CS	W	CS	W
Basic model	467	490	434	494	400	446	416	445	431	474
WDM PON alternative									490	513
Increased incum-bency advantage	410	471	413	474	380	428	360	426	411	456
Smaller spread	454	513	457	517	489	513	478	507	500	522
Increased incum-bency advantage and smaller spread	434	494	437	498	448	493	422	487	459	503

Table 2-32: Sensitivity to W and CS to WtP assumptions No-Hinterland Model, ranking

	P2P unbundling		GPON over P2P unbundling		GPON bitstream core		GPON bit-stream MPoP		WDM PON unbundling	
	CS	W	CS	W	CS	W	CS	W	CS	W
Basic model	1	1.5	2.5	1.5	4	4.5	3	4.5	2.5	3
WDM PON alternative	2	2.5	3.5	2.5	4	4.5	4	4.5	1	1
Increased incumbency advantage	2.5	1.5	1	1.5	4	4.5	5	4.5	2.5	3
Smaller spread	4.5	3	4.5	3	2	3	3	5	1	1
Increased incumbency advantage and smaller spread	3.5	3.5	3.5	1.5	2	3.5	5	5	1	1.5

Compared to the basic model (Model I):

An increase in the incumbency advantage (Model II) leaves the rankings with respect to CS and W largely intact. CS and W generally decrease because of the lower WtP for entrants' and cable services.

A decrease in the spread of WtP (Model III) changes the CS ranking against the two P2P topology scenarios. WDM PON emerges as the first-ranked and GPON bitstream core as second.[53] The change in rankings is less pronounced for W, but WDM PON unbundling is again first. CS and W increase in all cases, due to the implied higher WtP for all scenarios.

53 The ranking of Scenario 3a could be negatively affected by replacing strong with weak regulation.

Model IV leads to the most even levels of CS and W under all scenarios. WDM PON unbundling again comes out ahead.

Model V only changes the ranking of WDM PON unbundling by moving it ahead of the P2P topologies scenarios.

2.6.3.3 Conclusions on sensitivities

The sensitivity analyses have added the following to the basic conclusions:

Moving from a Greenfield approach to a Brownfield approach for the incumbent's FTTH investments affects (and increases) competition only if the regulator deviates from LRIC pricing of wholesale access. Profits of the incumbent are increased even if the wholesale access charge is adjusted downward.

Changes in the WtP assumptions can have substantial effects on the model results.

However, results of the basic model are reemphasized for the most likely alternative to the basic model, which is to increase the incumbency advantage (Model II).

The next realistic alternative (Model IV) provides very similar market outcomes to the basic model, but leads to different rankings in the valuations of CS and W.

The least realistic alternative (Model III) changes many outcomes.

An adaptation of WtP for the WDM PON unbundling scenario to those of GPON over P2P unbundling (Model V) leads to a reversal in the CS and W ranking between the P2P topology scenarios and WDM PON unbundling.

Rather than coming up with an unambiguous winner the competitive analysis has revealed some consistency along with major tradeoffs. Considering the consistency of CS and W rankings of individual scenarios across models WDM PON unbundling always comes up among the best, while GPON bitstream MPoP always is among the lowest-ranked. P2P unbundling shows a highly variable ranking, but is usually in the first tier. GPON over P2P unbundling is also quite variable but mostly ahead of P2P unbundling. GPON bitstream core is as variable as P2P unbundling, but shows up mostly in the second tier and would rank even worse under weak regulation. The main explanation for the lack of consistency in ranking for P2P unbundling, GPON over P2P unbundling and GPON bitstream core scenarios lies in the fact that the rankings in terms of costs are almost exactly the reverse of the rankings of the scenarios in terms of consumer valuations. For given cost differences any changes in the valuations therefore can have large effects on the net results of valuations minus costs.

3 Opex and capex of different FTTH technologies

3.1 The modelling approach

3.1.1 General approach

Our basic modelling relies upon an engineering bottom-up cost modelling approach. This means we model the total cost of the services considered under efficient conditions, taking into account the cost of all network elements needed to produce these services in the specific architecture deployed. This approach is coherent with an (LRIC) approach as applied in regulatory economics.

Our model consists of a static and a dynamic approach. In the static model we compare the cost of a specific NGA deployment in a steady state in the future. In the steady state the roll-out is completed and the FTTH network has (fully) substituted the copper access network. By increasing the market share and comparing the resulting cost per customer with the fix revenue per customer we determine the point, where, if at all, the revenue equals the cost. This is the “critical market share” necessary to make the NGA business profitable and hence it determines the viability range of a network operator. Therefore we model the complete value chain of the operators. Contrary to the steady state model the dynamic approach considers the time path of investment according to a particular roll-out as well as the re-investment pattern. This methodology is explained in more detail in section 3.1.8 and only covers the expenses/cost side of the business.

The critical market share may not exceed a dedicated percentage of the potential subscriber base. In the telecommunications market all fixed network operators together will never achieve 100% market share since there are always potential subscribers who are not willing to use a fixed NGA network, but instead favor the use of a mobile network only, the use of a cable-TV network or even do not use telecommunication access at all. Thus, we believe the maximum achievable market share of an FTTH network of all potential subscribers is in the range of 70% for Euroland, which is the lower level of the fixed network market share in most European countries today.

According to the chosen LRIC approach we calculate the cost of each of the four architectures considered following a Greenfield approach. This means that the investor will construct a new, efficient state of the art network from scratch, assuming that currently existing infrastructure, if included in the new network, has to be considered at (full) cost. However, in reality there often is available infrastructure from legacy networks which may be reused for NGA to generate investment savings. This possibly could have an impact on the investment decision. We analyze this aspect in a sensitivity calculation carried out later on in section 0 as "Brownfield deployment".

With WDM PON many of the MDF locations are no longer used but replaced by larger manholes to host the additional splitters. These MDF locations may be sold. For this purpose they have to be dismantled and the technical installations have to be removed, thereby reducing the net proceeds of selling MDF locations. For an incumbent investor's decision the net dismantling lump sum revenues may be a relevant element of his decision process. Since these revenues are not part of the relevant cost, nor do they in fact reduce cost, we consider these revenues and their influence on the total ranking of the different solutions in the dynamic model within the net present value calculation (section 3.2.3) and also in the competition model influencing the incumbent's profit (see section 2.6.3.1).

3.1.2 Geotypes of Euroland

The viability of access networks strongly depends on the subscriber density (subscribers per km²) and on settlement structures. The denser the subscribers, the sooner the access network will become viable. Thus the modelling has to rely upon a concrete settlement structure, a given country, and the results derived depend on that country.

For purpose of this study we decided not to choose a dedicated European country but chose a settlement structure which is typical for European countries and to design the hypothetical country for approximately 22 million households or a population of around 40mn inhabitants. This country is referred to as "Euroland". We have defined 8 clusters, each having typical structural access network parameters derived from detailed geo-modelling of access networks in several European countries on a nationwide basis. The geotypes characteristics rely on exact data from several countries. In that sense, Euroland is a generically representative country.

Each of the 8 clusters is characterized by specific subscriber densities. The viability of a specific business model is calculated for each cluster separately, like for a separate profit center, i.e. the viability of a business model in Cluster 1 is independent from the viability in Cluster 2. In each of the clusters we assume the access network to be rolled out to 100% homes connected. For each of the clusters, the point where the NGA business may become viable is calculated individually and independently from the results of other clusters. The operators (incumbent and entrants) invest in all clusters which are viable.

The clusters are composed in a way that they address similar numbers of potential subscribers. Table 3-1 provides an overview of the resulting cluster classification.

Table 3-1: Structural parameters of Euroland

Geotype	Cluster ID	Potential customers per km²	Total potential customers per cluster	Share of total customers	Potential customers (cumulated)	Number of MDF	Potential customers per MDF	Average trench length per potential customer (m)
Dense urban	1	4,000	1,763,916	8%	1,763,916	69	25,564	2.4
Urban	2	1,600	2,163,672	10%	3,927,588	168	12,879	5.4
Less Urban	3	800	2,646,000	12%	6,573,588	252	10,500	7.8
Dense Suburban	4	470	2,062,480	9%	8,636,068	280	7,366	10.2
Suburban	5	280	2,460,360	11%	11,096,428	303	8,120	13.1
Less Suburban	6	150	2,989,056	14%	14,085,484	417	7,168	17.4
Dense Rural	7	60	4,331,208	20%	18,416,692	1,421	3,048	28.6
Rural	8	< 60	3,448,368	16%	21,865,060	2,488	1,386	55.1
			21,865,060	**100%**		**5,398**		

The steady state model will run for all 8 clusters described in Table 3-1. Typically in the dense clusters there are larger MDF locations concentrating significantly higher numbers of potential subscribers than in the rural areas, thus with 28% of the MDF one can already cover 64% of the potential subscribers (Cluster 1–6).

The clusters are mainly used to consider the cost differences due to the different geographic and settlement information. We use cluster-specific individual input data for access line length and DP sizes, for construction cost and for deployment methods (e.g. underground ducted, buried or aerial cabling). Main cluster specific values are the construction cost of ducts/cables, manholes, sleeves and aerial cables and the inhouse cabling. Construction costs are highest in the densely populated areas, while aerial cabling is used to a larger degree in the rural areas.

Table 3-2: Aerial deployment share per cluster

Cluster ID	Aerial share
1	0%
2	0%
3	10%
4	20%
5	30%
6	40%
7	60%
8	60%

Identical for all clusters are the values for MPoP components like Ethernet switches/ports, OLTs, ODF ports and patch cables and fibre splices and also the values for fibre cables and CPE.

Result of this approach is the viability of each of the clusters, which allows one to determine the profitable reach of a market approach on a per cluster level (independent from other clusters).

3.1.3 Network structure

The network modelled consists of a core network, a concentration network and one of the next generation access network architectures as described in section 2.3.

For sake of modelling simplicity we have chosen existing core and concentration network bottom-up LRIC models for several countries which we adapted to the Euroland circumstances concerning business and residential end customers and their data volumes transmitted.

According to the defined size of Euroland the core network consists of 45 core layer nodes where core routers are located. These are Label Edge Routers (LER) for managing the access and Label Switch Routers (LSR) for managing a fast switching of the IP data packets. At five locations we also assume IP core backbone layer functions of additional LSR, building the upper network layer and reducing meshing complexity of a 45 location core network. We do not model the core network explicitly but describe it as a cost function with a fixed fee element and variable cost per customer (usage-based).The cost curve is derived from existing bottom-up models as described above. The core network is the same for all access architectures considered. Since the cost share of the core network is small compared to the total cost and the absolute cost is the same for all architectures, we regard this approach as a reasonable approximation for our comparative results.

The concentration network bridges the gap between the MDF locations (MPoPs) and the core layer nodes. We assume it to consist of state of the art Ethernet switches. Also these cost have been derived as a cost function of fixed cost plus usage (customer) dependant variable cost from an existing model which has been scaled for Euroland. The cost share of the concentration network is small compared to the access network cost. Thus, we are convinced that proceeding in this way is reasonable. For WDM PON the concentration network is replaced by a passive backhaul network.

The fixed cost of the national core and concentration network is distributed to the clusters by defining a fixed share for each cluster and distributing the remaining fixed cost according to the number of node locations (MPoP) per cluster.

The main cost of these NGN/NGA architectures is borne by the access network, especially by the civil engineering cost of digging trenches etc. The different NGA networks therefore are modelled in detail in a bottom up manner

The bottom-up modelling requires calculating the network cost item per item, considering each fibre per end customer, the splices, manholes and ODF ports needed, cable sizes and optimal trench sizes, space and energy requirements etc. All these items are considered according to the architectural solutions described in section 2.3.

3.1.4 The incumbent as investor

We consider two different types of players in the NGA market:

- An incumbent as investor
- A competitive entrant as wholesale access seeker.

The incumbent may deploy his NGA network in one of the above described technical architectures (GPON, P2P, GPON over P2P or WDM PON). The investor will roll out the NGA network to those areas (clusters) where the business will be viable, in a Greenfield approach.

The wholesale access seeker does not need to construct all infrastructure on his own, but could use the access network from the incumbent. Thus, the competitor can enter the market either by fibre unbundling, or by using bitstream access at MPoP or at core level. We assume the retail price a competitor may achieve for his services to be less than the price for the investor by 5%.

3.1.5 Demand

The model applies an average subscriber with a demand of about 400kbps capacity in the busy hour of the day and an Average Revenue Per User (ARPU) of 44.25€ per month. This is based on the customer mix of

- single play (voice only),
- double play (voice and broadband),
- triple play (voice, broadband and IPTV) and
- business users (mix of voice, broadband internet and VPN)

as shown in Table 3-3. Compared to previous studies by WIK this is a relatively high ARPU as we generally argue that ARPUs will not substantially increase through the transition to the NGA. The reason for a higher ARPU is that in this model the operator has borne the cost of inhouse cabling and the CPE and we assume that he will price the service accordingly to at least cover (some of) this cost. The assumed ARPU is the same for all considered architectures.

Table 3-3: Customer mix

	Traffic in the Busy Hour per subscriber (in kbps)	Revenue per subscriber (in €)	Share of subscribers
Voice only	20	17	5%
Voice and Broadband	380	36	25%
Voice, Broadband and IPTV	425	44	60%
Business customer	600	80	10%
Average user	411	44.25	100%

When analyzing the wholesale access scenarios we have decreased the ARPU of competitors by 5% to 42.04 € per month reflecting the incumbency advantage of e.g. brand and customer base. Also in the competitor case this ARPU remains the same regardless of the considered scenario (e.g. P2P unbundling or GPON bitstream). The ARPU of the static and dynamic modelling approach is used to determine the competitive edge of the scenarios, the critical market share and the viable clusters. We will develop a more sophisticated demand approach in the oligopoly modelling for determining the competitive results.

3.1.6 Major assumptions on capex and opex

3.1.6.1 Capex

The cost model annualizes the investment positions derived in a bottom-up manner by multiplying them with the corresponding capital cost factor. This factor is specified according to the tilted annuity formula which takes into account the WACC (Weighted Average Cost of Capital) as relevant interest rate, the economic lifetime and the average relative price change that is to be expected over the considered time period. It is expressed as follows:

$$CCF = \frac{WACC - PC}{1 - (\frac{(1+PC)}{(1+WACC)})^n}$$

where n = economic lifetime of network element and PC = expected price change of the equipment.

The model considers as additional investment positions assets that are not directly, but indirectly assigned to the network deployment, such as motor vehicles, office equipment, land and buildings etc. These positions are considered as mark-ups to be applied to the (direct) investment calculated for the network deployment. The factors are input parameters and are set for each direct investment position separately, e.g. trenches, manholes, sleeves etc. This indirect investment is then assigned to the modelled network deployment and annualized to yearly indirect cost (indirect CAPEX) by multiplying it with the Capital Cost Factor described above.

The multiplication of the investment positions with the capital cost factor results in annualized direct and indirect capital cost (CAPEX). Economic lifetimes are considered separately for all investment components required directly or indirectly for the network deployment. For the passive infrastructure from customer's premise to MPoP we assume the economic lifetime to be 20 years, for active equipment in the MPoP (OLTs, Ethernet switch ports) 7 years and 5 years for the CPE unit. We assume a WACC of 10% to be adequate for the scenarios considered taking into account the risk of deploying a fibre network. In all our calculations introduced in this report price changes are set to zero.

3.1.6.2 Opex

In addition, the model considers costs resulting from operating the network and carrying out regular maintenance works (OPEX). In general, these costs are calculated as a mark-up which is applied to the direct and indirect investment positions, distinguishing between passive (0.5% mark-up) and active equipment (8% mark-up). For aerial cables we assume a higher OPEX mark-up (15%) than for cables deployed in ducts since aerial cables are more sensitive to damages and require more maintenance. However, they are less investment intensive than duct cables so that this mark-up is applied to relatively low values.

The model determines the cost of energy and floorspace rental in a bottom-up manner. Based on discussions with equipment vendors we have assumed average energy consumption on a per port per month basis. We can therefore easily track cost of energy in the MPoP through the number of ports required. Energy consumption per port is higher for WDM PON than for GPON OLTs and higher for 10 Gbps Ethernet ports than for 1 Gbps ports. We have not tracked the energy consumption of CPEs because the subscribers bear energy cost themselves. From a “green IT” or macro-economic point of view it would be important to also take CPE energy cost into account when comparing technologies, since more power consuming technologies at the central site are less power consuming at the end customer sites (e.g. Ethernet P2P). We have only focused on the operator case.

Regarding floorspace we have made assumptions on the number of ports (ODF, Ethernet, OLT) that fit into a standard 2 m² footprint rack based on feedback from equipment vendors. ETSI racks are considered to be deployed back to back. Equipments (OLT, Splitter, Ethernet switch, …) do not share racks, so rack space is tracked separately for each equipment port type. In the case of GPON and WDM PON rack space in the MPoP is predetermined by the assumption of 100% coverage in a cluster because this also determines the number of network sided ODF ports, OLTs and PON (upstream) Ethernet Ports. Contrarily, in case of P2P and GPON over P2P the network sided ODF ports and the active electronics – and hence the required rack space - depend on the number of subscribers. It was assumed that the incumbent plans his floorspace according to a 70% take-up on his network (retail and wholesale customers). In addition to the rack-dependent floorspace 30 m² per MPoP have been considered as base floorspace needed for office, restrooms, circulation areas etc. equally for all architectures. Having determined the required floorspace in m² we assume both an initial investment per m² to set-up the room (1000€) and a monthly rental cost per m² (20€).

A “retail cost” of 5€ per subscriber per month was assumed. These costs cover customer acquisition, sales and marketing, customer care and billing. We believe this to be at the lower end of such costs at least if compared with today’s market level.

Finally, a common cost mark-up of 10% is applied to the sum of operational and capital expenses. Common costs are expenses for positions which are not directly involved with the network, but which are needed for other processes of the enterprise. Among others management, administration, human resources and strategy and research (overheads) are positions which are part of these costs.

3.1.7 Wholesale cost and prices

Wholesale prices for the competitor's business case have been determined as LRIC (Long Run Incremental Cost) of the network elements of the incumbent which are used for wholesale access, i.e. they directly base on the cost determined for the incumbent. Since a significant part of costs is fix the total cost per customer strongly depends on the number of customers on the incumbent's network. Wholesale prices have been determined under the assumption that the incumbent's network operates at a 70% take-up. This rate corresponds to the market share of the FTTH network against the competition of mobile and cable networks.[54] This also means that these are the lowest possible wholesale prices under the LRIC assumptions. Depending on the scenario, they include active equipment in the MPoP (e.g. scenario GPON with bitstream access at MPoP) or even transport through the incumbent's concentration network (e.g. scenario GPON with bitstream access at core layer). Section 2.3 explains the components in more detail. The cost of the optical inhouse cabling is also part of the wholesale charge. All analysis is cluster-specific, so the wholesale price in Cluster 1 is independent from the wholesale price in other clusters.[55]

Wholesale prices used in this cost model to calculate the business model of a competitor are always a fixed monthly access charge per user per month (linear access charge). On top of the LRIC network cost per customer a wholesale cost of the incumbent's wholesale division is applied to determine the access charge for wholesale access seekers. This wholesale division cost was assumed to be 0.90€ per user per month (less than 20% of the assumed retail cost that incumbent and competitors both spend for each subscriber).

The primary analysis assumes a Greenfield deployment of NGA in which the network is built from scratch. We do however also do a sensitivity run, in which the incumbent benefits from existing duct infrastructure and reduces his investments. Under this sensitivity we have calculated a case in which competitors buy wholesale at Greenfield LRIC and a case in which Brownfield LRIC are the basis of the competitors' wholesale price inputs. The results can be found in section 0.

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54 The corresponding share in Germany of the fixed network today amounts to about 80% of potential subscribers.
55 In the competition model an average of the first 4 clusters has been chosen and discussed.

3.1.8 Dynamic approach

In the steady state analysis we do not consider the ramp-up period that is required to first deploy the network and then to acquire customers until the market reaches a steady state and the copper network is fully substituted. Significant investments are required upfront, e.g. all civil works which is why investment peaks relatively early. Architectures exhibit differences in their investment profile over time which could have an impact on their ranking in relative financial performance. For example, while P2P generally is the most expensive solution it allows one to spread investments in active electronics better over the course of actual subscriber acquisition than GPON. In order to analyse this we have modelled a successive deployment in “Euroland’s” first six clusters because these have shown to be profitable for at least some of all four architectures (the two rural geotypes have not been run through the dynamic model extension). The dynamic analysis is more inclined to model the actual deployment over large parts of a country consisting of different clusters.[56] We have analysed investments and costs over a period of 20 years (no revenues were taken into account) to assess the relative performance of architectures. So we have only looked at the investor’s side in this analysis and not at the wholesale access seeker’s.

3.1.8.1 Network roll-out

To define the time-path of the FTTH roll-out we have assumed that an operator would have restrictions on the operational resources for deploying FTTH (e.g. civil works subcontractors) that limit him to a maximum capacity of 2mn passed homes per year. We have assumed that he will focus deployment on the three densest and most profitable clusters initially and use any remaining capacity as it becomes available to deploy clusters 4-6. As a result the operator has the deployment path that is shown in Table 3-4. Deployment in clusters 1-4 commences in year 1 and ends between year 3 (Cluster 1) and year 5 (Cluster 4). Only when these dense clusters have been passed does deployment in clusters 5 and 6 begin. The deployment in all six clusters is completed after 8 years passing about 14mn homes.

56 In the steady state analysis the results are primarily “stand-alone” cluster-specific.

Table 3-4: Deployment of FTTH in Euroland (passed homes per year)

Cluster	Total customer base	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
1	1,763,916	600,000	600,000	563,916					
2	2,163,672	600,000	600,000	600,000	363,672				
3	2,646,000	600,000	600,000	599,400	846,600				
4	2,062,480	200,000	200,000	236,684	789,728	636,068			
5	2,460,360					1,363,932	1,096,428		
6	2,989,056						903,572	2,000,000	85,484

Again, the deployment path is the same for all architectures. However, there are differences in how active electronics are deployed over time: In the case of GPON and WDM PON OLTs have to be deployed together with the roll-out of the passive network. This means that e.g. a GPON OLT is deployed in the MPoP for every 64 homes passed[57] and - since initially only 10% of homes are acquired - will run at a relatively low efficiency initially. Contrarily GPON over P2P will deploy one OLT for every 64 acquired subscribers[58] and will hence operate at a higher level of efficiency even at low penetration levels.

3.1.8.2 Subscriber acquisition

Acquisition of subscribers is modelled on the basis of a generic penetration that grows relatively quickly to a 70% take-up within 5 years. Every year that new homes passed are added, penetration starts at 10% for these homes and grows to 70% over 5 years. This means that the total roll-out area of e.g. Cluster 1 will have reached an overall take-up of 70% at the end of year 7 in which the homes passed in year 3 have reached said target penetration. Considering all six clusters of Euroland, the ramp-up is concluded in year 13 when all clusters have reached 70% penetration.

Table 3-5: Evolution of take-up rate in the dynamic model

Year of service availability	1	2	3	4	5
Take-up rate	10%	20%	40%	60%	70%

3.1.8.3 Replacement investments and price adjustments

We have considered replacement investments for all network elements within the 20 year period. All equipment prices and costs have been set constant, so replacement investments occur at the level of the initial investment and direct costs such as retail cost remain at the same level throughout the 20 year period.

57 Since we account for 10% spare capacity in splitters the true load is actually even a little lower.
58 10% spare capacity means that the OLT will actually serve about 57 users.

3.1.8.4 Interest rate and present values

Discounting of investment and cost positions was conducted by applying the WACC of the steady state model (10% p.a.).

3.1.8.5 Other parameters

All input parameters such as equipment lifetimes, prices etc. have been taken from the steady-state model.

3.2 Our results

3.2.1 Area of profitable coverage and critical market shares

A major set of results of the steady state model consists of the critical market shares required for the viability of the FTTH roll-out for the incumbent and the relevant wholesale access seeker as well. “Market share” always refers to a share of the total potentially addressable market and is in many sections synonymously used with take-up or penetration rate. The “critical market” share is the minimum share of the total potentially addressable market where the operator deploys his network at lower cost per subscriber than the ARPU. The calculation of the critical market share is done separately for each cluster and the results for the clusters are independent from each other. As the maximum achievable market share we assume for fixed lines 70% (taking into account DOCSIS, mobile-only households, and households that do not use telecommunications services at all), a cluster is considered not to be viable if the critical market share for this cluster exceeds this value. It is worth noting that the incumbent may reach the critical market share for viability by his own retail business, by his wholesale business or a combination of both.

The following two tables (Table 3-6 and Table 3-7) show the critical market shares required for deploying P2P and GPON over P2P architectures and the profitability of the corresponding wholesale scenario (fibre unbundling). In case of P2P, the incumbent could profitably roll out up to the suburban cluster or up to 50.7% of the customer base. However, if he deploys a GPON over P2P architecture he could expand his viability up to Cluster 6 and thus cover 64.4% of the addressable subscribers. The viability of this architecture increases up to six percentage points in Cluster 6 compared to P2P primarily due to the smaller number of Ethernet ports required or the port reduction by the OLTs.

Moreover, replicability (another operator building a second NGA identical to the incumbent’s) of the FTTH infrastructure for both technologies is theoretically possible only in the densest cluster or for about 8% of the population. In all other viable areas the investor needs a critical market share of more than 38% to become profitable, which makes the market entry of an infrastructure competitor inefficient.

It is evident from the tables that the first two scenarios are identical wholesale cases. Even though the P2P roll-out requires higher market shares for the incumbent to be viable in total, the network segment rented via unbundled fibre (from the customer's premise to the network sided ODF port) is the same and therefore exhibits equal wholesale prices in both cases. In both cases we have assumed that the fibre unbundler always implements P2P in his own network. Therefore the first two wholesale scenarios lead to identical results for the competitor.

Table 3-6: P2P Critical market shares

Architecture:	P2P		**Critical market shares**	
Geotype	**Cluster ID**	**Potential customers**	**Incumbent**	**Competitor (LLU)**
Dense urban	1	1,763,916	29%	9%
Urban	2	2,163,672	41%	10%
Less Urban	3	2,646,000	53%	24%
Dense Suburban	4	2,062,480	52%	25%
Suburban	5	2,460,360	67%	> 100%
Less Suburban	6	2,989,056	76%	> 100%
Dense Rural	7	4,331,208	> 100%	> 100%
Rural	8	3,448,368	> 100%	> 100%

Table 3-7: GPON over P2P Critical market shares

Architecture:	GPON over P2P		**Critical market shares**	
Geotype	**Cluster ID**	**Potential customers**	**Incumbent**	**Competitor (LLU)**
Dense urban	1	1,763,916	26%	9%
Urban	2	2,163,672	38%	10%
Less Urban	3	2,646,000	49%	24%
Dense Suburban	4	2,062,480	47%	25%
Suburban	5	2,460,360	61%	> 100%
Less Suburban	6	2,989,056	70%	> 100%
Dense Rural	7	4,331,208	> 100%	> 100%
Rural	8	3,448,368	> 100%	> 100%

Notable here is the huge difference between Cluster 4 and 5 in the wholesale access seeker's profitability. This is caused by the shape of the competitor's cost curve which becomes flat at relatively low take-up rates contrary to the steeper curve of the incumbent. The cost curves per subscriber and month for both incumbent and fibre unbundler with the corresponding ARPU lines are illustrated in the following figures.

Figure 3-1: P2P Cost curves of incumbent and competitors (Cluster 4)

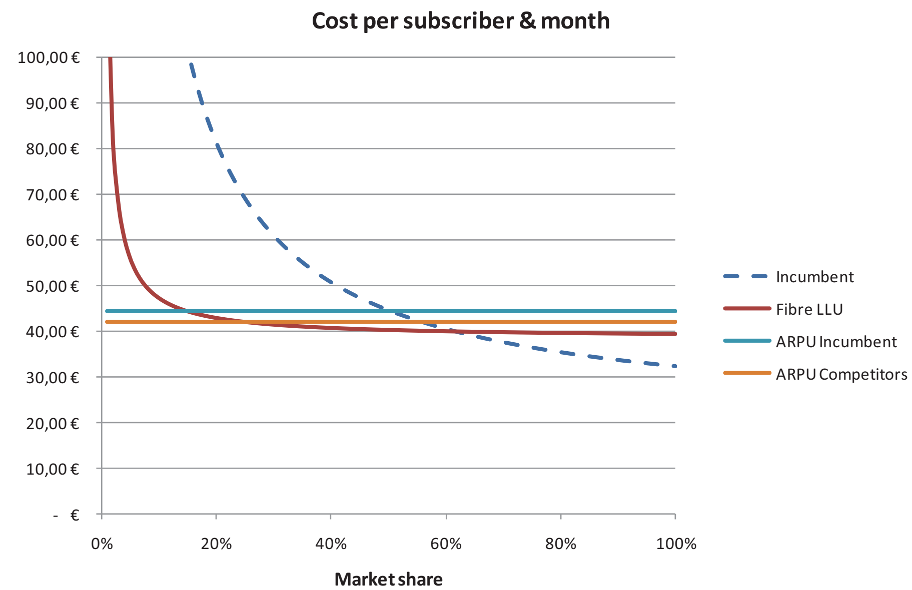


Figure 3-2: P2P Cost curves of incumbent and competitors (Cluster 5)

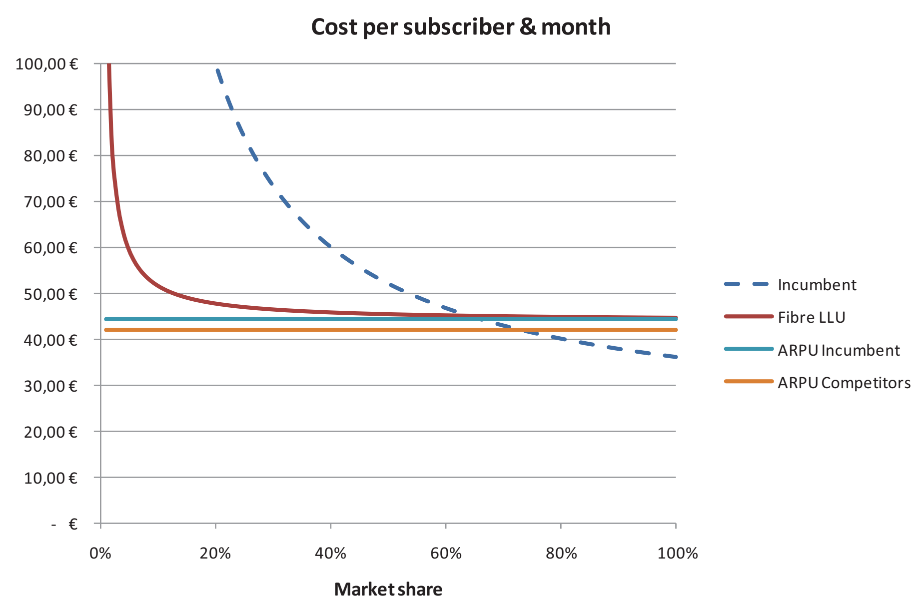


Figure 3-1 shows the cost and revenue curves for Cluster 4 which is the marginal cluster for the competitor. In the next cluster (Figure 3-2) his cost curve is shifted upwards, never going below the ARPU.

The critical market shares for GPON and WDM PON architectures are shown in the next two tables (Table 3-8 and Table 3-9). Except for Cluster 1 the viability potential of rolling out FTTH on the basis of GPON architecture is higher than with WDM PON. Similar to the GPON over P2P technology the incumbent could profitably roll out his network up to the Less Suburban cluster corresponding to 64.4% of the potential customer base. Again, there is no possibility for replication of the FTTH infrastructure except for the densest Cluster 1, since the critical market shares needed for a profitable roll-out in all other viable areas are higher than 38%.

Bitstream access at the core network requires less market share to be profitable than bitstream access at the MPoP level. Furthermore, comparing the three competition scenarios below with the unbundling scenario in Table 3-6, one can state that, for similar ARPUs, business models on the basis of unbundling require higher critical market shares than business models based on bitstream access.[59] For instance, the unbundling scenario already requires a critical market share of 24% in our Less Urban cluster to be profitable, while GPON bitstream access is viable already at 4% / 8% critical market share in the same cluster.

Table 3-8: GPON Critical market shares

Architecture:	GPON		Critical market shares		
Geotype	**Cluster ID**	**Potential customers**	**Incumbent**	**Competitor Bitstream Core**	**Competitor Bitstream MPoP**
Dense urban	1	1,763,916	26%	4%	6%
Urban	2	2,163,672	38%	3%	5%
Less Urban	3	2,646,000	48%	4%	8%
Dense Suburban	4	2,062,480	47%	5%	10%
Suburban	5	2,460,360	60%	16%	28%
Less Suburban	6	2,989,056	69%	> 100%	> 100%
Dense Rural	7	4,331,208	98%	> 100%	> 100%
Rural	8	3,448,368	> 100%	> 100%	> 100%

59 This result goes conform with the Ladder of Investment concept of the ERG, now BEREC.

Table 3-9: WDM PON Critical market shares

Architecture:	WDM PON		Critical market shares	
Geotype	**Cluster ID**	**Potential customers**	**Incumbent**	**Competitor WDM PON Unbundling**
Dense urban	1	1,763,916	25%	4%
Urban	2	2,163,672	39%	3%
Less Urban	3	2,646,000	50%	6%
Dense Suburban	4	2,062,480	49%	6%
Suburban	5	2,460,360	63%	92%
Less Suburban	6	2,989,056	72%	> 100%
Dense Rural	7	4,331,208	> 100%	> 100%
Rural	8	3,448,368	> 100%	> 100%

Another interesting comparison is the one between GPON bitstream core and WDM PON unbundling: As both tables show, the critical market shares of entrants are equal for the first two clusters but the relative profitability of WDM PON unbundling decreases as clusters become less dense. This behaviour is explained by the higher CPE cost for the WDM PON architecture, which overcompensates the savings from the lower wholesale charge (see section 3.2.2.3).

The critical market shares of the different scenarios indicate that in all architectures and wholesale access scenarios considered, potentially several competitors could survive in the market. The highest potential number of competitors occurs in the case of GPON bitstream access at the core network. Critical market shares only provide a theoretical maximum of potential competitors in the market. In particular they do not allow to define an equilibrium between the integrated incumbent and the competitors. The strategic interaction between competitors which also determines the actual number of competitors in the market is produced by our oligopoly model (see chapter 2).

The cost and ARPU curves for the incumbent and the related competitor’s scenarios are illustrated in the following figures for GPON (Figure 3-3 and Figure 3-4) and WDM PON (Figure 3-5 and Figure 3-6) showing in each case the last profitable cluster for both operators. Similar to the other two architectures the cost curve of the wholesale scenarios is flatter than the incumbent’s one due to lower economies of scale. Thus, the competitor cannot expand his viability to the same cluster as the incumbent.

Figure 3-3: GPON cost curves of incumbent and competitors (Cluster 5)

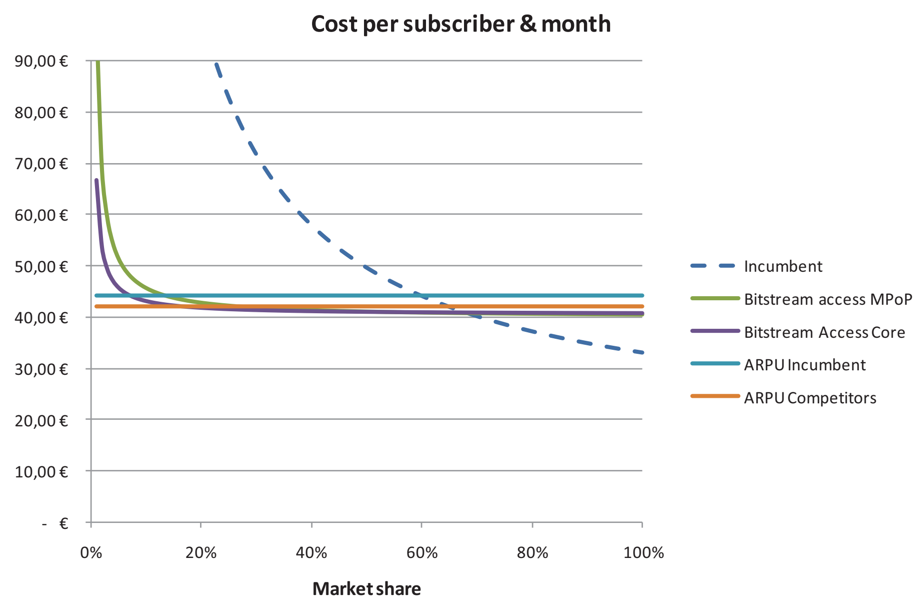


Figure 3-4: GPON Cost curves of incumbent and competitors (Cluster 6)

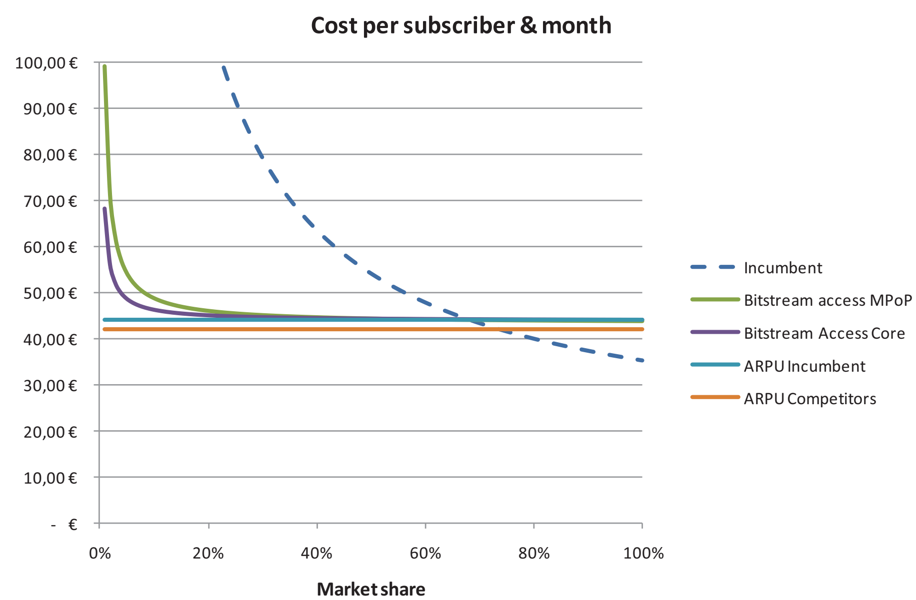


Figure 3-5: WDM PON Cost curves of incumbent and competitors (Cluster 4)

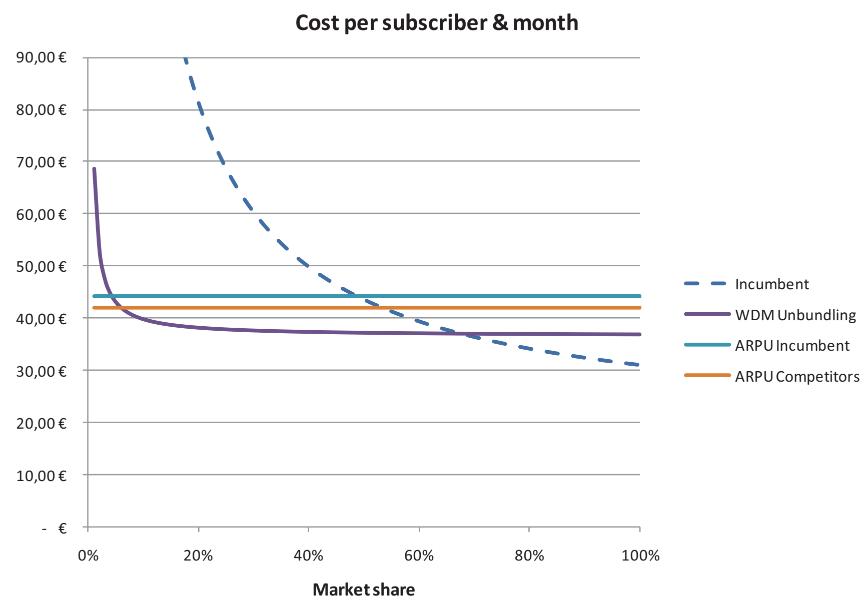


Figure 3-6: WDM PON Cost curves of incumbent and competitors (Cluster 5)

3.2.2 Investment and cost differences of technologies – static approach

3.2.2.1 Investment

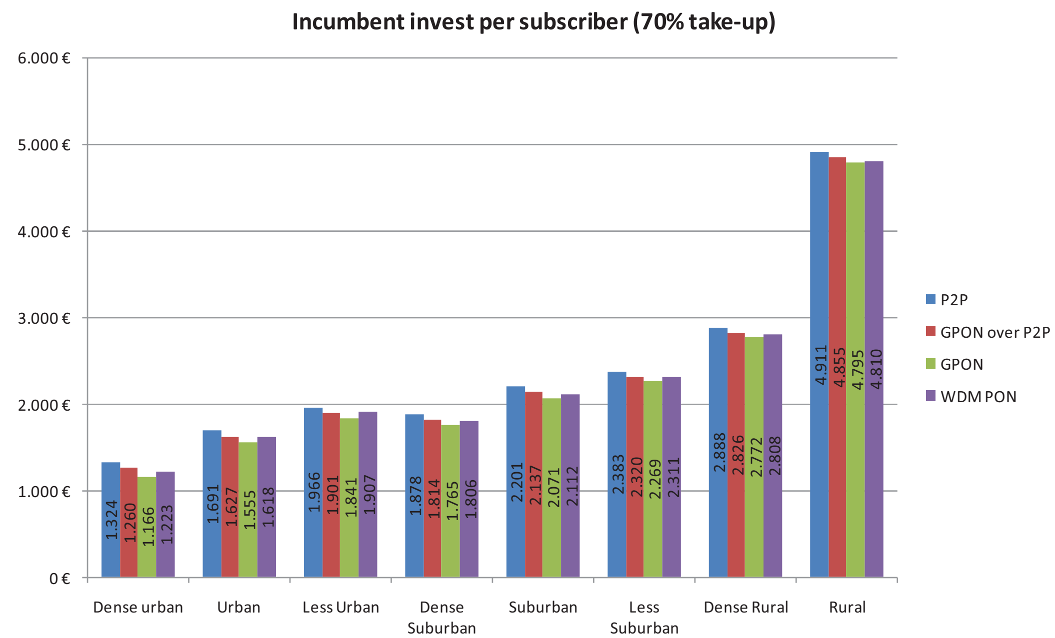
This section analyses investment and its breakdown into access network and MPoP related elements. Table 3-10 shows total investment values for each architecture and cluster at 70% take-up and Figure 3-7 illustrates the corresponding values per subscriber.[60] It is evident that a GPON roll-out requires less investment than all other architectures regardless of the cluster geotype. Except for the third cluster WDM PON shows the second lowest investment and the smallest difference to GPON. As expected P2P is the most investment intensive technology in all clusters. The table also highlights the ranks of the different architectures (1 – lowest investments, 4 – highest investments).

Table 3-10: Total investment per cluster at 70% market share (in Euro, excl. invest in IPTV equipment)

Cluster ID	P2P	GPON over P2P	GPON	WDM PON
1	1,635,366,872 (4)	1,555,206,492 (3)	1,440,199,143 (1)	1,509,953,842 (2)
2	2,561,483,941 (4)	2,463,597,630 (3)	2,355,780,633 (1)	2,450,763,909 (2)
3	3,640,644,636 (4)	3,521,369,571 (2)	3,409,503,170 (1)	3,531,819,963 (3)
4	2,711,585,679 (4)	2,619,329,432 (3)	2,548,335,778 (1)	2,607,106,253 (2)
5	3,790,501,685 (4)	3,680,408,786 (3)	3,566,194,709 (1)	3,638,063,505 (2)
6	4,986,264,055 (4)	4,853,230,188 (3)	4,746,971,414 (1)	4,834,521,602 (2)
7	8,755,484,768 (4)	8,568,721,800 (3)	8,405,447,141 (1)	8,513,102,826 (2)
8	11,854,443,121 (4)	11,718,576,564 (3)	11,574,690,285 (1)	11,609,743,918 (2)
Total	**39,935,774,757 (4)**	**38,980,440,463 (3)**	**38,047,122,274 (1)**	**38,695,075,817 (2)**

60 The values shown in Table 3-10 and throughout this chapter show investments in the NGA up to the MPoP only. For determining the total costs per user and critical market share a national IPTV platform in the core network was also accounted for. The total investments of 15mn € were spread over the clusters.

Figure 3-7: Total investment per subscriber and cluster at 70% market share (excl. invest in IPTV equipment)



In order to better understand the relation between the four architectures and their spread through the different clusters we have classified the investment into access network and MPoP related investments. The following tables (Table 3-11 and Table 3-12) show this breakdown for Cluster 1 and 3 with the corresponding shares of total investment. One can see that the main reason for the advantage of GPON compared to P2P and GPON over P2P consists in the much lower investment in MPoP components due to the use of splitter in the outside plant. Only in case of WDM PON there is less investment in MPoP equipment, however this saving is overcompensated by higher CPE investment due to the increased price per unit. The investment in a standard P2P roll-out is always higher than in a GPON over P2P case which is due to the higher number of Ethernet ports required.

Furthermore, it is notable that investment in floorspace exhibits significant differences among the architectures. P2P requires more than two times higher floorspace investment than GPON and even nearly 40 times more than WDM PON in the first cluster. However, these huge differences only have a very limited impact on the overall investment performance of technologies because the investment share of this factor is negligible (< 1%).

Despite of the differences in the implementation of the four technologies, the overall investment deltas between the architectures are relatively small. This follows mainly from the fact that the network elements which are most investment intensive (inhouse cabling and drop cable) and which are identical for all alternatives account for around 75% of total investment, while the feeder segment in which investment savings of e.g. GPON vs. P2P can reach over 100% in the dense areas, has a share of total investment of less than 10% in dense clusters. The difference in feeder investment is not as large as one would initially foresee. The reason is that in this Greenfield deployment civil works have to be undertaken in all cases anyway. Only where the higher fibre count of P2P exceeds the capacity of the standard trench and a wider trench is required does this actually lead to additional civil works cost for P2P. In Euroland this is only the case in the densest Cluster 1. In all other clusters the standard trench has enough capacity to host all required cables. Therefore, from Cluster 2 on the higher fibre count of P2P only leads to additional invest in cables but not to invest in trenches and duct infrastructure. The lower the fibre count becomes as the clusters become less dense, the less pronounced are the differences between P2P and GPON.[61] Therefore, the overall investment deltas between P2P and GPON remain moderate and range from 14% (Cluster 1) to 2% (Cluster 8).

61 A Brownfield sensitivity in section 0 will show how strong the differences between P2P and PON architectures become when taking the feeder fibre count into account for selecting usable duct infrastructure.

Table 3-11: Investment in network elements (Cluster 1)

Cluster 1		Investment in € (70% take-up)							
		P2P	Share of total investment	GPON over P2P	Share of total in-vestment	GPON	Share of total investment	WDM PON	Share of total investment
Access Network									
	CPE	135,204,161	8%	155,484,786	10%	155,484,786	11%	233,227,178	15%
	Inhouse fibre	515,707,301	32%	515,707,301	33%	515,707,301	36%	515,707,301	34%
	Drop cable	632,759,654	39%	632,759,654	41%	632,759,654	44%	632,759,654	42%
	Distribution point	-	0%	-	0%	52,359,615	4%	52,359,615	3%
	Feeder cable	88,415,780	5%	88,415,780	6%	40,111,359	3%	40,111,359	3%
	MDF	-	0%	-	0%	-	0%	4,117,748	0%
	Backhaul cable	-	0%	-	0%	-	0%	11,106,585	1%
	Total	**1,372,086,897 €**	**84%**	**1,392,367,521 €**	**90%**	**1,396,422,715 €**	**97%**	**1,489,389,440 €**	**99%**
MPoP									
	ODF customer sided ports	44,424,224	3%	44,424,224	3%	802,847	0%	66,488	0%
	ODF network sided ports and patch cabling	50,566,356	3%	50,566,356	3%	1,210,554	0%	100,253	0%
	Splitter	-	0%	35,586,405	2%	-	0%	-	0%
	OLT	-	0%	23,724,270	2%	34,906,410	2%	14,454,000	1%
	Ethernet Ports	162,244,994	10%	3,022,200	0%	4,363,301	0%	5,781,600	0%
	"Last Ethernet Port"	151,110	0%	151,110	0%	151,110	0%	8,760	0%
	Floorspace	5,893,290	0%	5,364,405	0%	2,342,205	0%	153,300	0%
	Total	**263,279,975 €**	**16%**	**162,838,971 €**	**10%**	**43,776,428 €**	**3%**	**20,564,401 €**	**1%**
Total invest NGA*)		**1,635,366,872 €**	**100%**	**1,555,206,492 €**	**100%**	**1,440,199,143 €**	**100%**	**1,509,953,842 €**	**100%**

*) Total invest in NGA without investment in IPTV equipment

Table 3-12: Investment in network elements (Cluster 3)

Cluster 3		Investment in € (70% take-up)							
		P2P	Share of total investment	GPON over P2P	Share of total investment	GPON	Share of total investment	WDM PON	Share of total investment
Access Network									
	CPE	202,815,900	6%	233,238,285	7%	233,238,285	7%	349,857,428	10%
	Inhouse fibre	773,597,790	21%	773,597,790	22%	773,597,790	23%	773,597,790	22%
	Drop cable	2,026,707,904	56%	2,026,707,904	58%	2,026,707,904	59%	2,026,707,904	57%
	Distribution point	-	0%	-	0%	86,921,100	3%	86,921,100	2%
	Feeder cable	237,302,426	7%	237,302,426	7%	211,398,839	6%	211,398,839	6%
	MDF	-	0%	-	0%	-	0%	7,588,350	0%
	Backhaul cable	-	0%	-	0%	-	0%	40,728,744	1%
	Total	**3,240,424,020 €**	**89%**	**3,270,846,405 €**	**93%**	**3,331,863,919 €**	**98%**	**3,496,800,155 €**	**99%**
MPoP									
	ODF customer sided ports	66,639,510	2%	66,639,510	2%	1,332,790	0%	113,333	0%
	ODF network sided ports and patch cabling	75,853,147	2%	75,853,147	2%	2,009,616	0%	170,886	0%
	Splitter	-	0%	53,394,390	2%	-	0%	-	0%
	OLT	-	0%	35,596,260	1%	57,947,400	2%	24,637,500	1%
	Ethernet Ports	243,379,080	7%	4,966,920	0%	7,243,425	0%	9,855,000	0%
	"Last Ethernet Port"	551,880	0%	551,880	0%	551,880	0%	13,140	0%
	Floorspace	13,797,000	0%	13,521,060	0%	8,554,140	0%	229,950	0%
	Total	**400,220,617 €**	**11%**	**250,523,167 €**	**7%**	**77,639,251 €**	**2%**	**35,019,808 €**	**1%**
Total invest NGA*)		**3,640,644,636 €**	**100%**	**3,521,369,571 €**	**100%**	**3,409,503,170 €**	**100%**	**3,531,819,963 €**	**100%**

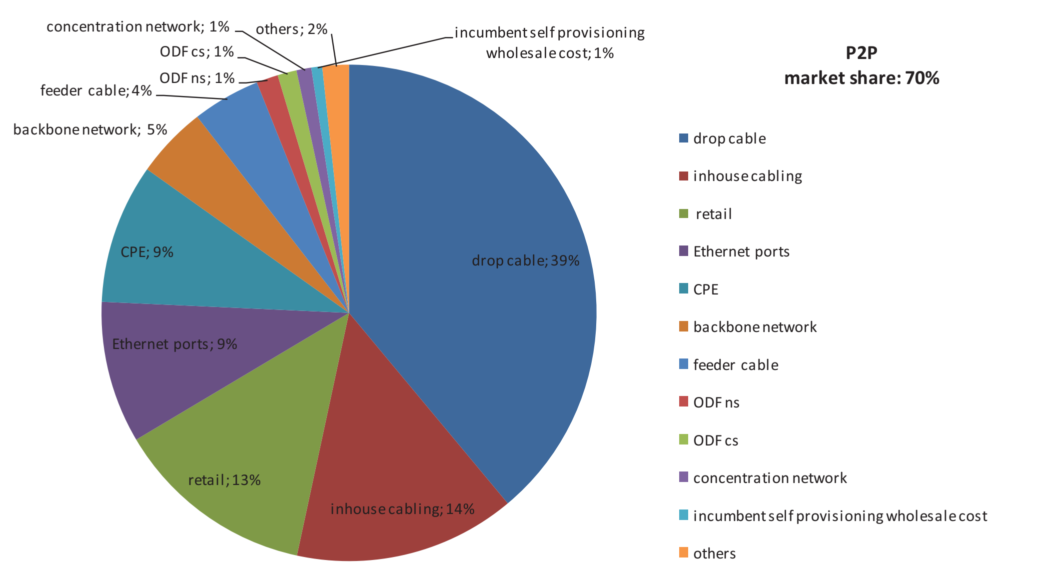
*) Total invest in NGA without investment in IPTV equipment

3.2.2.2 Cost

In the previous section the focus was on the analysis of the *investment* required for the roll-out of a certain technology. We now analyze the *cost* composition of the incumbent and competitors as we consider the annualized cost of NGA investment and direct cost which include floorspace rental, energy, concentration and core network as well as retail costs.

Figure 3-8 up to Figure 3-11 show exemplary for Cluster 3 cost shares of the incumbent's deployment at maximum penetration (70%) for different FTTH architectures. In line with the investment values analysed above, the drop cable segment exhibits the highest cost share regardless of the technology deployed (between 39% and 42%). The second largest cost component is the inhouse cabling (14%-16%), except for WDM PON case where the cost for CPE dominates with 16% cost share due to the higher equipment price assumed.[62] Retail cost ranges between 13% and 15% along the different architectures, CPE cost – between 9% and 11% (except for WDM PON). As expected, the costs of Ethernet ports have a significant impact only in case of P2P where it generates 9% of the total cost. Contrary to this, the PON architectures' cost of active equipment (OLTs and PON Ethernet ports) in the MPoP account for a maximum of 2% of the total cost.

Figure 3-8: P2P Cost structure of incumbent at 70% market share (Cluster 3)



62 We will show a sensitivity on CPE prices in section 0.

Figure 3-9: GPON over P2P Cost structure of incumbent at 70% market share (Cluster 3)

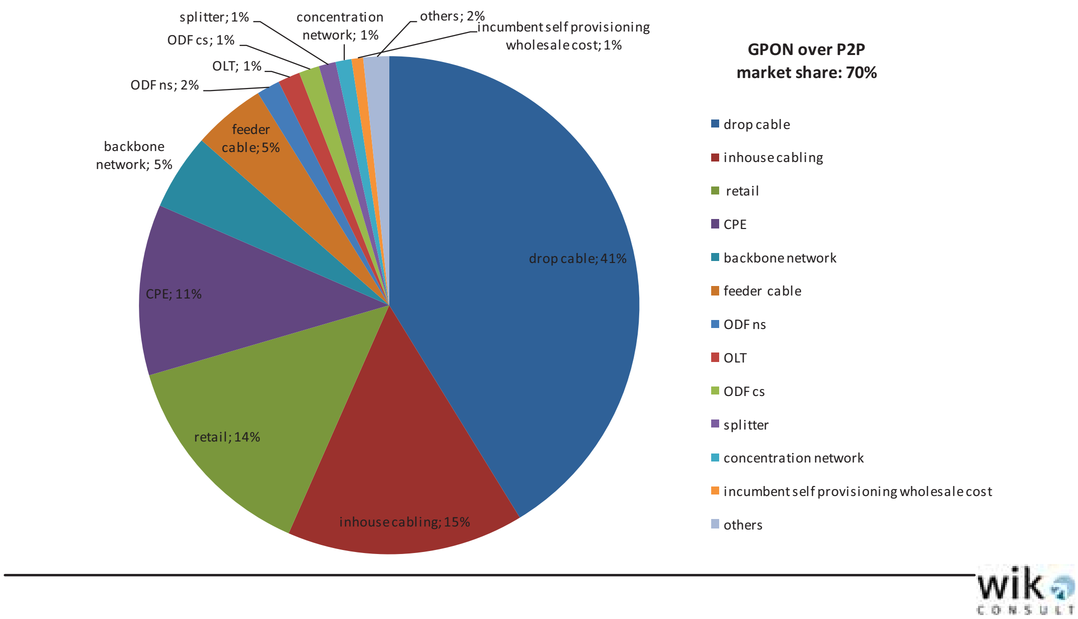


Figure 3-10: GPON Cost structure of incumbent at 70% market share (Cluster 3)

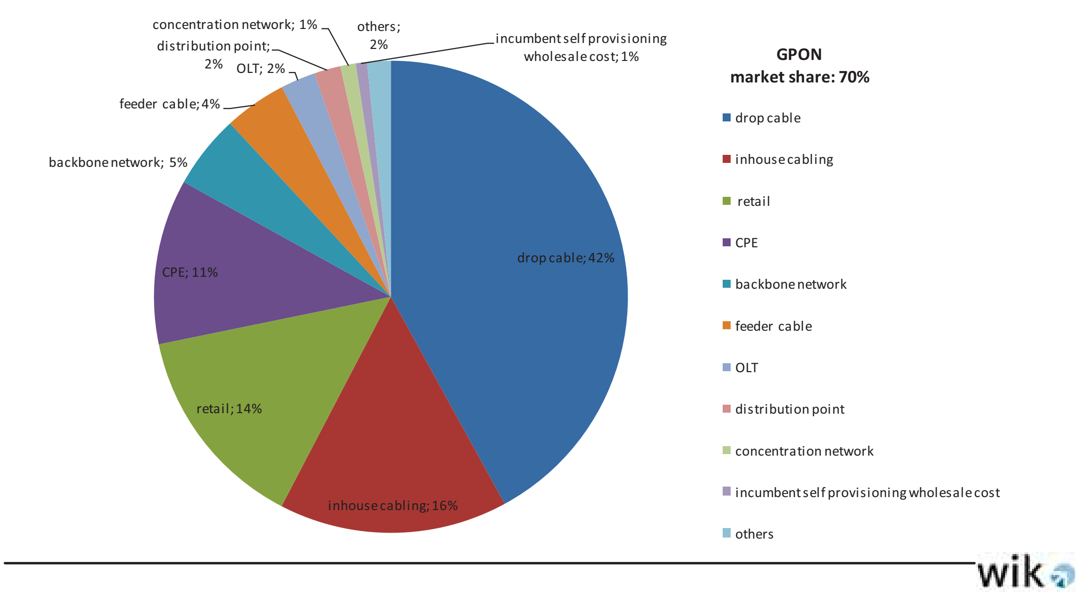
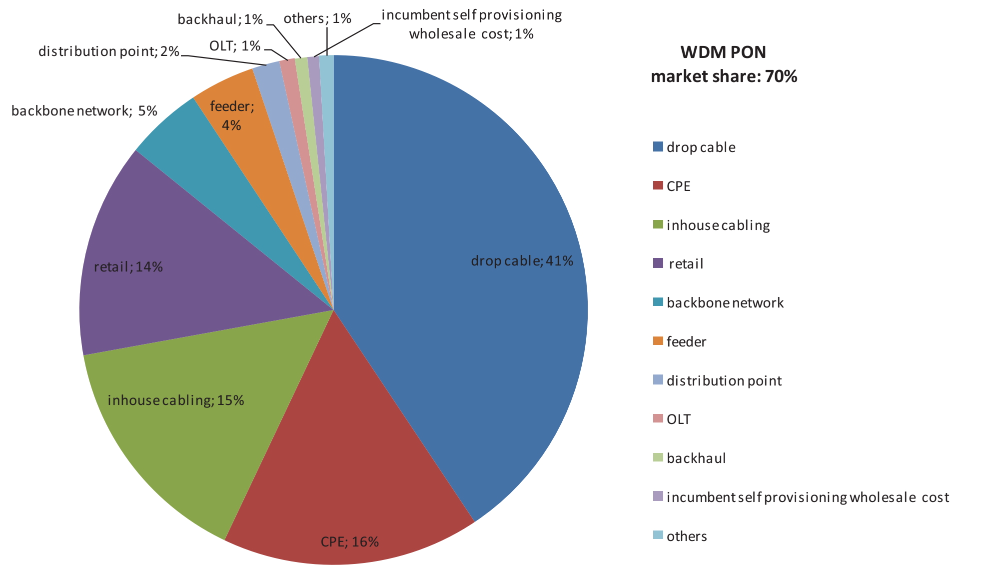


Figure 3-11: WDM PON cost structure of incumbent at 70% market share (Cluster 3)



In the relevant clusters 1-6 the cost comparison of our four network topologies has shown the following results: GPON is the cheapest technology, followed by GPON over P2P, WDM PON and P2P (see Table 3-13). With the exception of Cluster 1 where WDM PON and GPON over P2P switch ranks, this is consistent over the relevant clusters.

Table 3-13: Total cost per customer per month at 70% take-up (in Euro)

Cluster	P2P	GPON over P2P	GPON	WDM PON
1	29.85	27.67	26.55	27.49
2	34.17	32.00	31.18	32.42
3	38.19	36.03	35.37	36.62
4	37.73	35.58	35.04	36.33
5	43.02	40.87	40.14	41.50
6	46.21	44.07	43.50	44.83

The next four figures depict the cost composition of a competitor for the five wholesale scenarios and at 20% market share (examples shown for Cluster 3). One can see that the cost structure of a competitor in a FTTH network is strongly dominated by the wholesale price. In the bitstream scenarios the cost share of the wholesale price amounts to 65% on average. The cost share of the wholesale provision will be reduced to 57% in case of fibre unbundling.

Figure 3-12: Cost structure of fibre unbundler at 20% market share (Cluster 3)

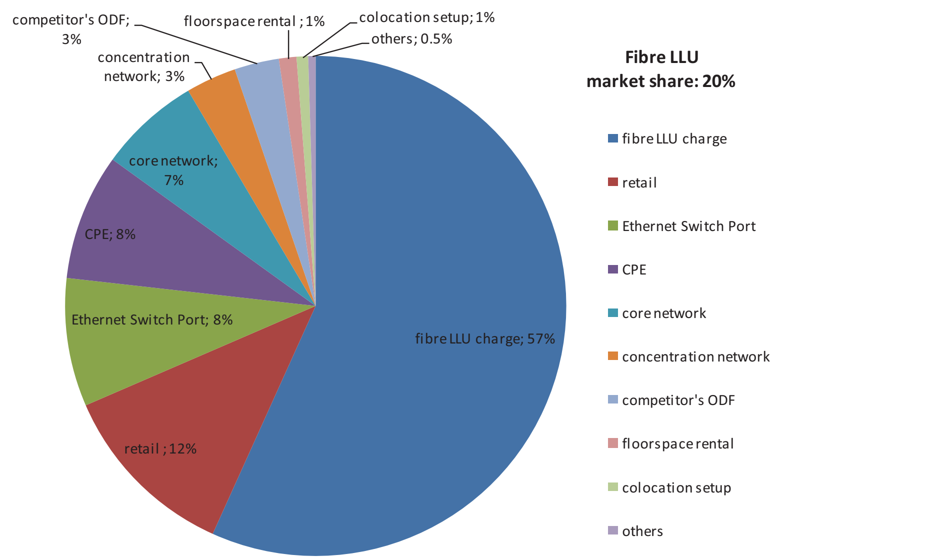


Figure 3-13: Cost structure of a bitstream MPoP access seeker at 20% market share (Cluster 3)

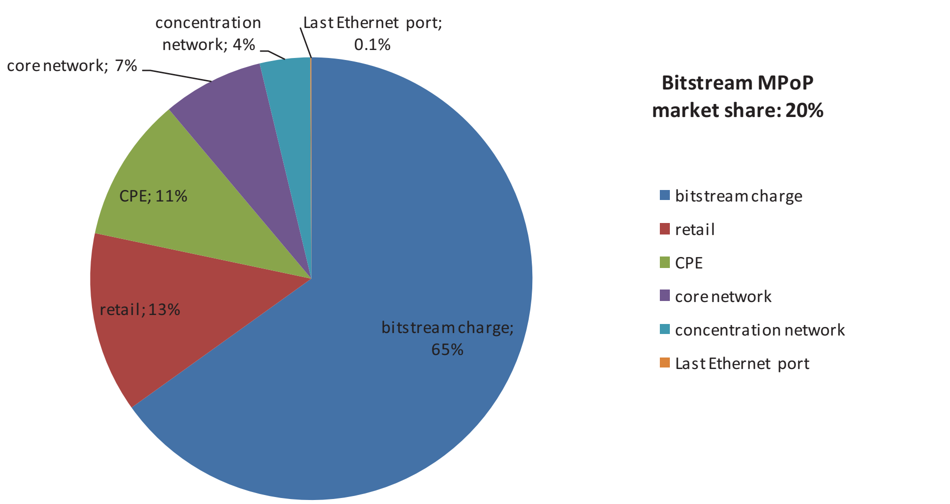


Figure 3-14: Cost structure of a bitstream core access seeker (GPON) at 20% market share (Cluster 3)

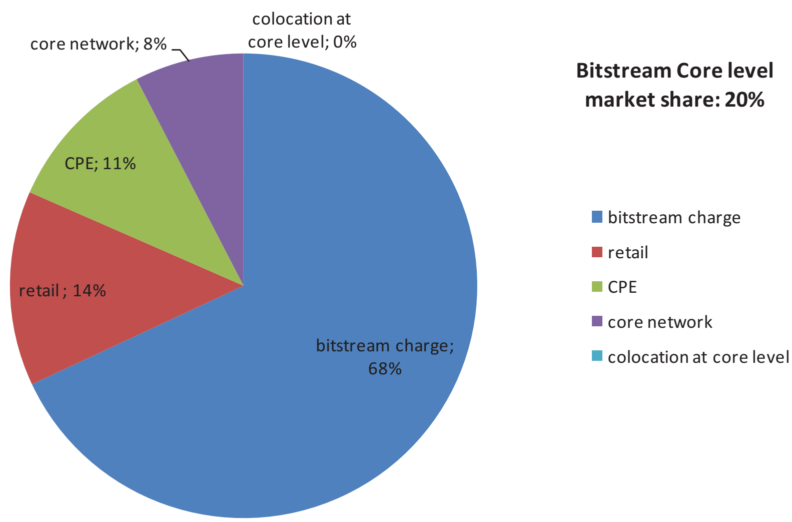
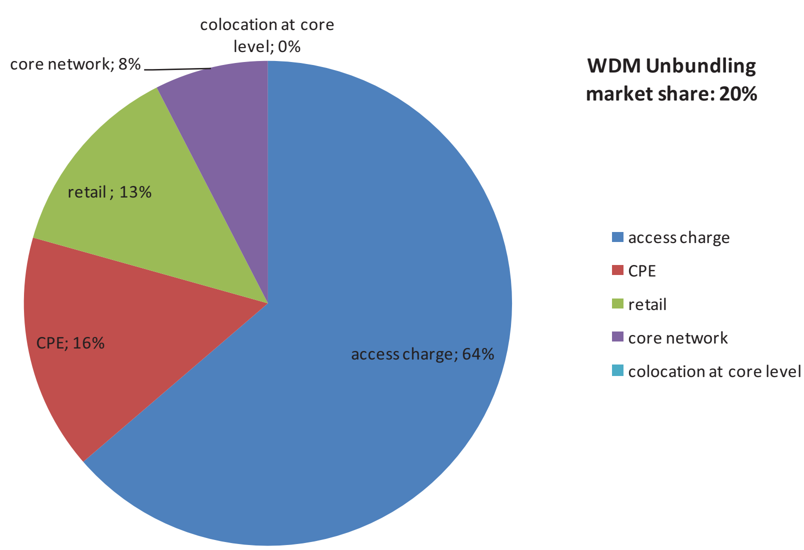


Figure 3-15: Cost structure of a WDM unbundler at 20% market share (Cluster 3)



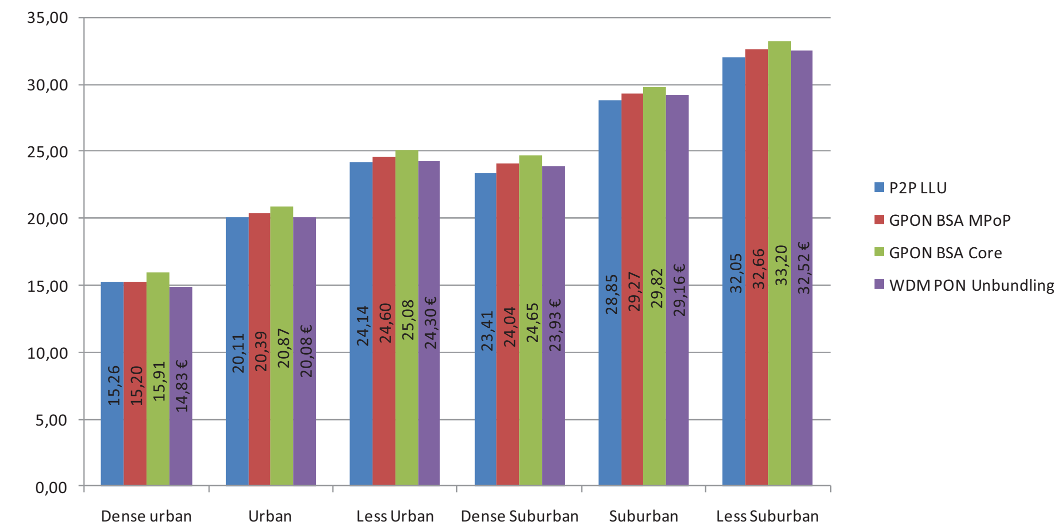
3.2.2.3 Wholesale prices

As explained before, wholesale prices for the competitor's business case have been determined based on the LRIC incurred for the incumbent at a 70% take-up which is the maximum penetration rate we assume for the incumbent's network. Depending on the scenario they can - in addition to the cost of the access network (which includes the optical inhouse cabling cost) – include cost for active equipment in the MPoP or cost for transport in concentration/the backhaul network.

Figure 3-16 provides an overview of the resulting wholesale prices. In line with the components included in the wholesale charge, bitstream access at the core level is more expensive than access at the MPoP or WDM unbundling along all clusters. Note that a comparison between the fibre unbundling charge and the wholesale prices of the other competition scenarios is not directly possible, since they are based on different access technologies according to the scenario definition. Accordingly the most valid interpretation is the comparison of the two GPON bitstream scenarios. The wholesale price increase for the bitstream access at the core level is relatively small. The reason is that the concentration network transport component of the access charge at the core level is based upon a 70% network load which results in very low transport cost per customer, considering that the dominant part of the concentration network costs is fix.

Furthermore, it is interesting to note that in some clusters the WDM PON access charge is below the GPON access charge level, but as we have seen GPON always leads in terms of overall cost and thus critical market shares. The reason is primarily the CPE price that is borne by every subscriber. We have run a sensitivity on the WDM PON CPE price and other parameters in the next section.

Figure 3-16: Wholesale prices



3.2.2.4 Sensitivities: Impact on critical market shares

Investment reduction for the incumbent ("Brownfield deployment")

In bottom up LRIC modelling we consider the situation that an investor constructs a new, state of the art forward looking fibre network, taking into account future demand (Greenfield scenario).

In the real world the investors often face the situation that locations and infrastructure already exist which may be reused by a new network generation in order to save investment. This will be considered in our modelling approach by taking the existing MDF locations as scorched nodes of the new network (maybe some of the MDF will be dismantled), not looking for new locations, thus the remaining are a subset of the existing. Regardless of any dismantling scenarios, the cost of the locations that are in use are fully considered.

The investor's decision nevertheless is driven by the level of (additional) investments he has to make, considering that there are existing ducts having spare capacity which could satisfy part of the demand of the new network, thus resulting in less investment expenditures. We face that situation by defining a scenario which we call Brownfield in contrast to the above mentioned Greenfield scenario, where we reduce the investment for the passive network components ducts, trenches and manholes[63] by dedicated per-

63 For ease of expression in this section we call these components „duct infrastructure" only, since the ducts determine their ability to be reused. Direct buried lines could not be reused.

centages due to the NGA architecture and their fibre demand and due to the part (segment) of the access network, where this spare capacity is located. This Brownfield scenario is part of the sensitivities we consider in all our models.

Proceeding like this requires that duct infrastructure exists which still has spare capacity in an amount being able to host all of the new required fibre cables. If only part of the cables could be hosted, a new trench has to be dug anyhow, so no significant savings would be achieved.

Our basic assumption is that on average the spare components have existed for half of the total equipment life time, thus we assume that the new FTTH network can use the duct infrastructure of an older network for an average remaining lifetime. In the cases where the existing infrastructure has been reinvested in the shorter term future (e.g. due to poor constitution of the ducts) an investor may decide to reinvest now before the new fibre cables will be plugged in. Otherwise reinvestment can hardly be managed without broadband customer interruption (relatively soon after they have taken up the service). In consequence for the components being reused we only consider half of the investment one would need in a Greenfield environment. E.g. we assume the few fibres in the backhaul segment of the highly aggregated WDM PON architecture will fit into the already existing ducts of the old concentration network by 100%. Due to the already used ducts and the sooner reinvestment we for simplicity assume that 50% of the investment may be saved, thus we reduce the investment for the trenches, ducts and manholes of the backhaul segment by 50%. We also did an additional sensitivity to consider that all ducts may still be usable for more than the fibre equipment lifetime considered (20 years).

In the feeder network segment the fibre plants of GPON and WDM PON are equal, and the fibre plants for P2P and GPON over P2P are also equal, requiring one fibre per home passed. Accordingly, P2P plants have 64 times more fibres than the PON plants. Therefore, we assume in our Brownfield scenarios that for the first two architectures (GPON and WDM PON) all feeder fibres fit into already existing ducts, thus reducing the necessary investment for the feeder duct infrastructure by 50% at the maximum. For the second two architectures, needing significantly more fibres, we assume that only in 20% of the cases the existing duct network may also host the new fibre cables, resulting in an investment reduction of 10% of the feeder duct infrastructure. We believe these assumptions to be optimistic, since we assume here that in Euroland all feeder cables are already constructed in a ducted manner.

In the drop network, the fibre plants of all network architectures are equal, all having one fibre from the home passed to the distribution point (DP). In this network segment sharing of existing ducts only can take place where ducts are deployed. For our Brownfield scenario we assume optimistically that ducts exist in half of the areas where there is no aerial construction[64] and that all of these ducts can be shared with the new fibre cables. For the ducts to be installed these assumptions reduce the required investment for duct infrastructure by 25% in the drop cable segment. The resulting investment reductions are given in Table 3-14.

The Brownfield scenario in this study considers the reduced investment for the calculation of the incumbent’s profitability. The comparison with the wholesale based competitors still assumes the Greenfield LRIC based wholesale prices as an input, since price regulation in all European countries operates accordingly. An additional sensitivity analyses the results if this assumption of existing regulatory practice would no longer hold and wholesale prices also reflected the investment savings of the Brownfield approach.

Table 3-14: Investment reduction for duct infrastructure per network segment in a Brownfield approach

Network Segment	P2P	GPON over P2P	GPON	WDM PON
Backhaul	--	--	--	50%
Feeder	10%	10%	50%	50%
Drop	25%	25%	25%	25%

Table 3-15 compares the resulting critical market shares for Greenfield and brownfield scenarios. Lower investment requirements in a brownfield approach enable the incumbent to increase the profitable coverage with P2P and WDM PON up to the Less Suburban Cluster 6. For all technologies costs and critical market shares decrease. The strongest effects occur for the WDM PON architecture. As Table 3-17 shows, total network costs here decrease from 5% (Cluster 1) to 11% (Cluster 8). The lowest cost savings occur with P2P from 4% (Cluster 1) to 7% (Cluster 3). Cost savings for GPON are higher than for P2P but slightly lower than for WDM PON, and range from 5% (Cluster 1) to 10% (Cluster 8).

The investment savings become more transparent by segment (see Table 3-16). The effective reduction in the drop segment ranges from 7% to 20% depending on the cluster and is similar for all architectures, as one could expect with the same fibre plant in all architecture variants. In the feeder segment, the savings for P2P are around 7% and for GPON around 40%. The savings in the backhaul segment amount to around 40% for WDM PON in the relevant cluster. In terms of total cost, investment savings reduce costs by 5% to 10% for GPON and 4% to 7% for P2P.

64 For aerial deployment shares see Table 3-2.

Table 3-15: Incumbent critical market shares (Greenfield vs. Brownfield)

Cluster ID	P2P - Greenfield	P2P - Brownfield	GPON over P2P - Greenfield	GPON over P2P - Brownfield	GPON - Greenfield	GPON - Brownfield	WDM PON - Greenfield	WDM PON - Brownfield
1	29%	25%	26%	23%	26%	23%	25%	22%
2	41%	34%	38%	32%	38%	31%	39%	31%
3	53%	45%	49%	41%	48%	40%	50%	41%
4	52%	45%	47%	41%	47%	40%	49%	41%
5	67%	60%	61%	55%	60%	52%	63%	54%
6	76%	68%	70%	63%	69%	59%	72%	62%
7	> 100%	> 100%	> 100%	95%	98%	86%	> 100%	89%
8	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%

Table 3-16: Incumbent investment at 70% market share

Cluster ID		P2P - greenfield	P2P - brownfield	Effective reduction of invest	GPON over P2P - greenfield	GPON over P2P - brownfield	Effective reduction of invest	GPON -greenfield	GPON - brownfield	Effective reduction of invest	WDM PON - greenfield	WDM PON - brownfield	Effective reduction of invest
1	**Total Investment**	**1.635.576.824**	**1.526.031.309**	**7%**	**1.555.416.445**	**1.445.870.929**	**7%**	**1.440.409.096**	**1.319.372.425**	**8%**	**1.511.413.842**	**1.385.957.204**	**8%**
	Drop	632.759.654	527.251.572	17%	632.759.654	527.251.572	17%	632.759.654	527.251.572	17%	632.759.654	527.251.572	17%
	Feeder	88.415.780	84.378.347	5%	88.415.780	84.378.347	5%	40.111.359	24.582.771	39%	40.111.359	24.582.771	39%
	Backhaul	-	-		-	-		-	-		11.106.585	6.686.618	40%
2	**Total Investment**	**2.561.995.131**	**2.294.654.186**	**10%**	**2.464.108.819**	**2.196.767.875**	**11%**	**2.356.291.823**	**2.056.035.267**	**13%**	**2.452.588.909**	**2.142.766.434**	**13%**
	Drop	1.298.246.556	1.039.134.514	20%	1.298.246.556	1.039.134.514	20%	1.298.246.556	1.039.134.514	20%	1.298.246.556	1.039.134.514	20%
	Feeder	138.607.451	130.378.548	6%	138.607.451	130.378.548	6%	108.237.243	67.092.729	38%	108.237.243	67.092.729	38%
	Backhaul	-	-		-	-		-	-		24.650.640	15.084.720	39%
3	**Total Investment**	**3.641.411.420**	**3.246.547.120**	**11%**	**3.522.136.355**	**3.127.272.055**	**11%**	**3.410.269.954**	**2.948.775.039**	**14%**	**3.534.009.963**	**3.056.289.777**	**14%**
	Drop	2.026.707.904	1.648.501.257	19%	2.026.707.904	1.648.501.257	19%	2.026.707.904	1.648.501.257	19%	2.026.707.904	1.648.501.257	19%
	Feeder	237.302.426	220.644.772	7%	237.302.426	220.644.772	7%	211.398.839	128.110.572	39%	211.398.839	128.110.572	39%
	Backhaul	-	-		-	-		-	-		40.728.744	24.503.472	40%
4	**Total Investment**	**2.712.437.661**	**2.461.888.717**	**9%**	**2.620.181.415**	**2.369.632.471**	**10%**	**2.549.187.760**	**2.221.175.028**	**13%**	**2.608.566.253**	**2.280.553.521**	**13%**
	Drop	1.385.532.510	1.154.349.513	17%	1.385.532.510	1.154.349.513	17%	1.385.532.510	1.154.349.513	17%	1.385.532.510	1.154.349.513	17%
	Feeder	250.087.722	230.721.775	8%	250.087.722	230.721.775	8%	248.622.143	151.792.407	39%	248.622.143	151.792.407	39%
	Backhaul	-	-		-	-		-	-		-	-	
5	**Total Investment**	**3.791.423.651**	**3.484.147.716**	**8%**	**3.681.330.753**	**3.374.054.817**	**8%**	**3.567.116.676**	**3.150.343.720**	**12%**	**3.639.888.505**	**3.223.115.549**	**11%**
	Drop	2.124.752.586	1.844.850.905	13%	2.124.752.586	1.844.850.905	13%	2.124.752.586	1.844.850.905	13%	2.124.752.586	1.844.850.905	13%
	Feeder	383.114.208	355.739.953	7%	383.114.208	355.739.953	7%	344.763.223	207.891.948	40%	344.763.223	207.891.948	40%
	Backhaul	-	-		-	-		-	-		-	-	
6	**Total Investment**	**4.987.532.900**	**4.600.961.461**	**8%**	**4.854.499.033**	**4.467.927.594**	**8%**	**4.748.240.259**	**4.169.922.776**	**12%**	**4.836.711.602**	**4.258.394.119**	**12%**
	Drop	2.819.303.502	2.480.668.573	12%	2.819.303.502	2.480.668.573	12%	2.819.303.502	2.480.668.573	12%	2.819.303.502	2.480.668.573	12%
	Feeder	607.049.450	559.112.940	8%	607.049.450	559.112.940	8%	603.733.176	364.050.622	40%	603.733.176	364.050.622	40%
	Backhaul	-	-		-	-		-	-		-	-	
7	**Total Investment**	**8.759.808.578**	**8.279.150.607**	**5%**	**8.573.045.610**	**8.092.387.639**	**6%**	**8.409.770.951**	**7.426.234.268**	**12%**	**8.516.022.826**	**7.532.486.142**	**12%**
	Drop	4.907.022.551	4.552.084.259	7%	4.907.022.551	4.552.084.259	7%	4.907.022.551	4.552.084.259	7%	4.907.022.551	4.552.084.259	7%
	Feeder	1.556.312.538	1.430.592.860	8%	1.556.312.538	1.430.592.860	8%	1.548.543.771	919.945.380	41%	1.548.543.771	919.945.380	41%
	Backhaul	-	-		-	-		-	-		-	-	
8	**Total Investment**	**11.862.013.592**	**11.118.086.847**	**6%**	**11.726.147.034**	**10.982.220.289**	**6%**	**11.582.260.756**	**9.997.802.281**	**14%**	**11.612.298.918**	**10.027.840.443**	**14%**
	Drop	7.379.700.453	6.845.906.641	7%	7.379.700.453	6.845.906.641	7%	7.379.700.453	6.845.906.641	7%	7.379.700.453	6.845.906.641	7%
	Feeder	2.601.283.443	2.391.150.511	8%	2.601.283.443	2.391.150.511	8%	2.588.298.413	1.537.633.751	41%	2.588.298.413	1.537.633.751	41%
	Backhaul	-	-		-	-		-	-		-	-	

Table 3-17: Incumbent total cost per subscriber and month at 70% market share

Cluster ID		P2P - greenfield	P2P - brownfield	Effective reduction of cost	GPON over P2P - greenfield	GPON over P2P - brownfield	Effective reduction of cost	GPON -greenfield	GPON - brownfield	Effective reduction of cost	WDM PON - greenfield	WDM PON - brownfield	Effective reduction of cost
1	**Total Cost**	**29,85**	**28,68**	**4%**	**27,67**	**26,50**	**4%**	**26,55**	**25,25**	**5%**	**27,49**	**26,15**	**5%**
	Drop	6,77	5,64	17%	6,77	5,64	17%	6,77	5,64	17%	6,77	5,64	17%
	Feeder	0,95	0,90	5%	0,95	0,90	5%	0,43	0,26	39%	0,43	0,26	39%
	Backhaul	-	-		-	-		-	-		0,12	0,07	40%
2	**Total Cost**	**34,17**	**31,84**	**7%**	**32,00**	**29,67**	**7%**	**31,18**	**28,56**	**8%**	**32,42**	**29,71**	**8%**
	Drop	11,33	9,07	20%	11,33	9,07	20%	11,33	9,07	20%	11,33	9,07	20%
	Feeder	1,21	1,14	6%	1,21	1,14	6%	0,94	0,59	38%	0,94	0,59	38%
	Backhaul	-	-		-	-		-	-		0,22	0,13	39%
3	**Total Cost**	**38,19**	**35,33**	**7%**	**36,03**	**33,17**	**8%**	**35,37**	**32,04**	**9%**	**36,62**	**33,17**	**9%**
	Drop	14,86	12,13	18%	14,86	12,13	18%	14,86	12,13	18%	14,86	12,13	18%
	Feeder	1,69	1,57	7%	1,69	1,57	7%	1,51	0,91	39%	1,51	0,91	39%
	Backhaul	-	-		-	-		-	-		0,29	0,17	40%
4	**Total Cost**	**37,73**	**35,35**	**6%**	**35,58**	**33,20**	**7%**	**35,04**	**31,96**	**9%**	**36,33**	**33,25**	**8%**
	Drop	13,51	11,31	16%	13,51	11,31	16%	13,51	11,31	16%	13,51	11,31	16%
	Feeder	2,29	2,11	8%	2,29	2,11	8%	2,28	1,39	39%	2,28	1,39	39%
	Backhaul	-	-		-	-		-	-		-	-	
5	**Total Cost**	**43,02**	**40,52**	**6%**	**40,87**	**38,38**	**6%**	**40,14**	**36,80**	**8%**	**41,50**	**38,16**	**8%**
	Drop	18,30	16,01	13%	18,30	16,01	13%	18,30	16,01	13%	18,30	16,01	13%
	Feeder	2,94	2,73	7%	2,94	2,73	7%	2,65	1,60	40%	2,65	1,60	40%
	Backhaul	-	-		-	-		-	-		-	-	
6	**Total Cost**	**46,21**	**43,56**	**6%**	**44,07**	**41,42**	**6%**	**43,50**	**39,63**	**9%**	**44,83**	**40,96**	**9%**
	Drop	20,59	18,25	11%	20,59	18,25	11%	20,59	18,25	11%	20,59	18,25	11%
	Feeder	3,83	3,53	8%	3,83	3,53	8%	3,81	2,30	40%	3,81	2,30	40%
	Backhaul	-	-		-	-		-	-		-	-	
7	**Total Cost**	**57,77**	**55,33**	**4%**	**55,69**	**53,25**	**4%**	**54,97**	**50,34**	**8%**	**55,68**	**51,04**	**8%**
	Drop	28,36	26,46	7%	28,36	26,46	7%	28,36	26,46	7%	28,36	26,46	7%
	Feeder	6,79	6,24	8%	6,79	6,24	8%	6,75	4,01	41%	6,75	4,01	41%
	Backhaul	-	-		-	-		-	-		-	-	
8	**Total Cost**	**92,44**	**87,71**	**5%**	**90,50**	**85,77**	**5%**	**89,53**	**80,20**	**10%**	**88,82**	**79,48**	**11%**
	Drop	53,56	49,98	7%	53,56	49,98	7%	53,56	49,98	7%	53,56	49,98	7%
	Feeder	14,24	13,09	8%	14,24	13,09	8%	14,17	8,42	41%	14,17	8,42	41%
	Backhaul	-	-		-	-		-	-		-	-	

We now assume that the wholesale prices are based on the incumbent's brownfield costs (and no longer on the Greenfield LRIC) and analyse the impact on the competition scenarios. As expected, wholesale access seekers improve their viability compared to a Greenfield environment, as Table 3-18 shows. All bitstream access seekers can expand their profitable coverage at least by one cluster. The limit of viability for the fibre unbundler remains in Cluster 4 but the critical market share decreases significantly in this marginal cluster (from 25% to 15%).

Table 3-18: Competitors critical market shares (Greenfield vs. Brownfield)

Cluster ID	LLU - Greenfield	LLU - Brownfield	Bitstream Core - Greenfield	Bitstream Core - Brownfield	Bitstream MPoP - Greenfield	Bitstream MPoP - Brownfield	WDM un-bundling - Greenfield	WDM un-bundling - Brownfield
1	9%	8%	4%	3%	6%	6%	4%	4%
2	10%	8%	3%	2%	5%	4%	3%	3%
3	24%	12%	4%	3%	8%	6%	6%	4%
4	25%	15%	5%	4%	10%	7%	6%	4%
5	> 100%	> 100%	16%	6%	28%	11%	92%	8%
6	> 100%	> 100%	> 100%	12%	> 100%	22%	> 100%	32%
7	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%
8	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%

So far, we have assumed that only (up to) 50% of the investment (where possible) may be saved due to the already used ducts and the sooner reinvestment required. We now run an additional sensitivity assuming a full duct lifetime of existing infrastructure. The resulting investment reductions are shown in Table 3-19. For all network segments we now consider twice as much savings as in the standard brownfield scenario. This means that in case of GPON and WDM PON the incumbent can even save the entire duct infrastructure investment in feeder and backhaul segment as all fibres fit into already existing ducts.

Table 3-19: Investment reduction for duct infrastructure per network segment in a Brownfield approach when considering full duct lifetime

Network Segment	P2P	GPON over P2P	GPON	WDM PON
Backhaul	--	--	--	100%
Feeder	20%	20%	100%	100%
Drop	50%	50%	50%	50%

Such drastic savings result in lower critical market shares for both incumbent (Table 3-20) and competitor (Table 3-21). The strongest impact occurs for GPON and WDM PON due to the higher reduction in feeder and backhaul (relevant only for WDM PON) segment. Nevertheless, the incumbent is not able to expand his profitable coverage compared to the previous calculation as the limit of profitable roll-out remains in the Less Suburban Cluster 6 for all architectures. This also holds for the competition scenarios except for the fibre unbundler, who can expand his viability one cluster further.

Table 3-20: Impact of assuming full duct lifetime on incumbent's Brownfield viability

Cluster ID	P2P - Brownfield	P2P - Brownfield sensitivity	GPON over P2P - Brownfield	GPON over P2P - Brownfield sensitivity	GPON - Brownfield	GPON - Brownfield sensitivity	WDM PON - Brownfield	WDM PON - Brownfield sensitivity
1	25%	22%	23%	20%	23%	19%	22%	18%
2	34%	28%	32%	25%	31%	24%	31%	24%
3	45%	36%	41%	33%	40%	31%	41%	31%
4	45%	38%	41%	35%	40%	32%	41%	32%
5	60%	52%	55%	48%	52%	43%	54%	45%
6	68%	61%	63%	56%	59%	49%	62%	51%
7	> 100%	96%	95%	88%	86%	74%	89%	76%
8	> 100%	>100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%

Table 3-21: Impact of assuming full duct lifetime on competitor's Brownfield viability

Cluster ID	LLU - brownfield	LLU - brownfield sensitivity	Bitstream Core - brownfield	Bitstream Core - brownfield sensitivity	Bitstream MPoP - brownfield	Bitstream MPoP - brownfield sensitivity	WDM unbundling - brownfield	WDM unbundling - brownfield sensitivity
1	8%	8%	3%	3%	6%	5%	4%	3%
2	8%	6%	2%	2%	4%	4%	3%	2%
3	12%	8%	3%	2%	6%	4%	4%	3%
4	15%	11%	4%	3%	7%	5%	4%	3%
5	> 100%	25%	6%	4%	11%	7%	8%	4%
6	> 100%	> 100%	12%	5%	22%	9%	32%	6%
7	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%
8	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%

Lower NGA penetration

Even though a 70% maximum take-up on a next generation fibre-based fixed network that has replaced copper appears realistic to us we have conducted a sensitivity analysis for which we assume a maximum take-up of only 60%. On the modelling side the only changes for the incumbent are that he will plan his MPoP floorspace for 60% instead of 70% take-up. This reduction of floorspace cost, however, does not have impacts on his critical market shares in any of the clusters. Accordingly, one can simply analyse Table 3-6 to Table 3-9 and draw the limit of viable roll-out at 60% for the incumbent. This reduces the viable reach by one cluster for all architectures except for GPON over P2P where the incumbent loses 2 clusters.

Since the wholesale price was determined on the basis of the maximum take-up rate, the impact on the competitor cases is much more significant as they have to cope with an increase of the wholesale price. Not only do competitors lose viable coverage for one cluster in bitstream cases and two clusters in the fibre LLU case, they also experience significant increases in critical market shares in some clusters that remain viable. Only in case of WDM unbundling the limit of profitable roll-out remains the same as in the base case, the critical market share, however, increases from 6% to 13% in the last profitable cluster.

Table 3-22: Competitors' critical market shares (70% vs. 60% incumbent maximum take-up)

Cluster ID	LLU - 70% incumbent max take-up	LLU - 60% max incumbent take-up	Bitstream Core - 70% incumbent max take-up	Bitstream Core - 60% incumbent max take-up	Bitstream MPoP -70% incumbent max take-up	Bitstream MPoP - 60% incumbent max take-up	WDM unbundling - 70% incumbent max take-up	WDM unbundling - 60% incumbent max take-up
1	9%	10%	4%	4%	6%	7%	4%	4%
2	10%	15%	3%	4%	5%	7%	3%	4%
3	24%	> 100%	4%	8%	8%	14%	6%	12%
4	25%	> 100%	5%	9%	10%	16%	6%	13%
5	> 100%	> 100%	16%	> 100%	28%	> 100%	92%	> 100%
6	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%
7	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%
8	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%

Table 3-23 shows the impact of setting 60% take-up as a maximum penetration level on wholesale prices. There is a similar increase of the prices in the range between 9% and 13% for all architectures. However, the overall effect on profitability differs between the competition scenarios due to the different shape of their cost curves.

Table 3-23: Impact of setting 60% take-up as target on wholesale prices (increase in %)

Cluster Type	P2P LLU	GPON Bitstream MPoP	GPON Bitstream Core	WDM PON Unbundling
Dense urban	9%	10%	10%	9%
Urban	11%	11%	11%	11%
Less Urban	12%	12%	12%	12%
Dense Suburban	12%	12%	12%	12%
Suburban	13%	13%	13%	13%
Less Suburban	13%	13%	13%	13%

Wholesale price increase

Our wholesale pricing has been determined endogenously as LRIC of the incumbent's cost at the maximum market share we have deemed reasonable to achieve. However, there can be different reasons why the wholesale price for the market will be higher than the "true" LRIC, such as risk premiums or asymmetric availability of information that prevent the regulatory authority from determining the real LRIC. A sensitivity was run that incorporates a 10% wholesale price mark-up to determine the impact on the business case of access seekers. Due to the flat cost curves of the wholesale scenarios and the dominant share of the access charge in the total cost of the access seeker a 10% wholesale price increase has a strong impact on viability. This holds especially true for the fibre unbundling case where again viable reach is reduced to the first two clusters.

Table 3-24: Impact of wholesale price increase on the critical market shares of access seekers

Cluster ID	Competitor (LLU)	Sensitivity LLU 10% mark-up	Competitor Bitstream Core	Sensitivity Bitstream 10% mark-up	Competitor Bitstream MPoP	Sensitivity Bitstream 10% mark-up	Competitor WDM PON unbundling	Sensitivity WDM un-bundling 10% mark-up
1	9%	10%	4%	4%	6%	7%	4%	4%
2	10%	14%	3%	4%	5%	6%	3%	4%
3	24%	> 100%	4%	7%	8%	12%	6%	10%
4	25%	73%	5%	8%	10%	14%	6%	11%
5	> 100%	> 100%	16%	> 100%	28%	> 100%	92%	> 100%
6	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%
7	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%
8	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%	> 100%

CPE price sensitivity

As shown in section 3.2.2.2, CPE cost has a significant impact on total cost especially when deploying WDM PON (16% cost share) due to the higher equipment prices assumed. The base case in our models assumes that the WDM PON CPE is 50% more expensive than the GPON CPE, due to the more complex optical electronics. Given the current uncertainty about future CPE cost trends we have conducted a sensitivity analysis in which we assume three possible CPE price scenarios for the WDM architecture depending on the price of a GPON CPE: WDM CPE price two times higher than GPON CPE price, at GPON price level and lower than GPON price (75% of GPON CPE).

Table 3-25 analyses the impact of a CPE price variation on the incumbent's viability. Setting the price equal to GPON CPE price improves viability of WDM PON compared to all other architectures and along all clusters. This effect occurs stronger when setting the price below the GPON price level. An increase of the CPE price is as expected followed by an increase of the critical market shares, however, without having an impact on the number of profitable clusters. The influence of the three sensitivity scenarios on the competitor's viability is similar to the incumbent's case when looking at the critical market shares of the WDM unbundler (see Table 3-26). The competitor can expand his profitability by one cluster, if the price for CPE is set equal to or lower than the price for GPON CPE.

Table 3-25: Impact of WDM CPE price sensitivity on the critical market shares of incumbent

Cluster ID	WDM PON (base case, CPE price = 1.5*GPON price)	WDM PON (CPE price = 2*GPON price)	WDM PON (CPE price at GPON level)	WDM PON (CPE price = 0.75*GPON price)
1	25%	27%	23%	23%
2	39%	42%	36%	35%
3	50%	54%	46%	45%
4	49%	53%	46%	44%
5	63%	68%	59%	57%
6	72%	78%	67%	65%
7	> 100%	> 100%	94%	91%
8	> 100%	> 100%	> 100%	> 100%

Table 3-26: Impact of WDM CPE price sensitivity on the critical market shares of access seekers

Cluster ID	WDM unbundling (base case, CPE price = 1.5*GPON price)	WDM unbundling (CPE price = 2*GPON price)	WDM unbundling (CPE price at GPON level)	WDM unbundling (CPE price = 0.75*GPON price)
1	4%	5%	4%	3%
2	3%	4%	3%	3%
3	6%	9%	4%	4%
4	6%	10%	5%	4%
5	92%	> 100%	12%	9%
6	> 100%	> 100%	> 100%	> 100%
7	> 100%	> 100%	> 100%	> 100%
8	> 100%	> 100%	> 100%	> 100%

3.2.3 Investment and cost of different technologies – dynamic approach

Moving from a static to a dynamic approach, where the time path of investment according to a particular roll-out and the re-investment pattern is taken into consideration, has some impact on the relative investment and cost performance of the different architectures. We will first consider investment only and then analyse investment and cost.

3.2.3.1 Investment

In the dynamic analysis investments are spread over time depending on the timing of FTTH deployment in each cluster and the successive acquisition of customers. The main investment driver is the deployment of the outside FTTH plant from the user to the MPoP which defines the time of the investment peak. The total investment into passive and active network elements over the full 20-year period is shown in the following table. As in the static modelling GPON has the lowest and GPON over P2P the second lowest investments. Up to the third cluster WDM PON requires less investments than P2P, in clusters 4-6 P2P requires less invest. In the steady state WDM PON ranks second place in denser clusters. In the ramp-up WDM PON‘s total investment are higher due to CPE replacement invest (WDM CPE is most expensive).

Table 3-27: Undiscounted total investments over 20 years (mn Euro) and ranking (1 – lowest, 4 – highest)

Cluster ID	P2P	GPON over P2P	GPON	WDM PON
1	2,333 (4)	2,043 (2)	1,982 (1)	2,224 (3)
2	3,390 (4)	3,041 (2)	2,988 (1)	3,296 (3)
3	4,624 (4)	4,206 (2)	4,146 (1)	4,525 (3)
4	3,396 (3)	3,102 (2)	3,060 (1)	3,460 (4)
5	4,461 (3)	4,178 (2)	4,145 (1)	4,631 (4)
6	5,709 (3)	5,400 (2)	5,342 (1)	5,977 (4)
Total	23,914 (3)	21,970 (2)	21,661 (1)	24,113 (4)

The following figures (Figure 3-17 and Figure 3-18) show how undiscounted investments per year evolve for all architectures. Because the deployment path and subscriber acquisition is the same for all architectures the evolution of annual investments is also very similar for the four considered NGA architectures (examples shown for Cluster 1 and 6).

Figure 3-17: Annual investment – Cluster 1

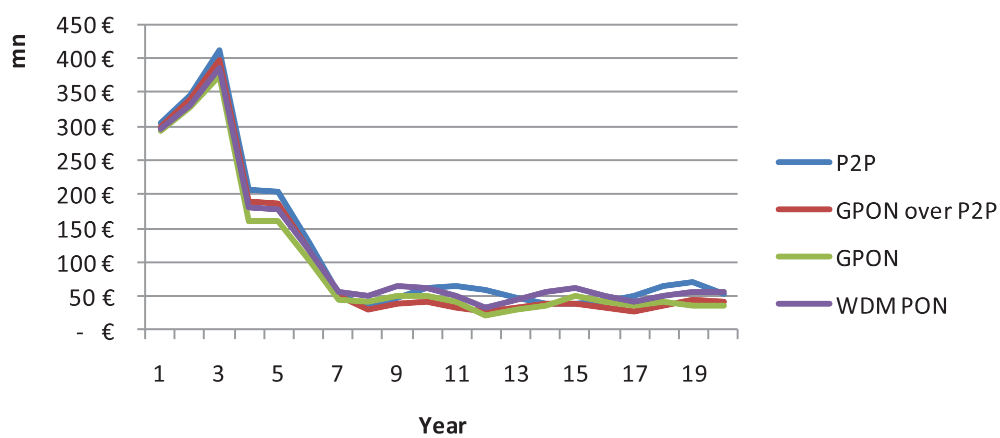
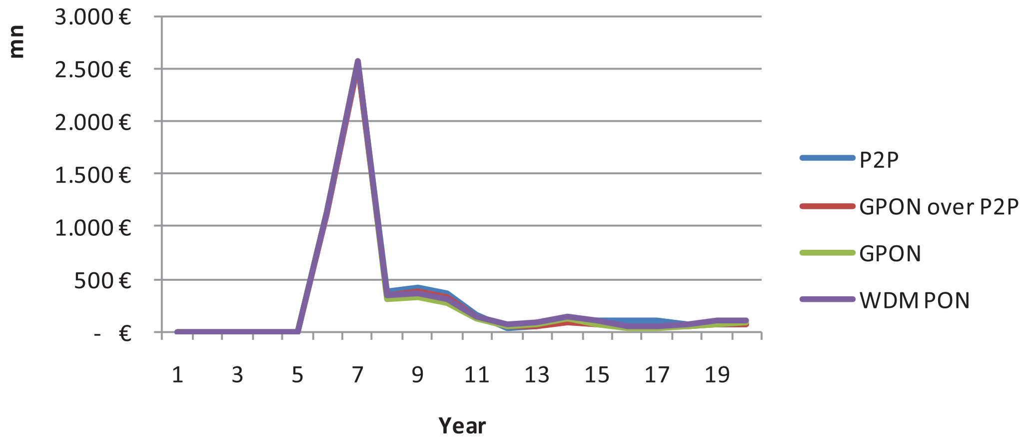


Figure 3-18: Annual investment – Cluster 6



Up to this point the effects of discounting future investments have not been considered. The following table shows the total investments at their present value (discounted at 10% p.a.). Discounting investments leads to an exchange of ranks for P2P and WDM PON.

Table 3-28: Discounted total investments over 20 years (mn Euro)

Cluster ID	P2P	GPON over P2P	GPON	WDM PON
1	1,427 (4)	1,317 (2)	1,257 (1)	1,354 (3)
2	2,138 (4)	2,009 (2)	1,961 (1)	2,086 (3)
3	2,936 (4)	2,784 (2)	2,739 (1)	2,892 (3)
4	1,970 (4)	1,867 (2)	1,843 (1)	1,923 (3)
5	2,290 (4)	2,197 (2)	2,164 (1)	2,238 (3)
6	2,652 (4)	2,556 (2)	2,531 (1)	2,611(3)
Total	13,414 (4)	12,729 (2)	12,496 (1)	13,104 (3)

Large parts of the total investment (inhouse and drop cabling account for over 70% of total investments) are actually the same for all architectures. In every case the majority of total investments is related to the network deployment in the early years. Therefore relative changes of cost differences occur if architectures are more or less “investment heavy” than GPON in the early years. This primarily depends on the share of investments directly tied to the network roll-out (happening earlier) as opposed to investments driven by subscriber acquisition (happening later). The following table provides an overview of network levels and their investment drivers.

Table 3-29: Investment relevance, driver and differences between architectures

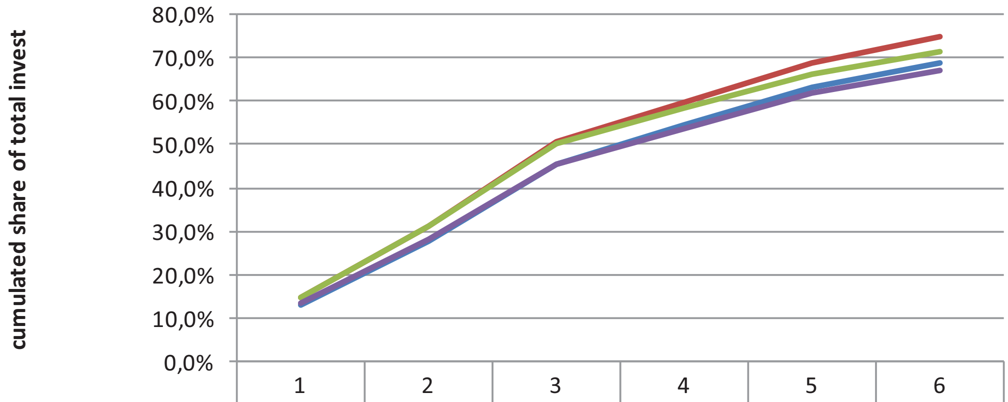
Network level	Relevance of total invest	Driver	Differences between architectures
Inhouse cabling	High (up to 36% of invest)	Subscriber	none
Drop cable	High (up to 60% of invest)	Homes passed	none
Distribution point	Low (less than 5%)	Homes passed	Only GPON and WDM PON
Feeder cable	Low in dense clusters (~5%), medium in less dense clusters (~13%)	Homes passed	Higher invest for P2P-topologies
MDF	Low	Homes passed	WDM PON only
Backhaul	Low-Medium (less than 10%)	Homes passed	WDM PON only
ODF	Low (less than 6%)	Homes passed (customer sided ports) Subscriber (network sided ports)	Higher invest for P2P-topologies
Active electronics at MPoP	Low-Medium (less than 10%)	Homes passed (GPON, WDM PON) Subscriber (P2P, GPON over P2P)	Higher for P2P

This explains why the time path of the investment differs to some extent between the architectures: Although most of the investment is front-loaded for all architectures, GPON has a smaller share of investment that is driven by the actual number of customers. While Ethernet ports in P2P are subscriber driven, GPON's investment in OLTs is not. The larger share of variable (customer driven) investment generates a slightly better risk profile for P2P compared to GPON.

WDM PON and GPON share the same passive network from the user's home to the former MDF location. WDM PON has a lower share of investments in the early years because even though OLTs for WDM PON are 5 times as expensive than GPON OLTs the high level of concentration means far less OLTs are required and overall the investment in OLTs is less than half that of GPON. Accordingly, even though the WDM OLT is an integral part of the early year roll-out driven investment, its investment share is lower than the GPON OLT equivalent. Because investment per CPE is 50% higher for WDM PON a higher part of the total investment is dependent on subscriber acquisition. The overall effect is a slightly lower share of investments for WDM in the early years.[65] Contrary to this the share of total investments for GPON over P2P in the first 6 years is slightly higher than GPON's (~74% Cluster 1). The reason lies in the additional investment into feeder and ODF ports which is completely driven by the network roll-out and not by subscriber acquisition and therefore occurs early.

65 Note that the reference in all cases is the share of total investments. We are not comparing absolute levels of investment, which – as we have shown earlier – are lowest for GPON.

Figure 3-19: Percentage of total investment during ramp-up (example Cluster 1)



	1	2	3	4	5	6
P2P	13,1%	27,9%	45,6%	54,4%	63,2%	68,7%
GPON over P2P	14,7%	31,3%	50,7%	59,9%	69,0%	74,7%
GPON	14,9%	31,3%	50,2%	58,4%	66,4%	71,5%
WDM PON	13,3%	28,3%	45,6%	53,7%	61,7%	66,9%

Year

To compare the impact of discounting investments we have computed the investment difference of the other technologies to GPON (which has the lowest investment level) and divided this by the investments into GPON. This was done for both discounted and undiscounted investments individually for each cluster and for the sum of clusters 1-6. Discounting future investment to a present value does not change the ranking between architectures. However, the relative differences to GPON decrease for P2P and WDM PON because they have a lower share of their total invest during ramp-up than GPON. Differences to GPON increase in case of GPON over P2P because it has a higher share of its total invest during ramp-up than GPON.

Table 3-30: Relative investment differences to GPON

Cluster	Sum of total invest P2P	P2P at present value	Sum of total invest GPON over P2P	GPON over P2P at present value	Sum of total invest WDM PON	WDM PON at present value
1	18%	14%	3%	5%	12%	8%
2	13%	9%	2%	2%	10%	6%
3	12%	10%	1%	2%	9%	8%
4	11%	7%	1%	1%	8%	4%
5	8%	6%	1%	1%	6%	3%
6	7%	5%	1%	1%	6%	3%
Total	10%	7%	1%	2%	8%	5%

When interpreting Table 3-30 one has to keep in mind that the roll-out is focused on the denser clusters first (Cluster 1 finished in year 3) and less dense clusters are finalised later (Cluster 6 fully covered in year 8).

3.2.3.2 Cost

The analysis now considers present values of investment, their associated OPEX and direct costs which are floorspace rental, energy, concentration and core network as well as retail costs ("total expenses"). We are hence looking at the expense side of the operator's cash flow. This once again does not change the overall ranking of architectures: GPON remains the lowest cost technology, GPON over P2P comes next[66] followed by WDM PON and P2P. The differences between technologies decrease when comparing total (discounted) expenses and investment.

Table 3-31: Ranking of architectures relative to lowest total expenses over 20 years at present value (1: lowest expenses, 4: highest expenses)

Cluster	P2P expenses at present value	GPON over P2P expenses at present value	GPON expenses at present value	WDM PON expenses at present value
1	4	3	1	2
2	4	2	1	3
3	4	2	1	3
4	4	2	1	3
5	4	2	1	3
6	4	2	1	3
Total	4	2	1	3

The following table shows details for the total cost over clusters 1-6 at present value.

66 Exception: In the dense urban cluster WDM PON ranks second.

Table 3-32: Present value of invest and cost over 20 years – Cluster 1-6

Invest + OPEX + Common Cost at present value	**P2P expenses at present value**		**GPON over P2P expenses at present value**		**GPON expenses at present value**		**WDM PON expenses at present value**	
CPE	1,926,728,564 €	8%	2,215,737,848 €	10%	2,215,737,848 €	10%	3,323,606,773 €	15%
Inhouse cabling	2,947,101,520 €	13%	2,947,101,520 €	13%	2,947,101,520 €	14%	2,947,101,520 €	13%
Passive network up to ODF (incl. floorspace invest for active equipment)	11,102,838,544 €	48%	11,102,257,961 €	51%	11,041,790,729 €	51%	11,108,317,322 €	50%
Network sided ODF port + patch cabling + splitter for GPON over P2P	289,102,242 €	1%	492,454,531 €	2%	9,188,345 €	0%	762,996 €	0%
P2P Ethernet ports	1,951,903,720 €	8%	0 €	0%	0 €	0%	0 €	0%
PON OLT & PON Ethernet ports	0 €	0%	316,036,416 €	1%	647,543,196 €	3%	335,038,558 €	2%
Direct Cost + Common Cost at present value								
MPoP energy	105,818,479 €	0%	26,687,866 €	0%	60,211,705 €	0%	18,755,358 €	0%
Floorspace rental	124,140,573 €	1%	122,949,414 €	1%	52,330,097 €	0%	1,388,713 €	0%
Concentration/backhaul network	381,658,132 €	2%	381,658,132 €	2%	381,658,132 €	2%	168,239,087 €	1%
Core network	1,190,313,113 €	5%	1,190,313,113 €	5%	1,190,313,113 €	5%	1,194,003,373 €	5%
Retail	3,112,308,200 €	13%	3,112,308,200 €	14%	3,112,308,200 €	14%	3,112,308,200 €	14%
TOTAL EXPENSES	**23,131,913,086 €**	**100%**	**21,907,505,000 €**	**100%**	**21,658,182,884 €**	**100%**	**22,209,521,899 €**	**100%**

There are significant differences between architectures regarding energy and floor-space rental: P2P has 2 times higher energy cost than GPON and nearly 6 times higher costs than WDM PON. P2P also has about 2.5 times higher floorspace rental cost than GPON and about 90 times more than WDM PON. However, the weight of these elements is negligible (not more than 1%) in the overall cost comparison. On the other hand, retail and core network cost which account for close to 20% of the total expenses are identical for all architectures. This explains why the differences between architectures decrease significantly compared to the pure investment analysis.

We have applied the same methodology to analyse the differences between architectures that was used in the previous section on investment (total expense difference of e.g. P2P to GPON divided by the total expenses of GPON). Results are shown in the following table.

Table 3-33: Cost difference to GPON: Total expenses (invest and OPEX, direct and common costs) at undiscounted and present value

Cluster ID	P2P sum of expenses	P2P expenses at present value	GPON over P2P sum of expenses	GPON over P2P expenses at present value	WDM PON sum of expenses	WDM PON expenses at present value
1	12%	11%	2%	3%	3%	2%
2	10%	8%	1%	2%	4%	3%
3	9%	7%	1%	1%	3%	3%
4	8%	6%	1%	1%	4%	3%
5	7%	6%	1%	1%	3%	2%
6	6%	5%	1%	1%	3%	2%
Total	8%	7%	1%	1%	3%	3%

The direction of the impact of discounting total expenses generally remains the same as in the sole analysis of investments. The spread between GPON and P2P or WDM PON decreases. The spread between GPON and GPON over P2P increases. Again, we find it especially interesting that GPON over P2P remains only slightly more expensive than GPON. In relative terms, the difference measured in present value of discounted expenses between GPON and GPON over P2P becomes negligible (~1%); P2P generates ~7% more expenses (Cluster 1 to 6), than GPON; WDM PON 3% higher expenses.

3.2.3.3 WDM PON sensitivity: Revenues from sale of MDF locations

The incumbent might realise windfall profits when selling former MDF locations. Such windfall profits are not part of the decision relevant costs of a certain architecture. They have, however, to be taken into account in the decision making process of the investor. This is of particular relevance, if such windfall profits are different among architectures.

Windfall profits can conceptually consistently be integrated into our dynamic discounted cash flow analysis. They simply diminish the discounted total expenses of a particular architecture. In this model MDF dismantling only occurs in the case of WDM PON. We have assumed that the sales revenue per MDF location is higher in the denser cluster than in the less dense clusters. One-time profits are realised after the former copper network is switched off. We have assumed that this will occur one year after the maximum penetration in a cluster is reached to reflect a certain delay, e.g. to ease the transition for competitors. Given our deployment path this means that the incumbent realises these net revenues in year 8 (Cluster 1) earliest and in year 12 (Cluster 6) latest. The following table shows the net revenues per MDF, per cluster and discounted net revenues per cluster.

Table 3-34: Sales from MDF dismantling

Cluster	net revenue per dismantled MDF (mn)	Dismantled MDFs	Net revenue from MDF dismantling per cluster (mn)	Discounted net revenue per cluster (mn)
1	2.0 €	65	130.0 €	60.6 €
2	1.0 €	163	163.0 €	69.1 €
3	0.5 €	246	123.0 €	52.2 €
4	0.4 €	276	110.4 €	42.6 €
5	0.3 €	298	89.4 €	28.5 €
6	0.2 €	411	82.2 €	26.2 €
Total			698.0 €	279.2 €

We have subtracted the discounted net revenues from the present value of WDM PON total expenses, working under the assumption that these revenues can fully be used to improve the WDM PON business case. When comparing this modified present value of total expenses WDM PON actually ranks first place with lowest discounted expenses in Cluster 1, so it actually becomes cheaper than GPON. WDM PON also overtakes GPON over P2P in Cluster 2 and ranks second after GPON. In all other clusters WDM PON remains in third place but the difference to GPON decreases.

Table 3-35: Comparison of discounted total expenses (mn Euro)

Cluster	P2P expenses at present value	GPON over P2P expenses at present value	GPON expenses at present value	WDM PON expenses at present value	WDM PON expenses at present value reduced by present value of MDF sales revenue, (ranking)
1	2,735 €	2,539 €	2,469 €	2,520 €	2,459 € (1)
2	3,735 €	3,504 €	3,452 €	3,553 €	3,484 € (2)
3	4,988 €	4,717 €	4,672 €	4,795 €	4,743 € (3)
4	3,426 €	3,242 €	3,218 €	3,312 €	3,269 € (3)
5	3,859 €	3,689 €	3,655 €	3,745 €	3,717 € (3)
6	4,390 €	4,216 €	4,192 €	4,285 €	4,258 € (3)
Total	23,132 €	21,908 €	21,658 €	22,210 €	21,930 € (3)

This is not only because dismantling revenues are higher in the denser clusters and discounted less because they occur earlier. Considering the spread between GPON and WDM PON the undiscounted MDF revenue potential only suffices to close the gap in clusters 1-3. In clusters 4-6 the gap between GPON and WDM PON total expenses at present value is higher than the undiscounted sales revenues from MDF dismantling. Therefore WDM PON cannot take the first place even when considering MDF sales revenues and also does not gain enough to overtake GPON over P2P even though the spread is reduced.

3.2.4 Summary of cost modelling results

3.2.4.1 Profitable coverage, investment, cost and competition in the steady state analysis

If we assume that the fixed network can reach a market share of up to 70% of the total potentially addressable market (access lines), an incumbent operator can profitably cover a significant part of Euroland with FTTH (about 50% of the population could be covered with P2P or WDM PON, about 64% could be covered with GPON over P2P and GPON).

Theoretically, a FTTH infrastructure can be replicated by a second investor only in the Dense Urban Cluster 1 or for about 8% of the population. In all other viable areas the FTTH investor needs a critical market share of close to or above 50% to become profitable which makes replicability impossible.

In the relevant clusters 1-6 the cost comparison of our four architectures has shown the following results: GPON is the cheapest technology, followed by GPON over P2P, WDM PON and P2P. With the exception of Cluster 1 where WDM PON and GPON over P2P switch ranks, this is consistent over the relevant clusters.

Lower investment requirements in a Brownfield approach enable incumbents to increase the profitable coverage with P2P and WDM PON up to the Less Suburban Cluster 6. Utilizing existing duct infrastructure benefits the two point-to-multipoint architectures GPON and WDM PON most, because they have fewer fibres in the feeder and backhaul segments and hence a higher chance of avoiding civil works. The investment savings by segment are as follows:

- The effective reduction in the drop segment ranges from 7% to 20% depending on the cluster, and is the same for all architectures, since the architectures do not differ in this segment.
- In the feeder segment, the savings for P2P are around 7% and for GPON around 40%.
- The savings in the backhaul segment amount to around 40% for WDM PON.

The segment specific savings in investment translate to overall cost savings of 5% (Cluster 1) to 11% (Cluster 8) for the WDM PON architecture which benefits most. Cost savings for GPON are higher than for P2P but lower than for WDM PON, and range from 5% (Cluster 1) to 9% (Cluster 4). The lowest cost savings occur with P2P from 4% (Cluster 1) to 7% (Cluster 3).

Should WDM PON vendors be able to reduce CPE prices to the level of GPON CPE the viability of WDM PON could be extended by one cluster to Cluster 6. In addition the critical market shares for viability could be reduced although not more than by 2-4%-points.

Competition cannot follow the incumbent in all areas of the FTTH roll-out. Independent of the network architecture and the access scenario considered, the viability of any competitive model ends at least one cluster less than the viability of the incumbent's roll-out. The critical market shares of the different scenarios indicate that in all architectures and competition scenarios potentially several competitors could survive in the market. The highest potential number of competitors may occur in the case of bitstream access and wavelength unbundling at the core.

As expected, business models on the basis of unbundling require (significantly) higher critical market shares than business models based on bitstream access. The unbundling model requires already a critical market share of 24% in Cluster 3, while bitstream access is viable at 4% to 8% critical market share in the same cluster.

Because the cost curve of competitors is relatively flat in the relevant range, only slight changes in the relevant parameters (e.g. ARPU) have a strong impact on the profitability. In case of unbundling, for instance, the critical market share jumps from 10% in Cluster 2 to 24% in Cluster 3. The structure of the cost curves in the relevant range makes unbundling a riskier business model than bitstream access.

If the wholesale prices also reflect the investment savings of the incumbent (Brownfield case) costs and critical market shares of competitors decrease in all competition scenarios. In addition, they can also expand competitive coverage by one cluster with the exception of the LLU scenarios.

We have calculated the impact of deviations from LRIC based wholesale prices on the structural conditions of competition. Under the assumption of fixed ARPUs even a moderate increase of the wholesale prices by 10% reduces the viability of competition and the competitive coverage in most cases. The most significant impacts occur in the LLU unbundling scenarios. Critical market shares of competitors in all scenarios increase significantly.

3.2.4.2 Impact of the ramp-up on costs and technology ranking

Taking a particular roll-out and the re-investment pattern into account, the relative performance of the architectures is somewhat impacted because of different time paths of investment. Although most of the investment is front-loaded for all architectures, a lower part of the GPON investment is driven by the actual number of subscribers. While Ethernet ports in P2P are subscriber driven, GPON's investment in OLTs is not. The larger share of variable (subscriber driven) investment generates a slightly better risk profile for P2P compared to GPON.

However, the overall relative performance only changes moderately: GPON remains the lowest cost technology, GPON over P2P comes next followed by WDM PON and P2P. The differences between technologies, however, decrease if comparing total (discounted) expenses and investment. In relative terms, the difference in terms of present value of discounted expenses (Cluster 1 to 6) between GPON and GPON over P2P become negligible (~1%); P2P generates ~7% more expenses than GPON and WDM PON ~3% more.

As in the static modelling single cost items like energy and floor space exhibit significant differences among architectures. P2P causes nearly double as much energy cost at the MPoP as GPON and nearly 6 times higher energy costs than WDM PON (in terms of present value). P2P has more than 2.5 times higher floor space costs than GPON and even nearly 90 times more than WDM PON. These huge differences, however, have only a very limited impact on the overall cost performance of architectures because the cost share of each of these factors is not more than 1%.

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Annex 1: Key parameters of cost modelling

Civil engineering parameters

In our model we consider duct and aerial deployment as possible deployment forms (no direct buried lines were assumed). Duct construction cost are highest in the dense populated areas and amount to 100 € per m in Cluster 1, while decreasing to 60 € per m in the last two clusters. Contrarily, aerial deployment costs are assumed to be equal for all clusters (15 € per m), however, aerial cabling is not used in the two densest clusters but is deployed to a larger degree in the rural clusters (up to 60%). Aerial deployment is only relevant for the drop segment, in the feeder and backhaul segment all cables are deployed in ducts.

Furthermore, we assume an invest of 548 € per distribution sleeve and 860 € per manhole along all clusters and segments.

Port prices

Based on discussions with equipment vendors and on WIK's modelling experience we have defined port prices for the active equipment installed at the MPoP. The following table provides an overview of the prices assumed.

Table A-1: Port prices for active equipment

	1 Gbps Ethernet port	10 Gbps Ethernet port	Standard OLT port	WDM OLT port
Invest per port	120 €	2.000 €	1.000 €	5.000 €

ODF

The fibres coming from the outside plant are terminated on the customer sided ports of an ODF in the MPoP and are accessible per patch cables. We assume a price of 23 € per ODF port and 11 € per patch cable.

In case of fibre unbundling the competitor places an additional ODF of his own at rented collocation space in the MPoP where he operates his own Ethernet Switch. The competitor's ODF is connected via connection cable to dedicated customer sided ports of the incumbent's main ODF. Therefore, we assume a higher price for the competitor's ODF port (46 €).

Energy consumption

We have assumed average energy consumption on a per port per month basis. Energy consumption per port is higher for WDM PON than for GPON OLTs and higher for

10Gbps Ethernet ports than for 1Gbps ports. The price per kWh of energy is set to 0.16 €. The energy consumption and the resulting cost for the different active equipment items are shown in Table A-2. We have not considered the energy consumption of CPEs because the subscribers bear energy cost themselves.

Table A-2: Energy consumption and cost

	1 Gbps Ethernet port	10 Gbps Ethernet port	Standard OLT port	WDM OLT port
Energy consumption per month (kWh)	1.08	14.4	14.4	43.2
Energy cost per port per month (€)	0.17	2.30	2.30	6.91

CPE prices

The prices for equipment installed at customer's premises depend on the access architecture deployed. We have assumed a price of 100€ for the P2P router and 115€ for a GPON ONT. In our base case we assume that the WDM PON CPE is 50% more expensive (172.5 €) than the GPON CPE due to the more complex optical electronics required.

Annex 2: NGA technologies not considered

FTTN/VDSL

With FTTNode/VDSL (also FttCurb) the copper access lines are shortened and already terminate at the street cabinet as the feeder segment between MPoP/MDF and street cabinet is replaced by fibre. Because the remaining copper segment is shorter – it now only consists out of the drop cable segment sub-loop (Figure 2-2) -, higher bandwidths can be realised, e.g. with VDSL technology. The street cabinets need to be upgraded to host DSLAMs (energy, air condition etc.), which terminate the electrical copper signal and concentrate it in an Ethernet protocol over fibre up to the MPoP.

Since the distance between the DSLAM in the street cabinet and the Ethernet switch in the MPoP, the feeder cable segment, is no longer limited by copper transmission characteristics it may become longer than before. Accordingly, MDF locations could be closed down, or remain as a mere infrastructure node point because of the existing duct infrastructure, and be replaced as an active node by an MPoP further up in the network.

Because VDSL technology still bases on a copper sub-loop it is still dependent on copper loop length and line quality. The available bit rates of VDSL are very much dependent on the length of the copper line[67] and the advantages of VDSL regarding bandwidth over ADSL disappear at sub-loop distances of more than 500m. In addition the transmission characteristics of copper lines vary strongly and also depend on cross talk effects of neighbouring pairs. Compared to FTTH technologies performance of FTTN therefore is very heterogeneous and falls far behind the potentials of a full fibre based loop.[68]

We have excluded this architecture from our considerations due to its poorer performance compared to FTTH.

DOCSIS 3.0

Data Over Cable Service Interface Specification (DOCSIS) is the standard according to which data and voice signals are transmitted in parallel over the existing cable-TV networks. The up to date standard is DOCSIS 3.0, which allows for up to 400 Mbps down and 108 Mbps upstream capacity[69] in a shared channel. A group of customers is connected to an active fibre node by the existing coaxial cable distribution (access) net-

67 See Wulf (2007) or Williamson/Klein/Reynolds/Jones (2008).

68 VDSL technology reaches 40Mbps downstream and more over distances of up to 1km. For longer distances the bandwidth decreases significantly. Over short loops below e.g. 250m bandwidth might even realize up to 100Mbps. The upstream bandwidth is typically below half of the downstream bandwidth. Typical sub-loop lengths strongly depend on country specific copper access network design and may be longer than 1 km for a significant number of customers.

69 EuroDOCSIS 3.0 with all bundle options for up- and downstream channels, thus being the maximum capacity.

work. The fibre node is connected via fibre lines to a central Cable Modem Termination System (CMTS), where the voice/data signals will be separated from the TV-Signals (RF-TV). Using Figure 2-2 as a generic reference the coaxial cable is in the drop cable segment, the fibre node is located in the splitter and the CMTS is located in the MPoP. Thus the DP is the point where the transmission media changes from coaxial cable to fibre, and many customers are concentrated to that fibre. Communication is organized comparable to GPON by administering the communication and possible communication conflicts by the CMTS instead of the OLT. Bandwidth per end customer is determined by the number of end customers per fibre node. A typical relation of today is spread between 2000 and 70 end users per node. The maximum average bandwidth per end customer then can reach 5.7 Mbps maximum.

In many areas of Europe the coaxial cable-TV networks are an already existing communication infrastructure which can be or already is upgraded to bidirectional communication as alternative to the classical telecommunication networks. A natural migration path towards higher bandwidth is increasing the number of fibre nodes and moving them closer to the end customer, until they end in FTTB and FTTH solutions. This can be done in a smooth process of incremental steps for single network segments, not requiring large one time investments. This is an advantage of the already existing operators.

A new entrant will not invest in coaxial cable infrastructure, but would deploy a GPON FTTB/FTTH architecture with RF channel if he wants to come close to the cable-TV business models.

Since the bandwidth per end customer is a magnitude lower compared to the FTTH architectures we consider and because technology and business model will be migrated to GPON when infrastructure is upgraded for bandwidth increase, we did not include the DOCSIS 3.0. architecture in our analysis.

Active Ethernet

In Active Ethernet architectures a concentrating Ethernet switch is placed between the MPoP and the customer location, e.g. in a cabinet at the distribution point (Figure 2-2). The drop cable segment consists of dedicated fibres per home and the feeder segment needs only very few fibres, one per Ethernet switch at the DP. Similarly to FTTN/FTTC the intermediate location in the field (e.g. the distribution point) requires energy and air condition to host the active switch.

Typically this architecture allows one to offer 100 Mbps symmetrical traffic per end customer home, which will be overbooked at the first Ethernet switch, who manages the shared use of the feeder fibre. Compared to an Ethernet P2P solution this approach is less flexible to offer higher bandwidth for individual customers, because switches with all speed ports are more expensive and the smaller spaces at the DP do in most cases not allow for a second high speed switch at this location and anyhow such a switch would not scale very well. Thus Active Ethernet is based on a Point-to-Multipoint fibre plant with all the inflexibility for future use as already described above.

The primary advantage of this architecture is the savings on feeder fibre count and potentially MPoP floorspace due to ODF and switch port reduction. However, that is very likely more than outweighed by the cost of active distribution points (switches, cabinets, energy…). Since decentral switches also increase operation cost for service and maintenance, these architectures of the early FTTH roll-out are no longer implemented in new deployments – at least to our knowledge.

We have therefore excluded this architecture from this study due to its poorer performance compared to Ethernet P2P and its expected higher cost.

Multi-fibre deployment

Multiple-fibre architectures deploy more than a single fibre per home, e.g. four as in the Swisscom approach, in the drop cable segment and (optionally) in the feeder cable segment. This is a risk sharing strategy option that allows several co-investors to share the investment into NGA and obtain parallel access to the same end customer. Basic thinking behind this approach is that even if the total investment for multiple fibres in the drop segment is higher, sharing the invest reduces the investment per investor compared to a single fibre approach.

The investing operator connects at least one fibre per home to its ongoing feeder network up to the MPoP. The second to fourth operator each shares fibres in the drop cable segment to the end customer homes and in principle has the choice to connect these fibres to its own separately ducted feeder network (e.g. local power utility ducts) at the Distribution Point or to also share fibres in the feeder infrastructure up to the MPoP and collocate there.

The Multi-fibre approach in the drop cable segment still allows one to deploy a fibre Point-to-Point or fibre Point-to-Multipoint architecture for the customer access, depending on how many fibres the different investors deploy in the feeder segment. In Switzerland the typical architectures as far as we know are based on Point-to-Point fibre plants.

We have analysed the implications of multi-fibre deployment already in our 2009 studies for ECTA[70] and have assessed the advantages and disadvantages as a competitive approach in more detail in a study for the Swiss regulator BAKOM[71].

Including the Multi-fibre approach within this study would have complicated it and at least duplicated the amount of scenarios considered. But the general results of the stud-

70 See Ilic/Neumann/Plückebaum (2009).
71 See Ilic/Neumann/Plückebaum (2010).

ies mentioned can also be transferred, thus we exclude the Multi-fibre consideration here.

FTTB

In FTTB architectures the complete copper loop down to the basement of the end customer buildings is replaced with fibre but the inhouse cabling remains the already existing copper or coax-based infrastructure. Mini-DSLAMs or ONUs can serve as fibre termination nodes in the building basement. Each building therefore only requires one fibre in the generic FTTB architecture thus reducing the fibre count strongly not only in the feeder but also in the drop segment.

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

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

As we have taken a rather forward looking approach we have decided to only assess FTTH solutions, which exclude any copper cable complexities and product quality dependency.

EPON

There are a variety of standards that define the communication of active electronics on a Point-to-Multipoint FTTH fibre plant. However, of the many (TDM) PON systems proposed only GPON (Gigabit PON) and EPON (Ethernet PON) have been used for mass deployment. Some characteristics of GPON in comparison to EPON are shown in Table A-3. Due to the fixed time interval based administration procedures of bandwidth allocation in GPON it is better suited to support TDM connections to dedicated customers, thus allowing more end customer flexibility than EPON.

Concerning fibre count and characteristics of the use of Point-to-Multipoint vs. Point-to-Point fibre plants there is no difference between both technologies.

In this study we therefore have exclusively referred to the GPON standard because it is the dominant technology applied in Europe and the US. EPON as far as we can see has no relevance for future FTTH deployment in Europe.

Table A-3: Comparison of PON standards

	GPON	**EPON**
Standard	ITU-T G.984	Ethernet-First-Mile standard, IEEE 802.3ah
Deployed in	Europe, USA	Japan, Korea
Capacity	Up to 2.5Gbps down, up to 1.25 Gbps up	1.25Gbps symmetrical
Max splitting	1:64, in future 1:128	1:32
Protocols supported	Ethernet, TDM, ATM	Ethernet
Max reach	20km 60 km (in future)	20km more (in future)

Source: WIK-Consult

Annex 3: Results in the literature related to NGA

Insights from earlier work on telecommunications markets partly apply to an NGA context. A number of works on one-way access concern optimal access prices set by a regulator in a second-best sense (Ramsey pricing), i.e. respecting the participation constraints of the firms involved. Most of these works consider homogeneous services on the retail market. Other works modify the assumption that all services are homogeneous and postulate that there are two types of firms, the incumbent with market power and a set of firms who act as a competitive fringe, i.e which offer homogeneous services among themselves and thus do not possess market power. In such frameworks the literature has formulated rules according to which access should be granted for given retail prices. In particular, the "efficient component pricing rule" (ECPR) received a lot of attention. It says that entrants should pay access charges equal to the incumbent's direct costs of access plus the opportunity costs of profit contributions forgone by the incumbent in selling access rather than selling to end-users.[72] For optimality this approach requires entrants to have no market power downstream. The works on the ECPR are not directly relevant to our context since our aim is to consider various firms that can exert market power.

Quite a large literature exists on unbundled access (motivated by developments in the European context). We refer to Gual und Seabright (2000), a contribution that was made at the request of DGCOMP at the European Commission, and de Bijl and Peitz (2005) which provide overviews over relevant economic issues, in particular from the view point of a regulator. Unbundled access tries to strike a balance between the interests of the owner of the access network and other parties who seek access. In the absence of externalities privately negotiated solutions may implement the efficient solution. However, in the presence of externalities the owner of the access network may have an incentive to refuse access by third parties. Mandated access is then needed to allow for competition and to assure that inefficient bypass is avoided.

Few works allow for imperfect competition at the retail level, arguably a key feature in actual telecommunications markets. Some of these shall be briefly disscussed below. Laffont and Tirole (1994) investigate a Ramsey price setting that includes the access price in a market with an imperfectly competitive retail segment. Ramsey pricing leads to higher markup in market segments in which demand is rather inelastic. Armstrong and Vickers (1998) consider an imperfectly competitive and possibly asymmetric market in which one of the two firms is more efficient. They show that optimal regulation has an, at first sight, surprising feature: The one-way access price should be used such that the more efficient firm obtains an even larger market share than absent regulation. This is due to the fact that in the type of differentiated product models commonly analyzed, the unregulated market outcome features a larger market share of the *less efficient* firm than what is socially optimal.

72 For an elaborate discussion, see Armstrong (2002); see also Laffont and Tirole (2000) and Vogelsang (2003).

De Bijl und Peitz (2006) distinguish between two types of models, a “Hinterland” and a “No-Hinterland” model. In the No-Hinterland model total demand for subscription is fixed. This implies that all potential consumers are subscribers. A higher price level that leaves market shares unchanged amounts to a transfer of rents from consumers to firms, while total welfare remains constant. By contrast, in the Hinterland model some consumers are captive in the sense that they only consider subscribing to one particular network operator. However, these consumers are, as a group, sensitive to price changes: The higher the price charged by a network operator the more consumers who are captive to this operator decide to abstain from the market. In effect, total demand depends on prices, and a higher price level that leaves market shares unchanged is *not* welfare neutral. Here, such a higher price level leads to a deadweight loss.

De Bijl and Peitz show that allocative and welfare effects critically depend on the type of model. In particular, in the No-Hinterland model the access price is neutral to the allocation and to the equilibrium profit of the entrant. This implies that the entrant’s investment incentive are not affected by access regulation. This general neutrality result breaks down in their Hinterland model (which they develop in a duopoly context) because total demand is price elastic and thus higher access prices that leave the entrant’s mark-up as well as its market share in the competitive segment unchanged are not neutral to the entrant’s profit. In the No-Hinterland model an access regime that is more favorable to the incumbent simply shifts rents from consumers to the incumbent. From a static consumer welfare perspective regulating access prices at marginal costs is called for. However, from a dynamic perspective the regulator has to allow for rents on the incumbent’s side because otherwise the investment will not be undertaken.

While the neutrality result is interesting as a theoretical insight, it does not apply to markets in which some consumers stay with a non-NGA provider. Therefore, the de Bijl/Peitz No-Hinterland model is conceptually different from the No-Hinterland model developed below because we here allow for a separate cable operator as one of the market participants, with the effect that the neutrality result for NGA services does not hold in any of our models. In general, a less favorable access regime for the entrants will result in lower entrants’ profits, affecting the entrants’ investment incentives.

While existing work on one-way access can uncover some economic forces at play, they cannot be directly linked to real-world markets because they are too stylized. Two important aspects are missing: 1) flexibility with respect to the number and nature of market participants and 2) flexibility with respect to cost and demand characteristics reflecting the asymmetries between market players. We provide such a flexible approach which, furthermore, allows for a variety of alternative regulatory regimes.[73]

73 In a different context, Hoernig (2010) developed a model which shares with the present analysis the features that it allows for market asymmetries and a finite number of market players. However, this framework is not directly applicable because of different institutional features and the focus on two-way access prices.

With respect to investment incentives, it is important to recall the, in general, ambiguous link between the realized level of investments and the intensity of competition in the product market. This line of research has been initiated by Arrow (1962).[74] An important insight in this literature is that an incumbent firm which replaces an older technology may have weaker investment incentives than a newcomer because it replaces its existing profits from the old technology. This so-called replacement effect tends to lead to weaker investment incentives by an incumbent firm. However, in a context with entry, a sucessful entrant may largely destroy the incumbent's profits due to the superiority of its new technology. Because of this, the incumbent may have stronger incentives to invest than an entrant. While most works on telecommunications markets take the investment decisions as given, these works can be extended to include such considerations.[75] To evaluate investment incentives, one has to consider differential profits that are due to the investment under consideration. Results are rather straightforward if, as we assume for FTTH infrastructure, only one of the firms has the option to invest. In this case, when comparing profits resulting in the absence of the investment to those when the investment has been made, access regulation that leads to an increase in profits can be considered as regulation that stimulates investments. If more than one operator can invest, the exact nature of the investment game has to be specified. There are a number of formal theoretical investigations that explicitly consider such links between one-way access and investment incentives.

First, several works analyze the incumbent's incentives to increase the quality of its access network.[76] In particular, Foros (2004) is concerned with regulation as a means to achieve efficient investment and to avoid foreclosure of the firm seeking access. Second, Gans (2001), Gans and King (2004), Hori and Mizuno (2006, 2009), and Vareda und Hoernig (2010) analyze the incentives of two firms in an investment race to establish an access network. Third, Bourreau und Dogan (2005) analyze a dynamic model to investigate the entrant's incentives to invest in its own access network. Here, the incumbent strategically grants access to delay the investment by the entrant.

Our focus will be on market outcomes for given investments that are based on the cost-modelling results (see chapter 3). However, our approach will allow us to quantify the gains from certain investment decisions. Thus, it can also shed some light on investment incentives of the different market players. Furthermore, we can evaluate the effect of regulation on these gains from investment.

74 For a first introduction into this topic, see chapter 18 in Belleflamme und Peitz (2010).
75 For discussions and overviews see Valletti (2003), Guthrie (2006), and Cambini und Jiang (2009).
76 See Foros (2004), Kotakorpi (2006), Vareda (2009a, 2009b), Brito et al. (2008, 2010), Klumpp and Su (2009) and Nitsche and Wiethaus (2009).

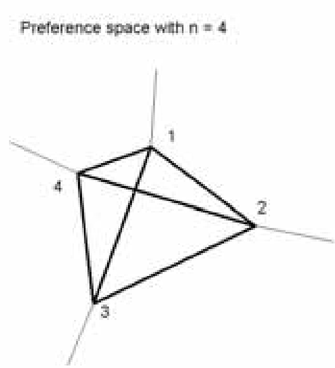
Annex 4: The competition models: Formal derivations

Hinterland model

Preference space

There are two consumer segments, N_c “Competitive" consumers who opt between pairs of networks, and N_e “captive" ones who either adhere to one network or do not subscribe. There are $n \geq 2$ networks, each at one of the n nodes of a complete graph of size N_c which describes competitive consumers' space of preferences over which they are uniformly distributed. The distance between two nodes is $l = 2N_c / n(n-1)$. All competitive consumers subscribe to some network. Horizontal differentiation is modelled in Hotelling fashion through a linear transport cost td, where $t > 0$ and d is the distance between the subscriber and his network. Higher t is interpreted as originating from more horizontal differentiation due to more varied offers by networks. Below we will let transport costs differ between pairs of networks, with $t_{ij} = t_{ji} > 0$.

Captive consumers are located on additional rays of size R_i, each emanating from the node of network i (This is the Hinterland model of elastic subscription demand generalized to multiple asymmetric backyards), with $\sum_{i=1}^{n} R_i = N_e$. In each Hinterland, some $y_i \leq R_i$ consumers will subscribe in equilibrium. On Hinterland i, consumers have a transport cost of $\tau_i d$, where d is the distance to network i.



Subscriber numbers

Individual subscriber numbers are $q_i \geq 0$ with market total $Q = \sum_{i=1}^{n} q_i$, and market shares are $s_i = q_i / Q$. Total penetration of the market is $\rho = Q / (N_c + N_e) \leq 1$. Subscribers of network i receive a gross utility of $w_i = S_i - f_i$, where S_i is the surplus from being connected to network i (a vertical differentiation parameter derived from quality and brand image), and f_i is the monthly subscription fee. The S_i must be large enough so that all competitive consumers subscribe, and their level also matters for adhesion of the captive segment.

We assume throughout that no competitive line ij is cornered by one of the networks, thus the indifferent consumer on line ij is located in its interior, at a distance x_{ij} from network i defined by

$$S_i - f_i - t_{ij}x_{ij} = S_j - f_j - t_{ij}(l - x_{ij}).$$

Solving for x_{ij} yields network i 's part of segment ij as

$$x_{ij} = \frac{l}{2} + \frac{1}{2t_{ij}}\left(S_i - f_i - S_j + f_j\right).$$

On the other hand, on each captive segment consumers at distance y from network i subscribe while $S_i - f_i - \tau_i y \geq 0$, i.e. we normalize the value of the outside option of captive consumers to zero. The indifferent elastic consumer is at

$$y_i = \frac{1}{\tau_i}\left(S_i - f_i\right).$$

Defining $\sigma_{ij} \equiv 1/2t_{ij} = \sigma_{ji}$, $\lambda_i = 1/\tau_i$ (with λ the corresponding ($n \times 1$)-vector and $\Lambda = diag(\lambda_i)$) and summing subscribers over segments yields network i 's subscriber number

$$q_i = \sum_{j \neq i} x_{ij} + y_i = \frac{N_c}{n} + \sum_{j \neq i} \sigma_{ij}\left(S_i - f_i - S_j + f_j\right) + \lambda_i\left(S_i - f_i\right).$$

With $\partial q_i / \partial f_i = -\left(\sum_{j \neq i} \sigma_{ij} + \lambda_i\right)$ and $\partial q_i / \partial f_j = \sigma_{ij}$, network i 's own- and cross-elasticities of demand are

$$\varepsilon_{ii} = -\frac{f_i}{q_i}\left(\sum_{j \neq i} \sigma_{ij} + \lambda_i\right), \varepsilon_{ij} = \frac{f_j}{q_i}\sigma_{ij}.$$

Let E be the $(n \times 1)$ vector of ones and $\boldsymbol{I}$ the $(n \times n)$ identity matrix. Let X be an $(n \times n)$ matrix with the values $X_{ii} = \sum_{j \neq i} \sigma_{ij} + \lambda_i$ and $X_{ij} = 0$ for $j \neq i$, and Y an $(n \times n)$ matrix with the values $Y_{ii} = \sum_{j \neq i} \sigma_{ij} + \lambda_i$ and $Y_{ij} = -\sigma_{ij}$ for $j \neq i$ ($E'Y = \lambda'$, $YE = \lambda$). Let S, f, q be the $(n \times 1)$ vectors of S_i , f_i , q_i . Then

$$q = \frac{N_c}{n} E + Y(S - f) = q_0 - Yf,$$

where q_0 is the vector of demands at zero subscription fees. Total demand is $Q(f) = E'q = N_c + \lambda'(S - f)$, with market demand elasticity (let $f = \bar{f}E$)

$$\eta = -\frac{\bar{f}\sum_{i=1}^{n}\lambda_i}{Q(\bar{f}E)}.$$

Consumer surplus is:

$$\begin{aligned} CS &= q'(S - f) + \sum_{i=1}^{n}\left(\sum_{j\neq i}\int_0^{x_{ij}} t_{ij} x dx + \int_0^{y_i} \tau_i y dy\right) \\ &= q'(S - f) + \sum_{i=1}^{n}\left(\sum_{j\neq i}\frac{x_{ij}^2}{4\sigma_{ij}} + \frac{y_i^2}{2\lambda_i}\right) \end{aligned}$$

Costs, access and profits

Networks have fixed retail cost K_i (which can include annualized backbone investment cost for entrants) and variable per subscription cost of $C_i(q) = c_i q + d_i q^2 / 2$ (where $d_i = 0$ with constant returns in the variable part). Let c be the $(n \times 1)$-vector of c_i and $D = diag(d_i)$. Wholesale cost of the infrastructure are a fixed cost K_0 and variable cost $C_0(q) = c_0 q$.

The infrastructure is owned by a subset of $m \leq n$ networks, and network i obtains a share $\gamma_i \geq 0$ of the access profits, $\sum_{i=1}^{n}\gamma_i = 1$, and let $\Gamma = diag(\{\gamma_i\})$. If there is a vertically integrated incumbent $i = 1$ then $m = 1$ and $\gamma_1 = 1$, $\gamma_i = 0$ for $i > 1$. Access is charged according to a two-part tariff $A + aq$, where $A = 0$ if the tariff is linear. All networks pay this access price to the infrastructure owner(s) (for the latter access payments and receipts for own customers cancel out). Network i 's profits are

$$\pi_i = (f_i - a)q_i - C_i(q_i) - K_i - A + \gamma_i[(a - c_0)Q(f) - K_0 + nA].$$

The first terms correspond to retail profits after access cost, while the bracket on the right captures the respective share of wholesale profits (which may be zero).

Total welfare then consists of

$$W = CS + \sum_{i=1}^{n}\pi_i.$$

Equilibrium fees

Noting that $\partial Q(f)/\partial f_i = -\lambda_i$ (i.e. each network's fee only affects total demand through its own Hinterland) each network's FOC for profit-maximization becomes

$$\frac{\partial \pi_i}{\partial f_i} = q_i - \left(\sum_{j\neq i}\sigma_{ij} + \lambda_i\right)(f_i - c_i - d_i q_i - a) - \gamma_i \lambda_i (a - c_0) = 0.$$

Necessary SOCs are

$$\frac{\partial^2 \pi_i}{\partial f_i^2} = -2\left(\sum_{j\neq i}\sigma_{ij} + \lambda_i\right) - d_i\left(\sum_{j\neq i}\sigma_{ij} + \lambda_i\right)^2 \leq 0,$$

which are satisfied as long as $d_i \geq -2/\left(\sum_{j\neq i}\sigma_{ij} + \lambda_i\right)$. Stacking the first-order conditions leads to:

$$q - X(f - c - Dq - aE) - (a - c_0)\Gamma\lambda = 0.$$

Solving for f leads to equilibrium fees

$$f^* = (X + Y + XDY)^{-1}\left[(I + XD)q_0 + X(c + aE) - (a - c_0)\Gamma\lambda\right].$$

With constant returns to scale ($D = 0$) we obtain

$$f^* = (X + Y)^{-1}\left[q_0 + X(c + aE) - (a - c_0)\Gamma\lambda\right].$$

The dependence of $X + Y$ on λ in the first bracket implies that having backyards leads to lower fees, as one should expect. The last term on the right-hand side translates the infrastructure owners' incentives to keep fees low and total demand high.

For the purpose of comparison with the traditional Hotelling model, consider also constant returns to scale and no backyards, i.e. $D = 0$ and $\lambda = 0$, together with $\sigma_{ij} \equiv \sigma$ for all $j \neq i$. Using that $\left[(2n-1)I - EE^T\right]^{-1} = \frac{1}{2n-1}\left(I + \frac{1}{n-1}EE^T\right)$, we find the equilibrium fees

$$f^* = \frac{N_c}{\sigma n(n-1)}E + c + aE + \frac{1}{2n-1}Y(S - c).$$

The terms in the latter expression are the following which we know from standard Hotelling models: 1. Returns due to local market power; 2. Individual marginal cost; 3. Costs common to all providers (here access cost); 4. Surcharges due to relative surplus (quality minus cost). It is known that with inelastic demand ($\Lambda = 0$) access charges just drive up the subscription fee, and so here they do.

Endogenizing the access charge

Since all firms in this model use access to the FTTH infrastructure, the LRIC access charge is

$$a = c_0 + K_0 / (E'q(a)),$$

where $q(a)$ is the vector of quantities as a function of the access charge a. We obtain the access demand function

$$\begin{aligned} E'q(a) &= E'q_0 - E'Yf^* \\ &= E'\left[q_0 - Y(X + Y + XDY)^{-1}((I + XD)q_0 + X(c + c_0 E))\right] \\ &\quad -\left[E'Y(X + Y + XDY)^{-1}(XE - \Gamma\lambda)\right](a - c_0) \\ &= b_0 - b_1(a - c_0), \end{aligned}$$

where $b_0 > 0$ is the equilibrium access quantity with access price equal to marginal cost, and $b_1 > 0$ indicates how access prices above marginal cost reduce access demand. Letting $\mu = a - c_0 > 0$ be the access margin, access revenue is $\mu(b_0 - b_1\mu)$, with maximum at $\tilde{\mu} = b_0 / 2b_1$. The condition defining the LRIC access charge is then

$$\mu(b_0 - b_1\mu) = K_0,$$

which, in the interval $[0, \tilde{\mu}]$, has the unique solution

$$\mu^* = \frac{b_0 - \sqrt{b_0^2 - 4b_1K_0}}{2b_1}.$$

No-Hinterland model

Consumers

There are N_c consumers who opt between pairs of firms (retailers). There are $n \geq 2$ firms, each at one of the n nodes of a complete graph of size N_c which describes competitive consumers' space of preferences over which they are uniformly distributed. The distance between two nodes is $l = 2N_c / n(n-1)$. All consumers subscribe to some firm. Horizontal differentiation is modelled in Hotelling fashion through a linear transport cost td, where $t > 0$ and d is the distance between the subscriber and his firm. Higher t is interpreted as originating from more horizontal differentiation due to more varied offers by firms or different technologies. Below we will let transport cost differ between pairs of firms, with $t_{ij} = t_{ji} > 0$.

Subscriber numbers

Individual subscriber numbers are $q_i \geq 0$ with market total $Q = \sum_{i=1}^{n} q_i$, and market shares are $s_i = q_i / Q$. Subscribers of firm i receive a gross utility of $w_i = S_i - f_i$, where S_i is the surplus from being connected to firm i (a vertical differentiation parameter derived from quality and brand image), and f_i is the monthly subscription fee. The S_i must be large enough so that all competitive consumers subscribe, and their level also matters for adhesion of the elastic segment.

We assume throughout that no competitive line ij is cornered by one of the firms, thus the indifferent consumer on line ij is located in its interior, at a distance x_{ij} from firm i defined by

$$S_i - f_i - t_{ij} x_{ij} = S_j - f_j - t_{ij}(l - x_{ij}).$$

Solving for x_{ij} yields firm i's part of segment ij as

$$x_{ij} = \frac{l}{2} + \frac{1}{2t_{ij}} \left(S_i - f_i - S_j + f_j \right).$$

Defining $\sigma_{ij} \equiv 1/2t_{ij} = \sigma_{ji}$ and summing subscribers over segments yields firm i's subscriber number

$$q_i = \sum_{j \neq i} x_{ij} = \frac{N_c}{n} + \sum_{j \neq i} \sigma_{ij} \left(S_i - f_i - S_j + f_j \right).$$

With $\partial q_i / \partial f_i = -\sum_{j \neq i} \sigma_{ij}$ and $\partial q_i / \partial f_j = \sigma_{ij}$, firm i's own- and cross-elasticities of demand are

$$\varepsilon_{ii} = -\frac{f_i}{q_i} \sum_{j \neq i} \sigma_{ij}, \varepsilon_{ij} = \frac{f_j}{q_i} \sigma_{ij}.$$

Let E be the $(n \times 1)$ vector of ones and I the $(n \times n)$ identity matrix. Let X be an $(n \times n)$ matrix with the values $X_{ii} = \sum_{j \neq i} \sigma_{ij}$ and $X_{ij} = 0$ for $j \neq i$, and Y an $(n \times n)$ matrix with the values $Y_{ii} = \sum_{j \neq i} \sigma_{ij}$ and $Y_{ij} = -\sigma_{ij}$ for $j \neq i$ ($E'Y = 0$, $YE = 0$). Let S, f, q be the $(n \times 1)$ vectors of S_i, f_i, q_i. Then

$$q = \frac{N_c}{n} E + Y(S - f) = q_0 - Yf,$$

where q_0 is the vector of demands at zero subscription fees. Total demand is $Q(f) = E'q = N_c$.

Consumer surplus is:

$$\begin{aligned} CS &= q'(S - f) + \sum_{i=1}^{n} \sum_{j \neq i} \int_0^{x_{ij}} t_{ij} x dx \\ &= q'(S - f) + \sum_{i=1}^{n} \sum_{j \neq i} \frac{x_{ij}^2}{4\sigma_{ij}} \end{aligned}$$

Costs, access and profits

Firms have fixed downstream cost K_i and variable per subscription cost of $C_i(q) = c_i q + d_i q^2 / 2$ (where $d_i = 0$ with constant returns in the variable part). Let c be the $(n \times 1)$-vector of c_i and $D = diag(\{d_i\})$. These downstream costs are assumed to contain any infrastructure-related cost not attributable to the wholesale FTTH infrastructure. Wholesale cost of the FTTH infrastructure are a fixed cost K_0 and variable cost $C_0(q) = c_0 q$.

The FTTH infrastructure is owned by a subset of $m \leq n$ firms, and firm i obtains a share $\gamma_i \geq 0$ of the access profits, $\sum_{i=1}^{n} \gamma_i = 1$, with $\Gamma = diag(\{\gamma_i\})$. If there is a vertically integrated incumbent $i = 1$ then $m = 1$ and $\gamma_1 = 1$, $\gamma_i = 0$ for $i > 1$. Access is charged according to a two-part tariff $A + aq$, where $A = 0$ if the tariff is linear. Let

$\delta_i = 1$ for any firm that uses the FTTH infrastructure, and $\delta_i = 0$ for any firm that does not (e.g. cable operators), with δ the vector of the δ_i. If $\delta_i = 1$ then firm i pays for access price to the infrastructure owner(s) (for the latter access payments and receipts for own customers cancel out). Network i 's profits are

$$\pi_i = (f_i - a\delta_i)q_i - C_i(q_i) - K_i - A\delta_i + \gamma_i\left[\delta'((a - c_0)q + AE) - K_0\right].$$

The first terms correspond to retail profits after access payments, while the bracket on the right captures the respective share of wholesale profits (which may be zero).

Total welfare is the sum of consumer surplus and profits:

$$W = CS + \sum_{i=1}^{n} \pi_i.$$

Equilibrium fees

We have

$$\frac{\partial(\delta' q)}{\partial f_i} = \sum_{j=1}^{n} \delta_j \frac{\partial q_j}{\partial f_i} = -\delta_i \sum_{j \neq i} \sigma_{ij} + \sum_{j \neq i} \delta_j \sigma_{ji}.$$

Each firm's FOC for profit-maximization becomes

$$\frac{\partial \pi_i}{\partial f_i} = q_i - (f_i - c_i - d_i q_i - a\delta_i)\sum_{j \neq i} \sigma_{ij} - (a - c_0)\gamma_i \left(\delta_i \sum_{j \neq i} \sigma_{ij} - \sum_{j \neq i} \delta_j \sigma_{ij} \right) = 0.$$

Necessary SOCs are

$$\frac{\partial^2 \pi_i}{\partial f_i^2} = -2\sum_{j \neq i} \sigma_{ij} - d_i \left(\sum_{j \neq i} \sigma_{ij} \right)^2 \leq 0,$$

which are satisfied as long as $d_i \geq -2 / \sum_{j \neq i} \sigma_{ij}$. Stacking the first-order conditions leads to:

$$q - X(f - c - Dq - a\delta) - (a - c_0)\Gamma Y \delta = 0.$$

Solving for f leads to equilibrium fees

$$f^* = (X + Y + XDY)^{-1}\left[(I + XD)q_0 + X(c + a\delta) - (a - c_0)\Gamma Y \delta\right].$$

With constant returns to scale ($D = 0$) we obtain

$$f^{*} = (X + Y)^{-1}[q_0 + X(c + a\delta) - (a - c_0)\Gamma Y\delta].$$

The last term on the right-hand side translates the infrastructure owners' incentives to keep fees low and demand of retail services based on their infrastructure high.

Endogenizing the access charge

Assuming that firm 2 is a cable company that does not use access to the FTTH infrastructure, we have $\delta = E - e_2$, and the LRIC access charge is

$$a = c_0 + K_0 / (N - q_2(a)) = c_0 + K_0 / (\delta' q(a)),$$

where $q(a)$ is the vector of quantities as a function of the access charge a . We obtain the access demand function

$$\begin{aligned}
\delta' q(a) &= \delta' q_0 - \delta' Y f^{*} \\
&= \delta'\left[q_0 - Y(X + Y + XDY)^{-1}\left((I + XD)q_0 + X(c + c_0\delta)\right)\right] \\
&\quad -\left[\delta' Y(X + Y + XDY)^{-1}(X - \Gamma Y)\delta\right](a - c_0) \\
&= b_0 - b_1(a - c_0),
\end{aligned}$$

where $b_0 > 0$ is the equilibrium access quantity with access price equal to marginal cost, and $b_1 > 0$ indicates how access prices above marginal cost reduce access demand. Letting $\mu = a - c_0 > 0$ be the access margin, access revenue is $\mu(b_0 - b_1\mu)$, with maximum at $\tilde{\mu} = b_0 / 2b_1$. The condition defining the LRIC access charge is then

$$\mu(b_0 - b_1\mu) = K_0,$$

which, in the interval $[0, \tilde{\mu}]$, has the unique solution

$$\mu^{*} = \frac{b_0 - \sqrt{b_0^2 - 4b_1K_0}}{2b_1}.$$

Access network costing

A REPORT PREPARED FOR VODAFONE GROUP

June 2011

Access network costing

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Tables & Figures

1 Introduction and summary

The roll out of next generation access (NGA) networks in Europe and internationally has re-ignited interest in the issue of the appropriate approach to the costing of fixed access networks for regulatory purposes. In this context, Vodafone asked Frontier Economics and Sir Ian Byatt, to consider the appropriate approach to the costing of the underlying network access elements, taking into account experience not only from the communications industry, but also other industries that have been subject to access regulation.

The largest element of the cost of access to fixed access networks relates to network assets and is an area where there is the greatest scope for differences in allowable revenues[1] under a price control in a given period, depending on the approach adopted as decisions need to be made about the timing as well as the level of cost recovery. In contrast operational expenditure can be directly included in allowable revenues in the year it is incurred. In this report, we consider both the economic case for different approaches as well as the practical implications.

We find that different elements of the network equipment required to offer fixed access services, each have sufficiently different characteristics to justify a different costing approach. Such an approach is consistent with the EU NGA Recommendation[2] which provides for the costing approach to vary between assets[3]. Our views in terms of the most appropriate cost based approach for each of the assets is summarised in the Figure below.

1 In this report we use the term 'allowable revenues' to refer to the cost oriented target level of revenues that a regulated company is allowed to earn under a price control. We make the distinction between 'allowable revenues' and 'cost' to emphasise that there is no single unique measure of cost.

2 COMMISSION RECOMMENDATION of 20 September 2010 on regulated access to Next Generation Access Networks (NGA)

3 Annex I of the NGA Recommendation provides that a consistent regulatory approach may "imply that NRAs use different cost bases for the calculation of cost-oriented prices for replicable and non-replicable assets, or at least adjust the parameters underpinning their cost methodologies in the latter case." Where there are relevant differences in the character of assets, those differences can and should be taken into account in the regulatory approach.

Figure S1: Summary of recommendations

	Duct	Copper	Fibre	Active equipment
Nature of assets	Long and unpredictable asset lives Single asset that needs to maintain in the long run	Predictable asset lives Discrete assets Assets largely sunk with little continuing investment	Unpredictable asset lives Discrete assets Network at beginning of lifecycle	Short, predictable asset lives Discrete assets High level of innovation and price reductions
Regulatory objectives	Provide certainty on cost recovery of future capex Maintain downstream prices at a low level	Ensure assets appropriately used Insulate downstream prices from copper price fluctuations	Provide certainty for investment Promote SFBB penetration	Provide correct build or buy signals for competitors Provide correct investment incentives for incumbent
Potential approach	Renewals accounting	HCA based valuation	Determine prices based on economic depreciation Create RAB by rolling forward value based on incurred capex less econ. depreciation	CCA based approaches Ensure allowable revenues reflect demand profile

Source: Frontier Economics

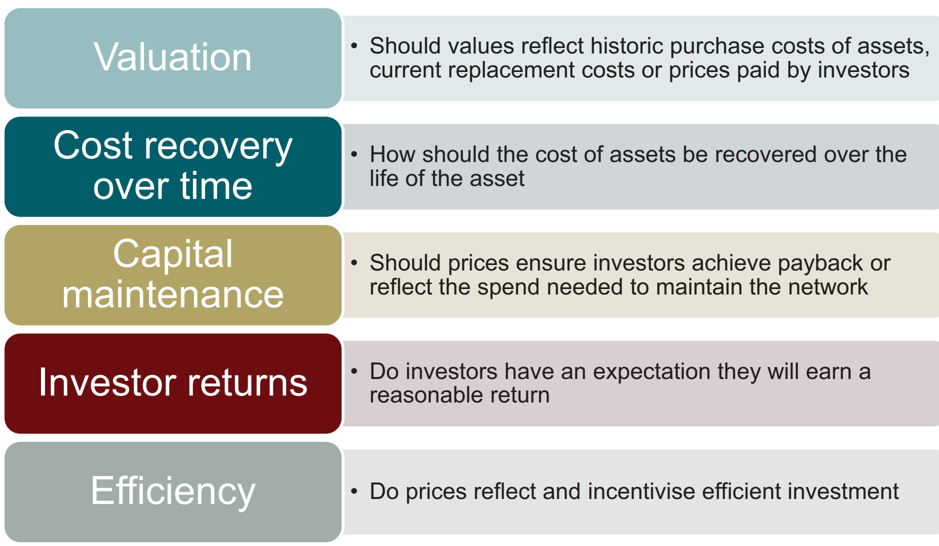
These recommendations are based on the principle of cost orientation and exclude the impact of any potential externalities which might justify a departure from these principles.

2 Asset costing and regulatory objectives

2.1 Regulatory objectives

Choosing the methodology to determining costs requires typically striking an appropriate balance between competing objectives[4]. There are a range of different decisions that need to be taken when determining asset summarised in **Figure 1**.

Figure 1. Objectives of access regulation



Source: Frontier Economics

The primary regulatory objective when costing methodologies were initially developed was to encourage the eventual deployment of competing fixed access infrastructures, where efficient for them to be deployed, with the ultimate aim of encouraging competition at the deepest level possible. In general, the most commonly used approach was a CCA-FAC method, which places weight on ensuring that prices match the regulator's current view of the 'competitive' level of prices, based on replacement costs in order to provide suitable entry signals. This was generally the case even where there was/is little prospect of the assets being duplicated by competitors.

Furthermore, regulatory costing in relation to access networks has commonly sought to use a 'one size fits all' approach, with all relevant assets being costed

4 A more extensive discussion of the objectives is provided in Annexe 1.

using a similar approach, with limited variations to reflect the underlying characteristics of the assets themselves, including their replicability.

As a result of developments in Next Generation Access technologies, and the need to consider expanding the capability of the fixed access network through the deployment of such technologies, there has now been a renewed interest in the appropriate approach to the costing of access network costs. This is considering not only the appropriate approach to the costing of the NGA assets, but also the 'legacy' copper access network assets.

Whilst the overall regulatory objective of encouraging competition at the deepest level of the network possible, to deliver long-term benefits to consumers, appears to continue to be an important objective, the consideration of the appropriate approach to costing needs to take into account two key developments:

- First, the deployment of NGA networks requires significant investment, which is expected to have a more risky profile than the previous access network investment into the legacy networks of today.

- Second, there is experience of the deployment of alternative fixed access infrastructures, which has led to a better understanding of the conditions under which fixed access infrastructures are replicable.

The need for significant new investment, and the improved understanding of replicability, suggests that a more refined approach to costing may now be desirable, with greater emphasis placed on the following objectives:

- The need to provide greater regulatory certainty to **investors,** to enable efficient investment in next generation access networks by both incumbents and competitors; and

- The need to ensure that **consumers** are not paying more than necessary for the use of legacy networks and do not disconnect or inefficiently switch to alternatives.

2.2 Potential methodologies

.A wide range of potential methodologies have been used and developed for determining the annual costs of assets in a regulatory context. These methodologies can be broadly classified into four groups:

1. Approaches consistent with statutory accounting standards used by the regulated operator;

2. Current cost accounting approaches that attempt to set prices that reflect the cost base of potential new entrant operators in order to ensure efficient entry;

3. Economic depreciation approaches which attempt to set the the profile of cost recovery over time to reflect demand for services; and

4. Regulatory asset valuation (RAV) approaches which focus on ensuring cost recovery over time.

Table 1 summarises the range of methodologies that have been used by regulators to determine costs for price control purposes with the most commonly used methodologies (in both telecommunications and other regulated sectors). Annex 2 provides a more extensive discussion of the different approaches.

Table 1. Approaches to asset valuation and determining allowable revenues

Approach	Valuation	Determining allowable revenues
Historic cost accounting	Valuation based on acquisition costs of individual assets used to provide regulated services	Allowable revenues consist of depreciation (typically straight line) and the cost of capital Constant depreciation charge and falling cost of capital leads to "front loading" of cost recovery
Current cost accounting (replacement costs)	Valuation based on replacement costs of individual assets used to provide regulated services	Allowable revenues consist of depreciation (typically straight line calculated as a percentage of the changing asset price), holding gain (loss) to reflect changing asset prices and the cost of capital Shifts cost recovery forwards (if asset prices are falling) or back (if asset prices are rising) compared to HCA
Annuities	Not required to estimate allowable revenues For an individual asset, derived using discounted future allowable revenues	Allowable revenues are constant over time in nominal or real terms
Economic depreciation	As for annuities	Allowable revenues may take account of the volume of output of assets in addition to changes in asset prices
Renewals accounting **(regulatory asset base)**	Changes in value calculated as capital expenditure less capital charges. Initial valuation may be exogenously determined, for example as price paid at acquisition.	Allowable revenues reflect capital expenditure required to maintain the asset base plus cost of capital employed

Source: Frontier Economics

Each of these approaches has strengths and weaknesses which may make them more or less applicable to a given set of assets as set out in **Table 2**. We consider these in the next section, where we provide our recommendations on the appropriate approaches to costing of fixed access networks.

Table 2. Strengths and weaknesses of approaches

Approach	Strengths	Weaknesses
Historic cost accounting	Costs can be precisely and objectively determined	Resulting prices do not reflect the changing costs of assets. Front loaded cost recovery may not be appropriate
Current cost accounting (replacement costs)	Costs reflect changes in underlying asset prices	Determining the replacement cost of assets introduces subjectivity and unpredictability Front loaded cost recovery may not be efficient
Annuities	No front loading of cost recovery Tilted annuities simple to implement in bottom up models	Allowable revenues are constant over time in nominal or real terms
Economic depreciation	Flexibility to profile cost recovery to reflect demand	High degree of subjectivity Valuations of existing assets may be highly sensitive to assumptions about future developments
Renewals accounting/regulatory asset base	Provides high certainty to investors that they will recover future investments	May be uncertainty over the correct level of maintenance expenditure Requires an initial valuation of existing assets

Source: Frontier Economics

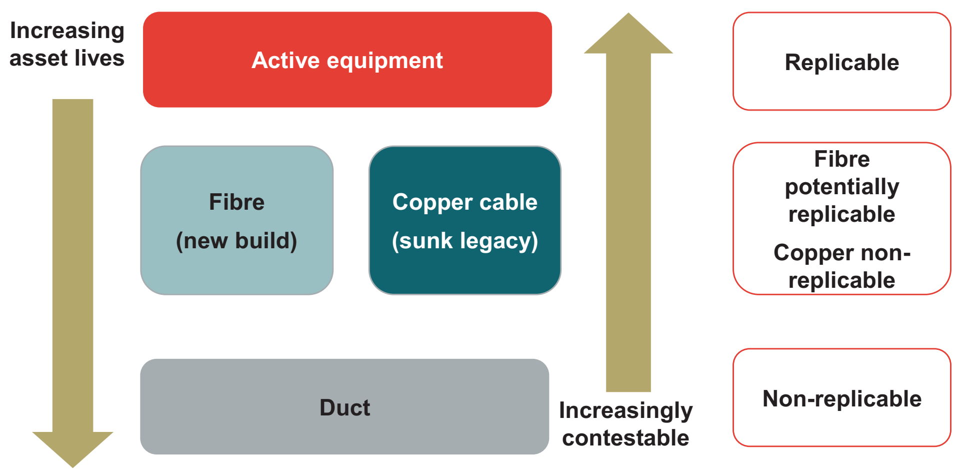
Asset costing and regulatory objectives

3 Recommendations

The review of different methodologies available highlights that there is no single methodology that will necessarily achieve the best balance of the differing objectives for all assets. Thus the choice of methodology should follow an analysis of both the characteristics of the assets themselves and the regulatory and market context.

In this respect, it is useful to consider the 'supply chain' of the network access services, and analyse the factors that will affect the choice of methodology for each of the different groups of assets, as illustrated in **Figure 2** below.

Figure 2. Network access asset groups - with NGA



Source: Frontier Economics

Our view is that different elements of the network equipment required to offer fixed access services, have sufficiently different characteristics to justify a different costing approach for the different elements. Regulation based on differential approaches reflecting the characteristics of each class of asset are widely used in both fixed telecommunications and other sectors[5], with the EU explicitly recognising this possibility in Annex I of the NGA Recommendation.

With the increasing complexity of regulated wholesale access in the EU, assets such as duct are inputs for a range of regulated services using different technology, for example fibre or copper, and for wholesale services in different parts of the value chain, such as active and passive services. Using different costing approaches for different assets should not lead to arbitrage opportunities

5 For example in the UK water industry 'underground' assets are accounted for on a renewals accounting basis while 'above ground' assets are accounted for on a CCA basis.

between the prices set for those services provided regulators ensure consistency between services in both the determination of costs and the recovery of fixed and common costs.[6]

A summary of our recommendations on the most appropriate cost based approach for each of the assets is summarised in **Figure 3** and explained in more detail in sections 3.1 to 3.4. These recommendations are based on the principle of cost orientation and therefore exclude the impact of any potential externalities on pricing. Section 3.5 discusses how externalities may be taken into account by policy makers.

Figure 3. Summary of recommendations

	Duct	Copper	Fibre	Active equipment
Nature of assets	Long and unpredictable asset lives Single asset that needs to maintain in the long run	Predictable asset lives Discrete assets Assets largely sunk with little continuing investment	Unpredictable asset lives Discrete assets Network at beginning of lifecycle	Short, predictable asset lives Discrete assets High level of innovation and price reductions
Regulatory objectives	Provide certainty on cost recovery of future capex Maintain downstream prices at a low level	Ensure assets appropriately used Insulate downstream prices from copper price fluctuations	Provide certainty for investment Promote SFBB penetration	Provide correct build or buy signals for competitors Provide correct investment incentives for incumbent
Potential approach	Renewals accounting	HCA based valuation	Determine prices based on economic depreciation Create RAB by rolling forward value based on incurred capex less econ. depreciation	CCA based approaches Ensure allowable revenues reflect demand profile

Source: Frontier Economics

6 We note for instance that the NGA Recommendation provides that IT and system costs fixed and common to different services should be allocated on a 'proportionate' basis across all access seekers including the downstream arm of the SMP operator. It also provides that costs for civil infrastructure access should be 'consistent' with the methodology used for pricing access to the copper loop. However, as noted in footnote [3] above, consistency does not imply an identical treatment particularly if there are relevant differences in the nature of the assets.

3.1 Duct

3.1.1 Nature of the assets

Duct assets are typically the longest lived assets in telecommunications network, with asset lives typically determined by regulators to be of the order of 40 years, although there is considerable variation in assumptions. The asset base is also not a collection of discrete assets as ducts are by their nature a continuous network. For example when a section of duct is replaced, it is not immediately obvious which, if any, part of the existing duct asset has been retired.

The asset valuation largely relates to the capitalised labour costs involved in installing and maintaining the duct network, rather than the underlying physical inputs, which also increases the difficultly of assigning value to individual assets. A single entry in the asset register for capitalised costs may related to a installation and maintenance activities across a range of duct assets.

3.1.2 Regulatory objectives

Given the very long life of access assets, the risk of setting allowable revenues which result in over- or under-recovery of efficient costs is considerable. This is accentuated by the difficulties of accurately measuring the installed asset base or accurately modelling the assets required for a hypothetical "efficient" operator through a model.

In addition, the roll out of NGA may require significant forward expenditure in upgrading the existing duct network to allow fibre rollout. Ensuring these investments are made will require providing investors with certainty on the future recovery of these asset costs.

As duct will be used for both current broadband services and SFBB services, keeping prices as low as possible consistent with efficient investment, and providing a smooth and predictable profile of allowable revenues appears to be the more important objective.

To the extent that ducts are largely non-replicable, setting prices to reflect the "competitive' level of prices based on replacement cost should not be one of the objectives.

3.1.3 Potential approach

A renewals accounting based approach[7] seems consistent with both the nature of the asset and the need to provide regulatory certainty. Such an approach raises some challenges in terms of:

7 See Annexe 2 for a more detailed description of the approach.

- Determining the opening valuation;
- Determining the operational capital maintenance based depreciation charge; and
- Ensuring that additions to the asset base are efficient and justified.

The most contentious issue is likely to be the opening valuation. A book value (HCA) based approach may be appropriate in many jurisdictions for a number of reasons.

First, there seems little reason to base an initial valuation on an estimate of net replacement cost for competition reasons to the extent that the network is assessed to be largely non-replicable.

Second, even where regulated prices are currently set based upon CCA this change is likely to have been made relatively recently. Thus any holding loss in moving from a CCA valuation to a HCA valuation will to a large extent be a reversal of the holding gain made when regulation moved to CCA.

Third, HCA based approaches are likely to result in relatively low prices in the future which is consistent with the objectives of ensuring high penetration of broadband services and ensuring productive efficiency by making full use of sunk assets.

Where evidence suggests that the book value of the network is overstated due to previous inefficiencies, additional downwards efficiency adjustments could be considered to the valuation.[8]

In theory, if the duct network is in a steady state, the average capital expenditure required to maintain the network should be approximately equal to a depreciation charge based on replacement costs. Thus, a move to a renewals accounting approach should not significantly alter the level of prices. In practical terms, basing prices on the directly observable level of capital expenditure, rather than a series of highly uncertain estimates of duct asset lives and the replacement cost of the complete network, are likely to provide far greater certainty to both regulators and to investors.[9]

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8 Such evidence may come from, for example, bottom-up cost models.

9 This should help achieve the objective of the NGA Recommendation which provides that access prices 'reflect the costs effectively borne by the SMP operator' taking account of actual asset lifetimes.

3.2 Copper cable

3.2.1 Nature of the assets

The asset life of copper cable is typically determined to be of the order of 20 years, reflecting degradation in the cable over time. While the cable network forms an end-to-end network, it can be broken down into individual assets in a way that is not possible with duct, for example. This is because the physical materials are a high proportion of the costs of copper cable and each cable will generally be replaced in its entirety at the end of its useful life.

3.2.2 Regulatory objectives

Copper cable is no longer likely to be the Modern Equivalent Asset (MEA), which can be observed by the increasing use of fibre only networks in new build property developments. Setting regulated prices based on the replacement cost of copper cable would not seem therefore to provide appropriate price signals for future investments by potential entrants or existing competitors to the incumbent network. Indeed, using replacement costs could mean that wholesale access prices would be driven by volatility in the prices of copper in commodity markets and could lead to a disincentive to invest in downstream markets as future profitability would be dependent on the price of copper. Linking regulated prices to volatile copper prices may also lead to significant under or over recovery of costs, compared to the valuation of existing assets.

Where the likelihood of future investment in copper cables is limited, incentivising future investment in copper is not likely to be a primary consideration. A more important consideration is likely to be maximising overall productive efficiency by ensuring that this existing asset is adequately utilised.

In areas where fibre is either already rolled out or could be rolled out, the level of prices determined for copper based services will have an effect both on the incentives for fibre investment and the penetration of fibre in the areas where it is rolled out. The exact relationships will be complex, depending on current and future parameters (such as cross price elasticities of demand between copper and fibre based products) which cannot be determined with any level of certainty at present.

In the absence of significant externalities, the regulator may not need to directly address issues of fibre investment when setting prices for copper based prices. If the regulator commits to setting prices that reflect forward looking costs for both copper and fibre based products, investors can internalise the decision as to whether a given fibre based investment is efficient or not. This case is addressed further below.

If NGA generates significant positive externalities, regulators may choose to set prices in a way to realise these gains by incentivising investment in NGA above a level that would occur when prices are set to solely reflect costs. This is addressed further in section 3.5 below

3.2.3 Potential approach

In the absence of any externalities, productive and allocative efficiency would suggest setting prices at a level that reflects the forward looking costs of operating and maintaining the network.

In terms of allocative efficiency, setting prices at this level would ensure that the existing sunk asset was efficiently utilised, avoiding the risk that demand that could be met went unserved, for example broadband customers leaving the network. In terms of productive efficiency, it would incentivise future investment in substitute networks where such alternative networks offered some combination of lower forward looking costs and increased capability.

However, setting prices to only reflect forward looking costs, if leading to an implicit writing off of the remaining value of past investments, would set a precedent which could discourage future investment. Thus, some account must be taken of the value of the existing assets. An HCA valuation of the existing network may be a reasonable opening RAV (Regulatory Asset Value), where this allows the operator to make a reasonable return on their past investment, without pricing copper based services significantly above forward looking cost.

3.3 Access fibre

3.3.1 Nature of the assets

Given the limited experience of operating mass market fibre access networks, the economic and engineering life of fibre cables may not be readily determined. Regulatory precedent for core transmission fibre and fibre serving large enterprises suggest an asset life similar to copper cable.

Similarly to copper cable, it should be possible to easily identify individual components of a fibre network, and given the availability of geographic information systems, as the fibre network is being rolled out, operators should have an accurate inventory of the network.

3.3.2 Regulatory objectives

The Commission has dual objectives of ensuring widespread availability of SFBB and encourage take up. This requires a balance between investment incentives for efficient roll out and maintain prices at a level that allows for rapid take up.

There is potential for competition for fibre based wholesale services, both from alternative networks and from operators using regulated access to the duct network. However, given the nascent stage of the market and the long pay back periods for competing networks, competitors' investment decisions may be less dependent on the level of prices in the period of network roll out and more dependent on certainty on the regulatory regime going forwards.

3.3.3 Potential approach

While the nature of the asset base means that it would be relatively straightforward to develop CCA estimates for fibre networks, on a straight line basis or a tilted annuity basis, the relative low utilisation of networks in the early years of roll out may result in achievable revenues being below the calculated allowable revenues based on a CCA straight line or annuity approach initially. This may lead to under-recovery over the longer term as the operator would never be able to recover the allowable revenues 'foregone' in the initial period.

An economic depreciation approach could be used initially to allow allowable revenues to reflect the limited demand during the phase when the network was being rolled out.

The main weakness of an economic depreciation approach which is dependent on judgemental assumptions about future developments, is the increased regulatory risk to investors. This risk is likely to be especially great for fibre roll out, given the high degree of uncertainty about future demand and costs. Under many economic depreciation approaches both the forward looking allowable revenues and the (implied) opening valuation of assets in each price control period will differ from the closing value from the previous control, reflecting the new information available since the previous price control. This could result in significant holding gains and losses at the beginning of each price control period as new data and revised forecasts of future market developments are included in the valuation. These holding gains or losses could in turn lead to under- or over-recovery of investments.

The regulatory risk due to resetting the valuation at the beginning of each price control period could be significantly reduced by using a RAV approach. Rather than independently setting the opening valuation for each price control, the opening regulatory valuation for successive price control periods would be calculated by "rolling forwards' the previously determined opening valuation adding the capital expenditure incurred and subtracting the determined depreciation charges in the previous period. This would remove the risk of significant holding gains or losses.

Such an approach would require three elements to be determined by the regulator:

- The opening RAV when the price control was first introduced;
- The depreciation charges used to set the allowable revenues; and

- The level of capital expenditure to include when the RAV is rolled forwards to the next period.

As investment in Next Generation Access networks has been relatively recent and to date has been limited, setting the opening RAV may not be critical, as the valuation should be relatively close to the expenditure to date, less an allowance for the costs recovered to date.

Depreciation charges can be determined according to an economic depreciation calculation, similar to that used in MTR determinations in many jurisdictions. This would be a two stage process:

- Setting the profile of future allowable revenues for existing assets to reflect expected changes in asset prices and demand; and
- Scaling this profile so that the net present value of the future allowable revenues equals the current RAV for the asset.

Setting forward looking prices controls will require some forecasting of future capital expenditure. In some regulated industries, for example UK water, forecasts have been included as an input when setting the RAV in order to provide incentives for the regulated company to ensure capital expenditure is efficiently incurred. However given the uncertainties surrounding investments in NGA, any regulatory forecasts are likely to be subject to a high degree of uncertainty and the incentive effects of giving weight to such forecasts is likely to be small. Thus it is likely to be appropriate to include actually incurred capital expenditure in the RAV.

Including actual capital expenditure would provide both investor certainty and protect consumers from over-recovery. Using an economic depreciation approach would set prices at a level that reflected the need to increase penetration in the medium term.

3.4 Active assets

3.4.1 Nature of the assets

Active assets used for providing broadband and/or narrowband services over the fixed access networks typically have relatively short economic lives, driven by technological developments making existing assets obsolete. Equipment may be in service for say 10 years, but for some of the operational life, the equipment may be used to provide support for legacy services in parallel with the latest generation of equipment. Thus some allowance may need to be made for the fact the equipment is not fully utilised for the whole of its operational life. Technological development typically results in comparable equipment either falling in price in real terms over time, or increasing in capability (on a MEA basis resulting in falling unit costs).

Recommendations

Compared to the passive elements of the access network, the number of active components is relatively small and the components are discrete, rather than continuous.

3.4.2 Regulatory objectives

Many active components may be considered to be replicable. For these components the regulator's objectives will need to balance allocative and productive efficiency with the benefits resulting from greater competition.

3.4.3 Recommendation

Given that assets are likely to be determined to be replicable a CCA based approach reflecting replacement costs is likely to be appropriate. The exact choice of methodology will need to take into account a number of factors including:

- Whether the network is in a "steady state' with an even mix of asset lives and steady demand or whether the allowable revenue profile needs to take account of rapidly changing utilisation; and
- The need to allow for the additional costs of dual running technologies.

3.5 Setting copper and fibre prices to account for externalities

If there are significant externalities associated with NGA roll out, then setting regulated prices on the basis of forward looking costs alone could lead to welfare enhancing investment not being undertaken. This is because investors would only take account of the potential increase in revenues due to the availability of fibre based services relative to the increase in cost of rolling out fibre. Thus there may be cases where the increase in revenues due to fibre is not sufficient, even where overall economic welfare would be enhanced by the investment being made. In these circumstances an efficient outcome may require the policymaker to provide a subsidy to the operator for rolling out fibre in these areas, which would reflect identified externalities. These subsidies could be funded from outside the industry, for example through general taxation, or within the industry if a direct subsidy from government was not available. Any subsidies would need to be directly linked to increased roll out, rather than simply increasing the revenues of fixed access operators.

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4 Annexe 1: Objectives of access regulation

In order to develop a framework for evaluating the appropriateness of different costing approaches, it is necessary to consider the explicit objectives of access price regulation. Estimates of network costs are used as directly as an input for price controls in order to calculate allowable revenues and may form part of the inputs of reviews to ensure compliance with other *ex ante* obligations such as non-discrimination, cost-orientation and transparency. Estimates of network costs may also be required to demonstrate that prices of regulated wholesale services do not result in margin squeeze as well as to calculate the cost of universal service obligations.[10]

Under the European regulatory framework, the overall objectives of regulation are *inter alia* to encourage efficient investment and promote competition. Where competition is not effective, *ex ante* regulatory measures (remedies) should be aimed at addressing market failure where a firm is found to have significant market power (SMP).[11] These objectives are echoed in the EC's recommendation on cost accounting.[12] In the case of fixed access networks, the market failure is due to the high fixed cost of parts of the network restricting competition as it is neither economically feasible nor efficient for entrants to duplicate the required facilities to enter the market.

These regulatory objectives are ultimately aimed at promoting the interests of consumers and European citizens. The objectives of access regulation are summarised in the figure below and described in further detail in the rest of this section.

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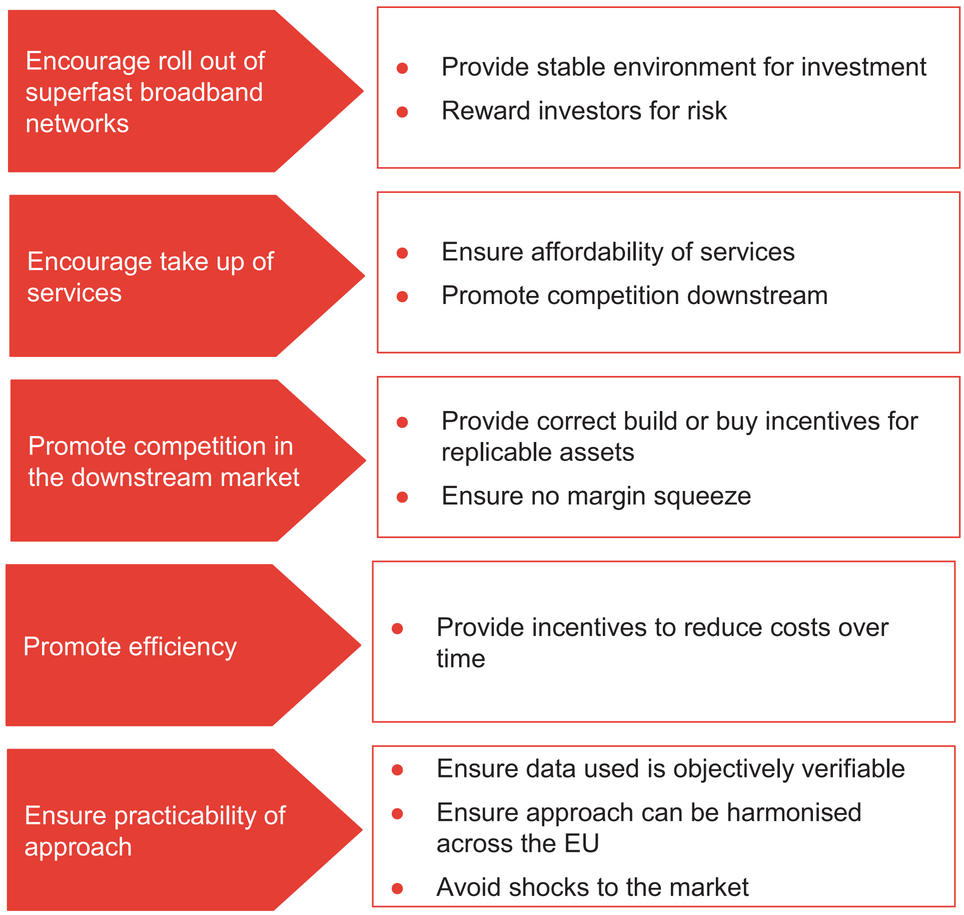
10 *Ex ante* margin squeeze tests are explicitly identified by the EC as being important to ensure downstream competition.

11 Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services (Framework Directive)

12 "Any mandated cost accounting or accounting separation methodology used in particular as a basis for price control decisions should be specified in a way that encourages efficient investment, identifies potential anticompetitive behaviour, notably margin squeezes, and should be in accordance with the national regulatory authority's policy objectives as set out in Article 8 of Directive 2002/21/EC." Source: EC 2005 Recommendation on cost accounting

Figure 4. Objectives of access regulation



Source: Frontier Economics

4.1 Ensuring efficient investment

The EC has set out ambitious targets for universal access to superfast broadband networks by 2020[13] requiring investment in both fixed and wireless[14] technologies. Cost based access prices can encourage efficient future investment both in access networks themselves and also in downstream markets. Providing a stable environment for investment

Regulatory uncertainty may deter investment with operators not exercising the option to invest until there is more clarity. In addition, regulatory regimes which lead to greater uncertainty in returns around a regulated rate will increase the risk associated with investment and therefore the cost of capital.[15] . This applies both to operators investing in access networks and to the operators that rely on access to provide downstream services. Therefore, provided that is does not disguise economic risks, regulation should seek to provide a stable and predictable environment for investment, reducing variability in returns.

Regulators can provide a stable environment for investment in three main ways:

- By providing clear signals early on of how access to new investments, such as NGA, will be regulated;
- By providing the expectation that efficient (i.e. after allowing for economic risk), future investment in the access network will make a reasonable return; and
- By adopting an approach that provides stability over time, minimising any variability in returns resulting from regulation.

These are described in further detail below.

4.1.1 Providing clear signals early on

In its NGA Recommendation[16], the EC emphasises the need for a consistent regulatory approach over time in order to provide investors with confidence in the design of their business plans. Further, the EC recommends that regulators

13 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Digital Agenda for Europe, 19 May 2010, COM (2010) 245

14 This includes both terrestrial and satellite wireless technologies.

15 Increased regulatory certainty can to a degree offset the additional risk associated with investing in NGA specific assets which should be duly taken account of in calculating costs. Such risk may include, for example, uncertainty over the future level of demand.

16 Commission recommendation of 20 September 2010 on regulated access to Next Generation Access Networks (NGA), (2010/572/EU)

"should clarify to the greatest extent possible how foreseeable changes in market circumstances might affect remedies". By providing clear signals early on, regulators can reduce the uncertainty at each future market review.

4.1.2 Rewarding and incentivising investment

Regulated charges should provide incentives for further investment and compensate investors for investments already made. Recognising this, the EC recommends that "access prices reflect the costs effectively borne by the SMP operator, including due consideration of the level of investment risk". This means that operators should be able to recover the costs efficient investments that it will incur and to earn a sufficient, but not excessive, return on capital employed to compensate it for the risk associated with investing in the access network.

If access prices are set so that an operator earns above the cost of capital, there may be inefficient investment for example through the inefficient duplication of networks as operators attempt to bypass existing infrastructure by building their own networks.[17] If access prices are set based on the regulated operator's capital base, there may also be an incentive for it to maximise its capital base inefficiently.

The treatment of existing assets may have an effect on future willingness to invest. If access prices for sunk assets are set too low, and an operator is not able to recover efficient costs it has already incurred, it could mean that investors would be unwilling to make sunk investments in the future. However in some cases it may be reasonable to set the regulatory valuation below the carrying value of the assets to reflect the fact that assets have been stranded, for example due to technological developments. Such stranding is a common risk in both regulated and unregulated businesses. Therefore, the regulated cost of capital will implicitly take account of the risk of not being able to fully recover the initial acquisition cost of assets due to stranding.

4.1.3 Providing stable outcomes over time

A regulatory approach which produces predictable and stable returns over time, can minimise the risks faced by investors in access networks. This can help reduce the returns they require and therefore increase the scope of efficient investment and reduce regulated prices. Such an approach can also help to provide operators that rely on regulated access to wholesale services with greater certainty and therefore reduce their costs. This can help to promote downstream competition.

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17 The extent to which this will be inefficient this will depend on whether assets are non-replicable (see Section 4.3).

Conversely a regulatory approach can increase investors' risk through inherent unpredictability (for example where prices not solely based on objective data) or if returns are correlated with external uncontrollable variables (such as commodity prices).

4.2 Encouraging take-up of services

The Europe 2020 Strategy[18] aims to have more than half of European households subscribing to internet connections above 100 Mbps by 2020. Lower retail prices and improved product offerings will play a key role in ensuring take-up of services and the availability of higher access speeds.[19] In the absence of regulation, operators with market power could set prices above an efficient level and thus reduce take up.

Allocative efficiency is maximised when the price to the end user reflects the forward looking marginal cost of serving that customer.[20] Setting prices at this level will often conflict with other regulatory objectives, such as ensuring investment as this does not allow the regulated operator to recover fixed and/or sunk costs from regulated services. Therefore, regulated prices may be set above marginal costs, for example, using long run incremental costs plus a mark up for common costs (LRIC+).

Rather than directly regulating retail prices where an operator has SMP, the EU regulatory framework focuses on setting wholesale access prices at a level as low as is consistent with providing the correct incentives for network investment and other regulatory objectives described in this section. This increases competition in downstream markets which drives retail prices down towards cost.

The high fixed cost of parts of the access network can represent a bottleneck if these cannot be efficiently replicated by competitors (these are non-replicable assets). This can be a source of market power for the incumbent operator. In such circumstances, the lack of competitive threat means that the access operator could seek to try to set retail prices above an efficient level and restrict or prevent access to the bottleneck, thereby restricting or excluding competitors in downstream markets. Therefore, the objectives of regulation can include setting wholesale access prices at an efficient level and creating "a genuine level playing field between the downstream arm of the SMP operator and alternative network

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18 "EUROPE 2020 - A strategy for smart, sustainable and inclusive growth - COM(2010) 2020." http://ec.europa.eu/europe2020/index_en.htm

19 While cost-based prices are generally considered to be the most efficient level, there may also be wider social objectives that justify the use of subsidised access for certain groups.

20 In the presence of positive externalities, that is benefits that are enjoyed by people who do not directly consume or produce the service, there may be an argument for divergence away from cost based pricing.

operators"[21] in order to promote competition in the downstream market. This requires non-discrimination, in both price and non-price terms, between the regulated operator's competitors and its own downstream activities.

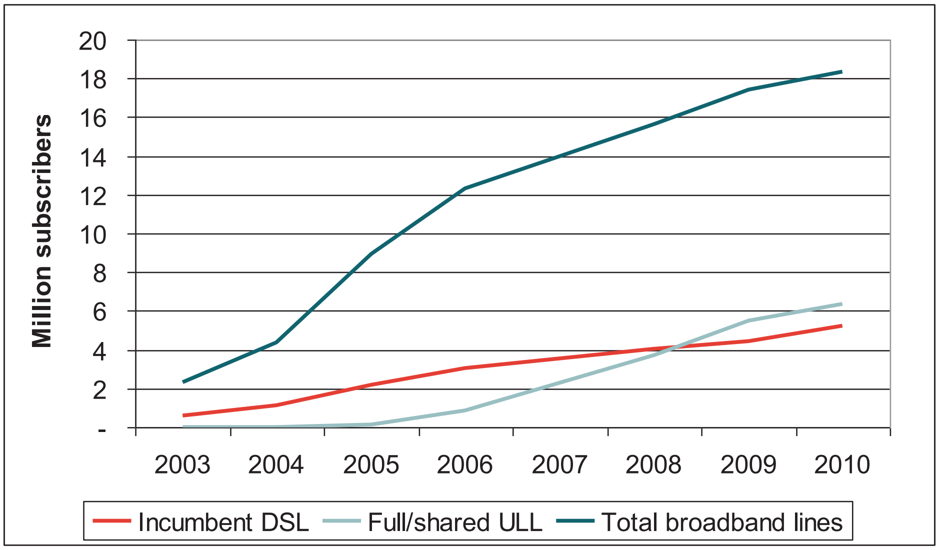
Competition through regulated access to fixed networks, for example local loop unbundling, has proven to be a key enabler of take-up of broadband services provided over traditional networks For example, in the UK, the effective implementation of local loop unbundling in mid-2005 with reduced access prices reflecting forward looking costs led to a sharp decline in retail broadband prices.[22] At the end of December 2009 85% of UK households were connected to an LLU-enabled local exchange (Figure 5.2), up from 67% three years previously.[23] **Figure 5** shows the total number of broadband lines in the UK from 2003 to 2010, as well as the number of DSL lines provided by the incumbent operator and alternative operators using full or shared ULL. It can be seen that the number of lines provided using LLU increased significantly after 2005.

21 Source: Annex 1 of EC recommendation on NGA regulation

22 BT voluntarily reduced the annual rental charge for metallic path facility (MPF) from £105.09 to £80. Ofcom set a price cap on MPF at £81.69 in November 2005 based on forward looking costs (source: "Local loop unbundling: setting the fully unbundled rental charge ceiling and minor amendment to SMP conditions FA6 and FB6", 30 November 2005). To date, MPF rental charges have remained close to this level. The ceiling for the annual rental charge is now £91.50 (Source: "Charges for LLU and WLR services from 1 April 2011", Ofcom, 1 December 2010).

23 http://www.ofcom.org.uk/static/cmr-10/NI-5.2.html

Figure 5. Broadband take up in the UK



Source: EC Implementation Reports

Further, competition has led to citizens across Europe gaining access to higher access speeds with average spending levels receiving 8 Mbps rather than 2 Mbps.[24]

4.3 Promoting competition

Where the regulator believes replication of the assets by competitors may enhance overall efficiency, and subject to other considerations and objectives, prices should be set in principle at a level which reflects the costs of efficient entrants – in other words, at the competitive level. This is so that access prices provide the correct "build or buy" incentives. In particular, prices should be set so that there is only duplication of infrastructure if an entrant is able to provide services over its own network at a lower cost than an efficient hypothetical operator. This means that regulation plays a role both in promoting competition in downstream markets as well as potentially in the provision of infrastructure.

While wholesale cost-based price regulation will seek to set prices at a level consistent with the regulated business making a reasonable return on capital expenditure (see Section 4.2), the costing of replicable assets also needs to take

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[24] "Europe's digital deficit: revitalising the market in electronic communications", Analysys Mason, Final report for ECTA, 3 March 2010. Available online: http://www.ectaportal.com/en/upload/Press%20Releases/2010/Europes_Digital_Deficit.pdf

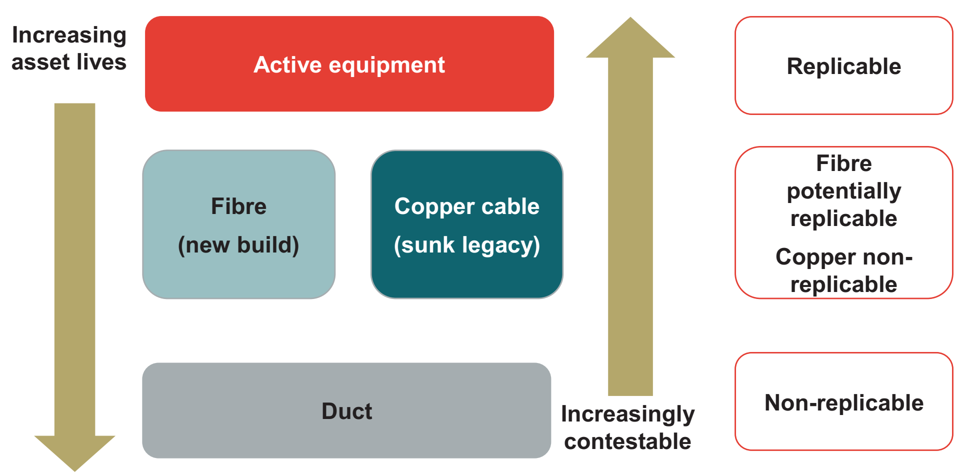
account of the impact on competitors or potential entrants in the provision of these assets and hence services. This additional constraint which applies to replicable assets, but which does not apply to the non-replicable bottleneck assets, may mean approaches to costing may also differ, as noted in the recommendation.[25] This may also mean that the returns of the regulated operator may vary to a greater degree around the cost of capital (for example, where the operator is not able to recover the cost of stranded assets as these do not represent the costs that would be incurred by a hypothetical efficient operator).

4.3.1 Different approaches may be required for replicable and non-replicable assets

Figure 6 provides an illustration of the main categories of assets in the access network and identifies replicable and non-replicable assets.

Active equipment (such as concentrators and DSLAMs), represents a relatively small proportion of access network costs and have relatively short useful lives. The development of LLU has implied that such assets are generally considered as being replicable by rivals.

Figure 6. Fixed access network assets with NGA



Source: Frontier

Whilst copper cable may be considered to be replicable in certain areas, it would no longer represent modern technology. In other words, if an operator was rolling out an access network today, it would most likely invest in fibre rather

25 Annex 1, NGA Recommendation

Annexe 1: Objectives of access regulation

than copper cable. Depending on the cost of fibre relative to its useful life, fibre could be considered to be replicable.

The high fixed costs of rolling out a duct network mean that any advantages brought by a duplication of the duct network would be more than outweighed by the additional fixed costs incurred. Thus, in general, regulators are likely to consider duct non-replicable.

For passive elements of legacy fixed access network (duct and copper cable) that can be treated as broadly homogeneous for the purposes of regulatory costing, and that are expected with a reasonable degree of certainty to be non-replicable, there would be a limited weight given to attempt to proxy competitive prices as an objective. There is therefore greater freedom to set valuation and allowable revenue calculation methodologies. In this case, in addition to the requirement for the regulated company to earn a reasonable return on the regulated assets, other objectives, such as providing regulatory certainty for investors or ensuring prices are stable over time, may also be taken into account.

4.4 Reducing costs and promoting efficiency

One of the goals of price regulation should be productive efficiency, in other words, minimising the resource inputs required to deliver a given level of demand. This can be seen from two perspectives:

- Ensuring that the regulated operator minimises the forward looking expenditures required to deliver a given level of demand; and
- Where there is a possibility of substitution between networks and/or operators, that services are delivered in a way that minimises the overall forward looking operational and capital expenditure required to deliver a given level of demand (in other words, regulation should seek to provide the correct "build or buy" incentives).

In both cases it is the forward looking costs that needs to be taken into account, with the past acquisition cost of sunk assets ignored, although the costs of operating these assets and any disposal value of the assets should be taken into account.

4.4.1 Efficiency within the regulated operator

Price controls can be designed to give the regulated business strong incentives to reduce operational expenditure over time. This can be done, for example, through multi-year RPI-X price controls where X represents expected efficiency improvements over time.

A well defined regulatory regime can help to provide incentives for efficient investment. In addition, the regulatory regime should also attempt to provide dis-incentives to inefficient investments when investment decisions are being made by providing investors with clear signals that operators would not be able to recover from regulated charges the costs of investments that are determined to be inefficient. This could help to ensure that operators invest in future network infrastructure in the most efficient way feasible. Nevertheless, such approaches have limited direct impact on operators' existing asset base (in terms of the volume of assets) where assets are largely sunk and thus the any inefficiently incurred investments cannot be easily removed from the asset base.

Further, the approach to asset valuation used to determine regulated charges can exclude assets that are found to be inefficiently employed (see Section 5.6). This would provide incentives to minimise capital expenditure as any inefficiently incurred costs would not be recoverable from regulated charges.

4.4.2 Overall productive efficiency

As noted in Section 4.2, although allocative efficiency is maximised by setting prices according to forward looking marginal costs, regulated prices may be set above this level to reflect other efficiency gains and policy objectives.

Where there is the possibility of substitution between networks and operators, setting prices above the level of marginal forward looking costs could lead to substitution even where the alternative network or operator faces higher costs. This could lead to the overall level of forward looking costs being higher than the minimum (efficient) level.

Setting regulated prices at the level of forward looking marginal costs (in other words, excluding sunk costs and fixed and common costs), would maximise overall productive efficiency as substitution would only occur if the forward looking marginal costs of the substitute network were lower.

4.5 Practicability and consistency with approaches to other assets

A regulatory approach that is simple and transparent can help to reduce the burden on both regulated operators and regulators. This can also help to provide stakeholders – including access seekers – with confidence in the regulatory process. This may be implemented in three main ways.

First, the approach used should be objectively verifiable. This relies on there being sufficient objective data to provide confidence in the accuracy of the calculation of costs used to set wholesale access prices. This may require data being collected from various sources (in other words, from the regulated operator and other stakeholders).

Second, the approach should be suitable to be applied in a harmonised manner across the EU. This would be consistent with the EC's objectives to avoid distortions of the single market and provide greater legal certainty for investors.

Nevertheless, there should be flexibility for regulators to take proper account of national circumstances.

Third, if the approach results in access prices that are very different to current access prices, there should be a mechanism to avoid shocks to the market. For example, the EC recommends that if changing the costing methodology leads to changes in regulated charges and/or price mechanisms, this could be spread over a reasonable period of time.[26] This would help to provide greater certainty to both the regulated operator and the operators that rely on it for access. In addition regulators should analyse the impact of any changes in methodology on the level of return.

26 Source: EC 2005 recommendation on cost accounting

5 Annexe 2: Asset costing approaches for price controls

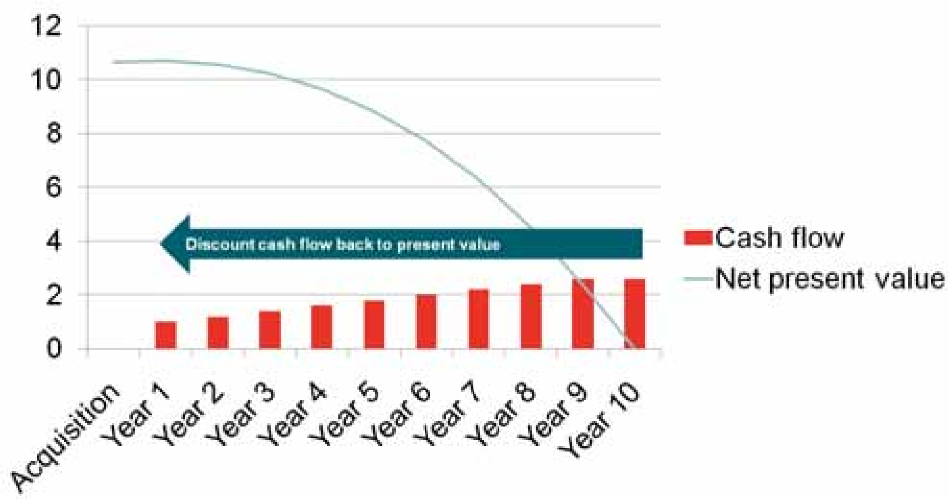
The EC has recommended that regulators should set regulated prices following an SMP determination based upon cost orientation[27]. The NGA recommendation recommends that regulators mandate access to passive and active access facilities, for both current and NGA networks, at cost-oriented rates. In Section 5.1, we examine the relationship between asset valuation and allowable revenues under price controls based on cost-orientation. In Section 5.2, we consider different approaches to asset valuation and determining allowable revenues under regulation. For each approach, we consider the main strengths and weaknesses.

5.1 Valuation and allowable revenues

Under standard financial theory, the value of an asset to an investor is dependent on the future cash flows resulting from operating that asset over its lifetime, with future cash flows discounted to a present value based on an appropriate discount rate (deprival value). This is illustrated in the figure below.

27 Commission Recommendation of 19 September 2005 on accounting separation and cost accounting systems under the regulatory framework for electronic communications (2005/698/EC).

Figure 7. Asset valuation based on deprival value



Source: Frontier Economics

If an asset is used to provide regulated services, an investor will only purchase that asset if it expects that allowable revenues under regulation will be at least as much as the cost of that asset. This means that for regulatory purposes, it is only necessary to determine either the asset valuation or the allowable revenues.

The relationship between valuation and allowable revenues is described in further detail below.

5.1.1 Relationship between valuation and allowable revenues

Assuming periodic cash flows and a constant discount rate, the value of an asset can be expressed as follows:

$$Asset\ value_t = \sum_{p=1}^{\infty} \frac{cash\ flow_{t+p}}{(1+WACC)^p}$$

This provides a simple relationship between the valuation of an asset in a given period (*t*) and its value in the next period (*t*+1).

$$Asset\ value_t = \frac{cash\ flow_{t+1}}{(1+WACC)} + \sum_{p=2}^{\infty} \frac{cash\ flow_{t+p}}{(1+WACC)^p}$$

$$= \frac{cash\ flow_{t+1}}{(1+WACC)} + \frac{1}{(1+WACC)} \cdot \sum_{p=1}^{\infty} \frac{cash\ flow_{(t+1)+p}}{(1+WACC)^p}$$

$$= \frac{cash\ flow_{t+1} + asset\ value_{t+1}}{(1+WACC)}$$

In a regulatory context, we can assume that operational expenditure is treated separately and as such the cash flow generated by the asset is the allowable revenues determines by the regulator. Rearranging then gives:

$$Allowable\ revenues_{t+1} = WACC.asset\ value_t + (asset\ value_t - \ asset\ value_{t+1})$$

The first component reflects the opportunity cost to investors for the capital employed for the assets. The second component is a compensation for the reduction in the value of the asset during the period. Based on this, the problem of determining the allowable revenues can be reduced to one of determining the opening asset and closing asset valuation and the WACC. Conversely, where future allowable revenues have been determined, we can calculate the asset value by discounting these to the present value.

5.1.2 Determining valuation

In the case of an asset used to provide regulated services, an investor will only purchase the asset if its expectation is that the value of the assets (in terms of allowable revenues) is at least equal to the acquisition cost of the asset. In addition, a regulator will wish to ensure prices are set at the minimum level that ensures investment. That is, the regulator will wish to ensure that the present value of future allowable revenue is no lower than the acquisition cost as shown in the equation below. This is also illustrated in **Figure 8** below.

$$Acquisition\ cost = \sum_{p=1}^{\infty} \frac{allowable\ revenues_{acquisition\ date+p}}{(1+WACC)^p}$$

Figure 8. Asset valuation under regulation

Source: Frontier Economics

This constraint does not uniquely define the profile of allowable revenues over time since the profile of allowable revenues can be altered while maintaining this constraint. In theory, investors should be indifferent between different profiles of cost recovery over time. Thus, additional criteria must be employed to determine the appropriate approach to valuation and the calculation of allowable revenues.

These additional criteria may include:

- Ensuring that the valuation of the asset base is dependent only on those assets that are in service (in other words, that all operating assets have positive valuations and those assets not is service have zero valuation);
- Ensuring that the valuation of an asset is always above realisable value to ensure assets are not scrapped;
- Ensuring that the valuation of an asset reflects current replacement costs of the asset;
- Ensuring the methodology is predictable and objective; and
- Ensuring that the profile of allowable revenues reflects demand side criteria (for example keeping the profile of prices smooth).

The relative importance of these criteria may depend on the type of asset or the services it is used to provide. Since the regulated business should be indifferent to the approach used, different approaches could be used for different assets within the regulated business.

Annexe 2: Asset costing approaches for price controls

5.2 Approaches to asset valuation and determining allowable revenues

In this section we describe the main approaches to valuing assets and determining allowable revenues under ex ante regulation. These are summarised in **Table 3** and described in further detail in the rest of this section. We also examine the strengths and limitations of each approach and provide examples of where they have been implemented in Europe.

Table 3. Approaches to asset valuation and determining allowable revenues

Approach	Valuation	Determining allowable revenues
Historic cost accounting	Valuation based on acquisition costs of individual assets used to provide regulated services	Allowable revenues consist of depreciation (typically straight line) and the cost of capital Constant depreciation charge and falling cost of capital leads to “front loading” of cost recovery
Current cost accounting (replacement costs)	Valuation based on replacement costs of individual assets used to provide regulated services	Allowable revenues consist of depreciation (typically straight line calculated as a percentage of the changing asset price), holding gain (loss) to reflect changing asset prices and the cost of capital Shifts cost recovery forwards (if asset prices are falling) or back (if asset prices are rising) compared to HCA
Annuities	Not required to estimate allowable revenues For an individual asset, derived using discounted future allowable revenues	Allowable revenues are constant over time in nominal or real terms
Economic depreciation	As for annuities	Allowable revenues may take account of the volume of output of assets in addition to changes in asset prices
Renewals accounting **(regulatory asset base)**	Changes in value reflect capital expenditure and capital charges. Initial valuation may be exogenously determined.	Cost of capital plus the capital expenditure required to maintain the asset base

Source: Frontier Economics

5.2.1 Historic cost accounting (acquisition costs)

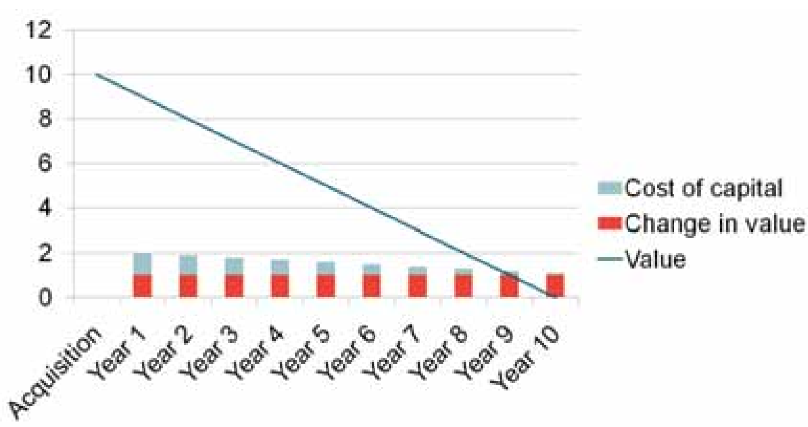
Valuation approach

Under historic cost accounting (HCA), the value of an asset at any point in time depends on the cost of acquiring that asset. In a regulatory context, the most commonly used depreciation method is straight line depreciation. Under this method, the asset value is assumed to decline in a straight line from the moment the asset is brought into service to the assumed disposal value at the end of its defined asset life[28].

Allowable revenues

Under straight line depreciation, the change in valuation (depreciation) is constant over the defined asset life. However, as the valuation of the asset is declining linearly over time, the component in allowable revenues related to the opportunity cost of financing the capital employed also falls linearly over time.[29] This leads to a "front loading" of cost recovery.

Figure 9. Allowable revenues under HCA



Source: Frontier Economics

Strengths and weaknesses

The advantage of HCA approaches is that once the asset life and form of depreciation is determined, the asset valuation and allowable revenues can be precisely calculated. For this reason, HCA approaches are favoured for applications such as statutory reporting and calculating tax liabilities.

The main disadvantage of this approach is that no account is taken either of general inflation (purchasing power) or of changes in the unit cost of assets resulting from technological change. In addition, under straight line depreciation

28 This should ensure Financial Capital Maintenance (FCM)

29 Assuming a constant WACC.

the allowable revenues decline over time. This may not reflect demand side factors or the utilisation of assets. This may mean that, where demand is increasing over time, regulated unit prices start relatively high and fall over time.

In addition, if the asset life assumption differs from the actual asset life then and the assumed asset life is too short, there may be fully depreciated assets still in use. If assumed the asset life is too long, the assets will have non-zero valuation at time of retirement, requiring the inclusion of a write down charge in allowable revenues[30]

5.2.2 Current cost accounting (replacement costs)

Valuation approach

Under current cost accounting (CCA) approaches used in a regulatory context, the value of an asset at any point in time depends on the cost of replacing that asset[31]. The EC notes that a key element of CCA approaches is the "evaluation of network assets at forward-looking or current value of an efficient operator, that is, estimating the costs faced by equivalent operators if the market were vigorously competitive."[32]

Replacement costs can be calculated either directly by estimating the costs of a similar asset or by applying an estimate of the price change since acquisition to the acquisition cost.[33]

Typically straight line depreciation is used. However, in this case, the valuation falls linearly as a percentage of the (changing) replacement cost over the assumed asset lifetime.

Allowable revenues

The change in the valuation in a given period is the combination of two factors:

1. The reduction in valuation (depreciation); and
2. Any changes driven by changes in the replacement cost (holding gains resulting from increasing asset prices or holding losses resulting from falling asset prices).

30 The write-down charge is required to ensure FCM.

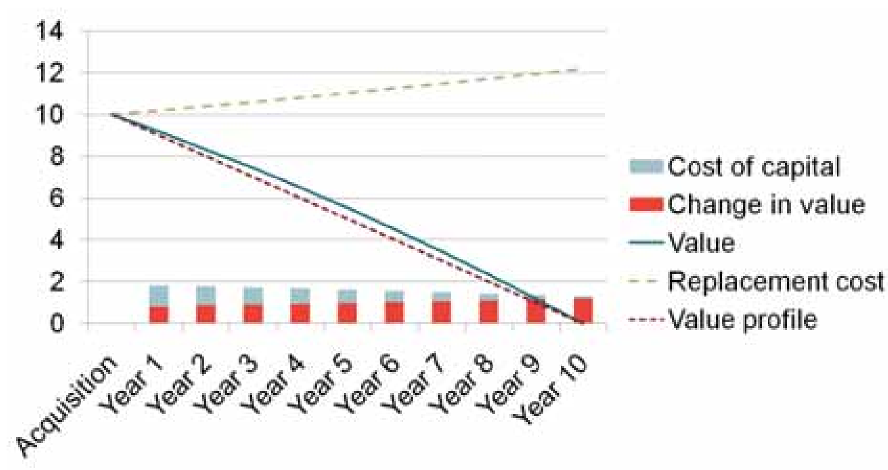
31 In other contexts, such as statutory accounting in jurisdictions with hyper-inflation, current costs approaches may be based on indexing asset values to take account of general inflation.

32 EC 2005 recommendation on cost accounting

33 Direct valuation or indexation (applying a price trend to the acquisition cost) can be used where the asset in service is still the appropriate replacement. A modern equivalent asset (MEA) approach should be used where the asset would be replaced by another asset which can deliver similar functionality.

These two elements are generally identified separately in CCA estimates. If real asset prices are falling over time, allowable revenues are greater leading to the front loading of cost recovery on a discounted basis.

Figure 10. Allowable revenues under CCA with increasing replacement cost



Source: Frontier Economics

Strengths and weaknesses

The key advantage of CCA approaches over HCA is that the allowable revenues in a given time period reflect replacement costs in that period rather than acquisition costs. As this reflects the costs that would be incurred by operators if there were effective competition, this can help to provide the correct "build or buy" signals for replicable assets. In particular, in a given time period, there will only be competition in the provision of infrastructure if the entrant is able to do so efficiently. Where duplication of infrastructure is not possible, entrants can compete in the downstream market by relying on the infrastructure of the incumbent.

A key disadvantage of CCA approaches, particularly for very assets with long lives, is that the estimation of replacement costs can be subject to a large degree of uncertainty, which introduces a degree of subjectivity. At best, this means that allowable revenues under CCA may not exactly reflect replacement costs, but are predictable. At worst, the level of allowable revenues can vary depending on subjective judgements on methodology rather than actual price movements[34].

Even where CCA estimates do closely reflect replacement costs, unpredictable price movements, for example changes in copper cable prices driven by copper

[34] [Reference to BT's 2010 duct valuation change]

metal price movements, can lead to significant changes in the level of allowable revenues due to large holding gains and losses. This can lead to a range of unwanted side effects including volatility in end user pricing if these price movements are passed on to end users; volatility in margins if wholesale prices vary but retail prices do not reflect this; or pricing above or below allowable revenues if wholesale prices do not reflect this.

Finally if asset values are changed from an HCA basis to a CCA basis for long lived assets, this can result in significant holding gains and losses, which in theory should be reflected in allowable revenues. For example, in the UK, Ofcom changed its approach to valuing BT's copper access network in 2005. This is because when Oftel (Ofcom's predecessor) moved from CCA from HCA for pricing LLU products in 1997, this led to a change in the path of cost recovery for assets purchased before the price control period.[35] This meant that BT would have over-recovered the cost of pre-1997 copper access networks. Therefore, Ofcom created a regulatory asset value based on HCA (see Section ****).

Recognising these issues with respect to long lived access assets, the Commission recommended "that national regulatory authorities have due regard to price and competition issues that might be raised when implementing CCA, such as in the case of local loop unbundling."[36]

5.2.3 Annuities

Allowable revenues

As described in Section 5.2.1, straight line depreciation tends to front load cost recovery by setting allowable revenues that decline over time[37]. This means that identical assets purchased at different times will result in different allowable revenues, even if used to deliver identical services.

The HCA and CCA approaches described above attempt to set the profile of valuation over the asset life to determine the allowable revenues. In contrast, an annuity approach sets directly the profile of allowable revenues to be either constant over time (standard annuity), or to vary at a constant rate (tilted annuity).

Under a standard annuity approach, the NPV in any given period is always higher than the NPV under straight line HCA.

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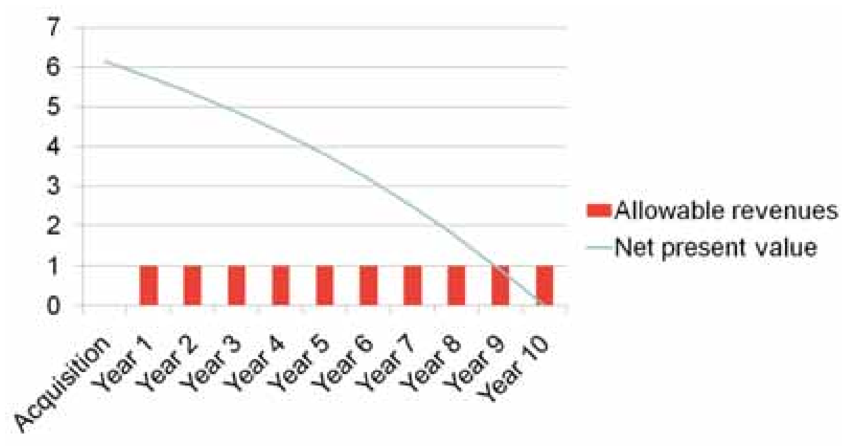
35 See "Valuing BT's copper access network", Ofcom final statement, 18 August 2005, available online: http://stakeholders.ofcom.org.uk/consultations/copper/value2/statement/

36 EC 2005 recommendation on cost accounting

37 Where replacement costs are increasing, allowable revenues may initially increase before falling towards the end of an asset's assumed life.

Figure 11. Allowable revenues under standard annuity

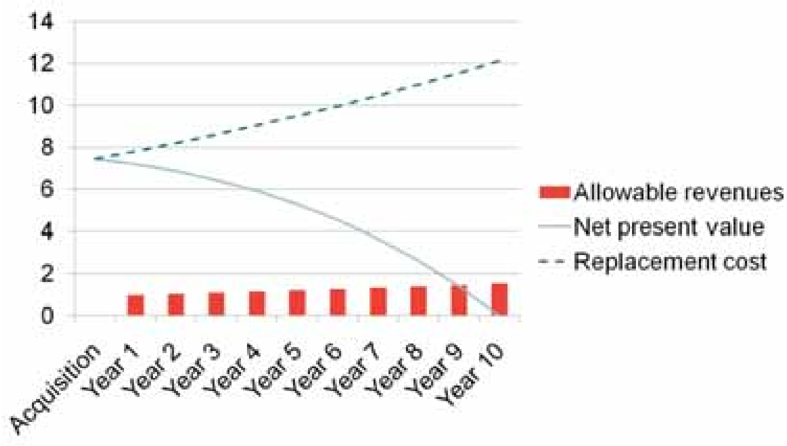


Source: Frontier Economics

A tilted annuity approach sets the rate of change in allowable revenues so that it reflects the rate of change in the replacement costs of assets. Such an approach has two key strengths. First, allowable revenues reflect replacement costs rather than acquisition costs. This means that it implements a form of CCA. Second, the allowable revenues for similar assets are independent of the date of purchase of the assets.

Annexe 2: Asset costing approaches for price controls

Figure 12. Allowable revenues under tilted annuity



Source: Frontier Economics

Valuation

As annuity formulae calculate allowable revenues directly rather than first calculating valuations, it is not necessary to estimate valuations. However for an individual asset, the valuation can be derived by discounting future allowable revenues.

The resulting valuation is higher than the corresponding straight line depreciation because the allowable revenues are higher towards the end of the asset life, compared to the front loaded straight line estimates.

Strengths and weaknesses

Standard and tilted annuities, while correcting for the front loading of straight line depreciation, will have similar strengths and weaknesses to any HCA or CCA approaches respectively.

One additional advantage of the tilted annuity approach over CCA is that detailed information on when assets were purchased is not required as allowable revenues are not dependent on the asset age. This means that in practical terms, tilted annuities are often used in bottom-up cost modelling since total allowable revenues can be calculated based solely on the volume of assets in service without the need to model past network roll out.

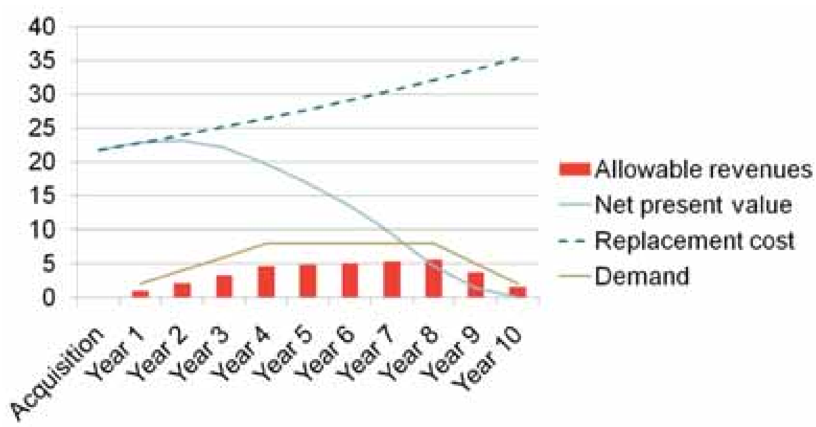
5.2.4 Economic depreciation

Allowable revenues

Annuities, which focus on determining the profile of allowable revenues with valuation being dependent on this profile, can be considered a form of economic depreciation.

More complex forms of economic depreciation attempt to set the profile of allowable revenues to take into account both changes in replacement costs and the volume of output of individual assets. Such approaches have been implemented in a regulatory context where supply and demand are evolving rapidly. The figure below illustrates allowable revenues over time taking account of increasing asset replacement costs, and changing demand.

Figure 13. Allowable revenues under economic depreciation



Source: Frontier Economics

Valuation

As with annuity approaches, valuation is not an explicit output bit the implied valuation under economic depreciation can be estimated by discounting determined future allowable revenues.

Strengths and weaknesses

While there are some theoretical advantages to complex economic depreciation calculations, implementation is typically complex, requiring models of assets deployed and demand over the whole network lifecycle. Given the high degree of uncertainty relating to the level of demand, future price changes and technological evolution, the resulting allowable revenue estimates will be subject to a high degree of uncertainty. This means that current regulated prices are dependent on subjective assumptions about future demand.

Annexe 2: Asset costing approaches for price controls

Economic depreciation: UK mobile termination

In the UK, mobile termination rates are calculated using a hybrid LRIC model which reconciles bottom-up and top-down approaches.

The cost of mobile termination services is calculated using economic depreciation. Economic depreciation is used in order to derive a path of cost recovery over the lifetime of the network based on reconciled estimates for the past and forecasts for the future taking into account changes in demand over time, changes in the costs of equipment and operations and the network required by technology. This allows a smooth profile of unit allowable revenues over time, despite rapid changes in demand, with the profile reflect both demand and supply side factors.

One disadvantage of this approach is that the current level of charges is dependent on forecasts of variables such as demand, equipment costs and technology transitions which are unavoidably judgemental and hence subjectivity.

Another major weakness is that at each and every point in time the resulting allowable revenues are dependent on the assumptions over the whole network lifecycle. As a result as new information becomes available and forecasts are revisited, not only do forward looking allowable revenues change but also the historical time series of allowable revenues and by implication the regulatory valuation of the existing assets. For example between the 2007 and 2010 versions of the model, Ofcom incorporated new information on equipment prices and revised estimated of future demand which significantly lowered the forward looking allowable revenues from 2010. The implied valuation of existing assets at 2010, based on the forward looking cash flows generated were consequently imposing a holding loss on the operators[38].

In theory the revised profile of allowable revenues is consistent with financial capital maintenance as under the revised depreciation profile, allowable revenues should have been higher in the years prior to 2007. In practice it is impossible to adjust regulated prices retrospectively to take account of the new information and hence there is under-recovery of costs.

The uncertainty and subjectivity of such approaches will increase the perceived risk of investments and hence the returns required by investors.

Figure 14. Comparison of economic depreciation results from Ofcom MTR models

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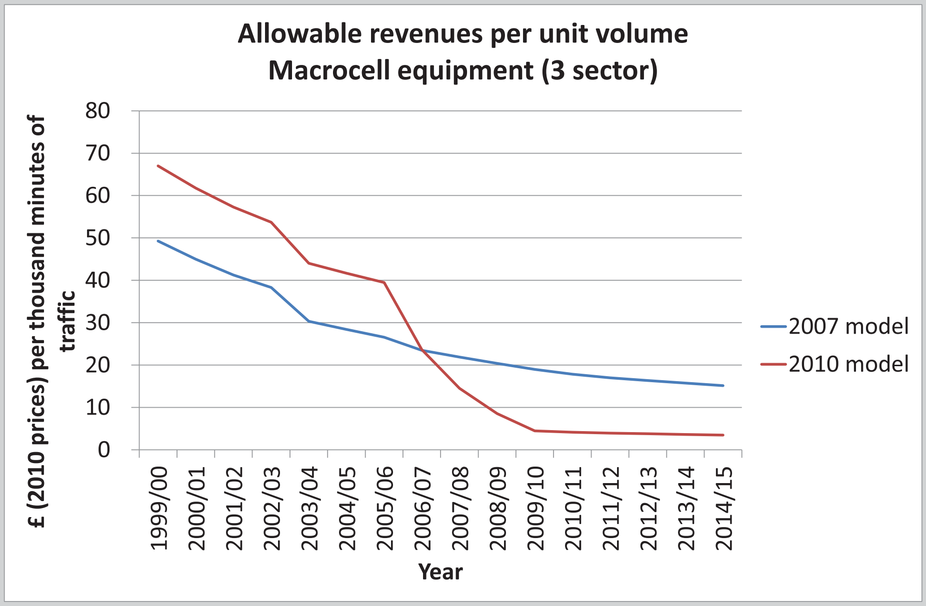
Annexe 2: Asset costing approaches for price controls



Source: Frontier Economics analysis of Ofcom models

5.3.1 Regulatory asset value and renewals accounting

Valuation

The approaches above attempt to determine valuations and allowable revenues for individual assets from the date they are brought into service for an assumed asset lifetime, at the end of which the asset value is set to zero.

However, in the case of infrastructure assets with long operational lives, it may not be possible to estimate a single typical asset life. This is because of wide variations in the time between installations. In addition, when assets are not discrete but part of an overall system (for example, a network of pipes or ducts), replacement of the system may be continuous over time. In these cases, a renewals accounting approach can be adopted. This treats the whole system as a single asset.[39]

Under renewals accounting, the reduction in valuation of the assets related to depreciation is an estimate of the required rate of expenditure to maintain the operating capacity of the system[40]. This reduction in value is offset by the capital

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39 Implicit in this is an indefinite asset lifetime for this single asset.

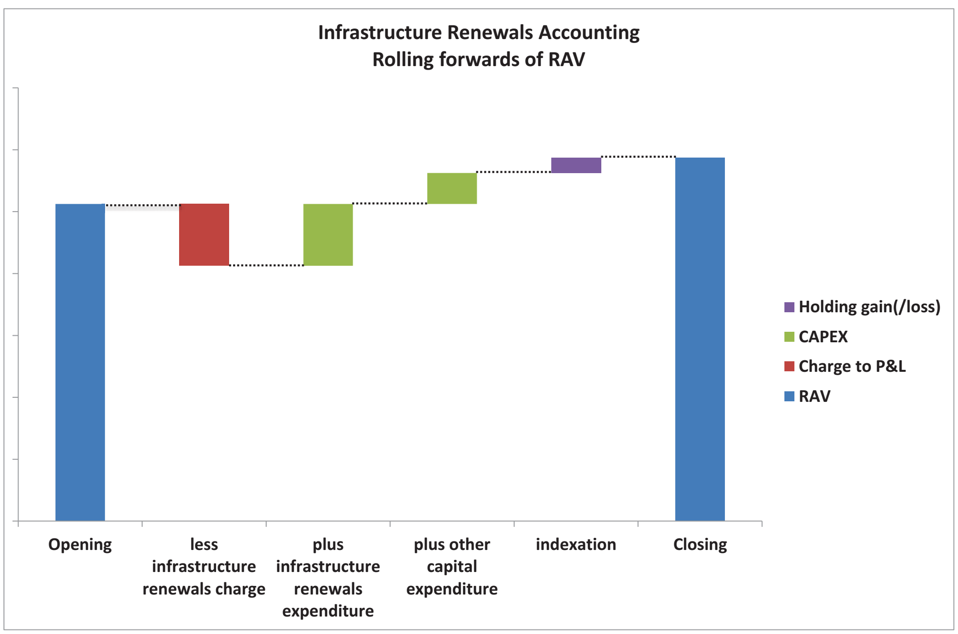
40 So called operational capital maintenance (OCM). This should be an average value which could differ from the actual expenditure in any given year due to some expenditure taking place in large

expenditure on the network. The capital expenditure required to maintain the network should on average be equal to the infrastructure renewals charge, and vice-versa. There may also be additional capital expenditure to extend the capability or size of the system which, if efficiently incurred, should also be added to the asset base. In a steady state, with no extensions to the network, the RAV will remain broadly constant over time, as the depreciation charge and capital expenditure are balanced. Regulators may choose to apply indexation so that allowable revenues reflect changes in purchasing power.

Under this approach, the valuation at the end of the period is estimated by "rolling forwards" the valuation at the beginning of the period:

$$Valuation_{closing} = Valuation_{opening} - depreciation + revaluation + CAPEX$$

Figure 15. RAV under renewals accounting



Source: Frontier Economics

increments at infrequent intervals ("lumpy' expenditure) or variations in expenditure for example due to variations in weather conditions.

Annexe 2: Asset costing approaches for price controls

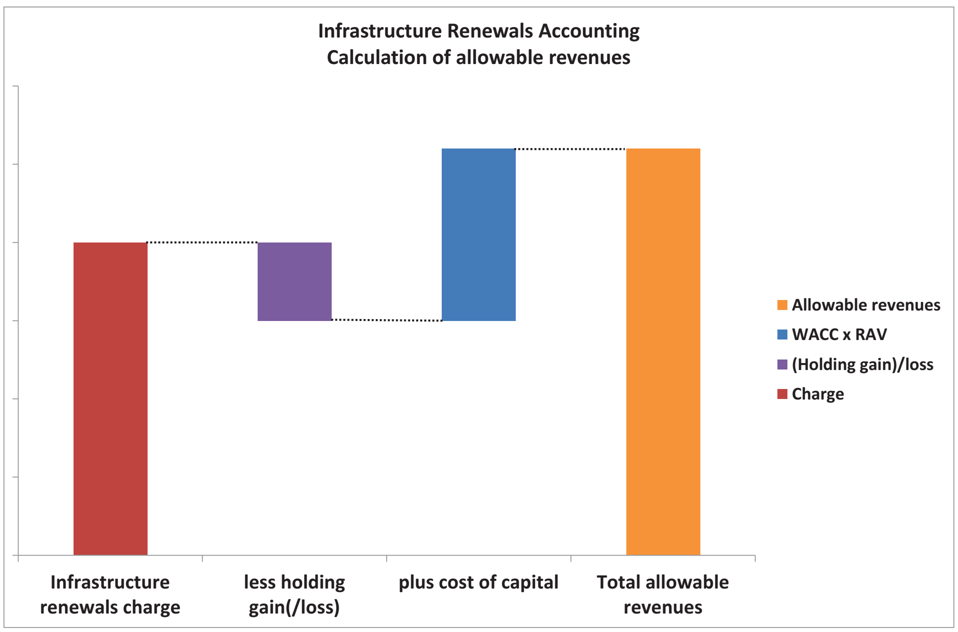
If renewals accounting is implemented from the start of the roll out of the infrastructure, then the initial valuation is zero. However, renewals accounting is typically applied when the system is already in service. Therefore, the valuation of the business must be exogenously determined, for example by determining a regulatory asset base based on the investors' valuation at privatisation or the book value of assets in the accounts.

Allowable revenues

The allowable revenues are determined as the sum of the cost of capital multiplied by the WACC plus the change in valuation of the existing asset base (i.e. excluding capital expenditure):

$$Allowable\ revenues = WACC.Valuation + depreciation - revaalution$$

Figure 16. Allowable revenues under renewals accounting



Source: Frontier Economics

Strengths and weaknesses

A renewals accounting approach, and indeed any approach in which the regulatory asset base is rolled forwards from the existing valuation, provides a high degree of certainty for investors. While the decision on the appropriate level of depreciation may be subject to some uncertainty, investors should be indifferent to the actual level of depreciation, as the return on the existing asset base and any efficient capital expenditure is assured. This approach is also likely to lead to smooth pricing evolution for customers and has limited data requirements. Where the RAV is linked to changes in asset prices through indexation, this approach may provide a reasonable proxy for competitive prices where demand is stable.

Disadvantages of the approach are the need to determine an opening asset base for existing systems when renewals accounting or a RAV is introduced. In addition, the lack of a one-to-one link between the valuation and individual assets can raise difficulties, for example, when disaggregated valuations are required for the purposes of cost allocation. Further, the efficient level of capital expenditure on maintenance must be estimated. However, incentive regulation, such as multi-year price controls, can be used to encourage efficient forward expenditure.

Renewals accounting: UK water industry

The approach of 'rolling forwards' a regulatory asset value is used in a number of regulated industries in the UK, including the water industry.

Ofwat sets the price control based on a financial forecasts ('business plans') for each regulated company required to meet a set of output requirements. Each companies 'revenue requirement' based on the output requirement is then calculated as the sum of: operating expenditure; capital charges; a return on capital and; taxation[41].

The capital charges are calculated using two different methodologies:

- a current cost depreciation charge (CCD) for above-ground assets such as treatment works; and
- an infrastructure renewals charge (IRC) for underground assets, such as pipes, which form part of either the water or sewerage networks.

The IRC is estimated as the annualised costs of maintain the system at its current level of operations based on a medium term view (15 years in recent price controls) of average annual capital expenditure requirements.

The return on capital is calculated by applying a cost of capital to the average regulatory capital value (RCV) during the year. The closing RCV at the end of each period is calculated by 'rolling forwards' the opening RCV by adding forecast capital expenditure and subtracting the capital charges included in the calculation of the revenue requirement plus a range of other adjustments[42].

The RCV was initial set with reference to the price paid by investors for the companies at privatization.

5.4.1 Changes to the regulatory valuation of existing assets

The relationships outlined above between acquisition cost, valuations and allowable revenues provide the correct incentives to make investments if they are applied consistently over the lifetime of each asset.

Over the lifetime of an asset, the regulatory environment may change. For example, regulators may choose to re-evaluate the methodology used to value assets. Similarly, where valuations rely on parameters such as the replacement

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41 As the financial forecast covers the whole business, financial forecasts can include a forecast of the tax paid by the business. This contrasts with the price regulation of telecommunications operators, where only a small proportion of the business is regulated and thus taxation is not separately identified but included within the cost of capital.

42 These other adjustments primarily related to 'grants and contributions' and incentive mechanisms designed to promote efficiency in capital expenditure.

cost of assets or assumptions about the useful economic life of assets, new information may come to light which leads to a re-estimation of these parameters. If existing assets are simply re-valued based on new information or methodologies without taking account of the allowable revenues to date, this will lead to holding gains or losses not included in allowable revenues. This will lead to investors being under- or over-compensated.

Where CCA asset valuations are used to set forward looking price controls, it may be the norm that some holding gains and losses are not reflected in allowable revenues. In this case, differences between forecast and out-turn asset price movements will result in divergences between forecast allowable revenues and the actual change in valuations. However, as long as these differences are *ex ante* expected to be symmetric, investors should have the expectation that the present value of future allowable revenues will equal the acquisition cost, even if the out turn returns will vary. However, this variation between the regulated cost of capital and actual returns will increase the cost of capital; compared to systems where returns are not subject to forecasting errors.

In the case of extraordinary changes in valuation (for example, due to changes in the valuation methodology),[43] regulators must judge whether overall efficiency will be enhanced by avoiding discontinuities in asset valuation or by incorporating new information directly in the calculation of allowable revenues.

Where regulators choose to avoid introducing discontinuities in valuation, there are a number of potential approaches that can be taken including:

- For reasons of consistency continue valuing the existing assets using the previous approach, but introduce the new methodology/information for assets acquired from this date;
- Maintain the asset valuation based on allowable revenues to date, but adjust the profile of forward looking allowable revenues to reflect the new information (for example, by simply applying a factor to the future allowable revenues calculated using the new methodology/information); or
- Setting a " glide path" from the old to new valuations with the allowable revenues calculated based on this glide path.

43 The change in valuation methodology may result from a changed regulatory or market environment or from methodological improvements, for example.

Annexe 2: Asset costing approaches for price controls

Adjusting for discontinuities in valuation: UK fixed access

Up to 1997, BT's regulated prices were set according to HCA valuations and depreciation charges. From 1997, both retail and wholesale regulated prices were set reflecting CCA valuations and depreciation charges.

At the time of the move to CCA, considered the holding gains (principally in the access network) and losses (principally in the core network) due to the change in methodology. Oftel decided not to make any changes to regulated prices to account for these holding gains and losses.

When Ofcom (the successor to Oftel) revisited the valuation of BT's copper access network in 2005, Ofcom reconsidered the CCA approach. In order to minimise the over-recovery of costs due to the holding gain for the assets that were in service at the time of the change in methodology, Ofcom decided to create a RAV for duct and cable to set the price controls for LLU and WLR services. This RAV differed from the CCA valuation and depreciation charges published in BT's Regulatory Financial Statement. The opening RAV of those assets purchased prior to the 1997 change was based on the HCA valuation of those assets while assets purchased after the change continued to be valued on a CCA basis.

5.6 Determining the efficient asset base

Under each of the approaches to asset valuation and determining allowable revenues described in Section 5.2, a regulator may wish to determine the underlying asset base so that the regulated operator is only recover efficiently incurred costs from regulated charges in order to dis-incentivise inefficient investment. This estimation may be done using:

- A top-down approach, where the operators report asset base is adjusted retrospectively for identified inefficiencies;
- A bottom-up approach where an independent assessment of the efficient level of assets is made based on an engineering model; or
- An *ex ante* determination of the efficient level of capital expenditure required.

For practical implementation reasons, there is an inter-dependency between the approach used to estimate the efficient asset base and the approach used to estimate allowable revenues. These approaches are summarised in **Table 4** below and described in further detail in the rest of this section. For example, economic depreciation approaches which are dependent on estimates of future utilisation of equipment generally require a bottom up engineering model.

Table 4. Approaches to estimating efficient asset base

Approach	Valuation/ allowable revenues approach typically used
Top down	Typically based on straight line depreciation (HCA or CCA) in order to allow reconciliation with statutory accounts.
Bottom-up	Tilted annuities typically used where model does not include the whole network lifecycle and hence information on asset purchase data is not estimated. Bottom up approaches covering the whole network lifecycle generally used for implementation demand dependent of economic depreciation.
Ex ante determination of capital expenditure	Valuation approaches based on rolling forwards existing asset valuations, such as IRA

Source: Frontier Economics

5.6.1 Top down approaches

Under a top-down approach, the regulator takes the asset base reported by an operator to provide regulated services and then revises it using estimates of the efficiency of the operator. These estimates may be based on benchmarking studies (ranging from simple unit cost comparisons to econometric studies) or on analysis of the operations of the operator itself. The main advantage of this approach is that it is relatively easy to implement and, when used with HCA, allows a direct reconciliation with data used in statutory accounts. However, the limitations of this approach include difficulties in finding appropriate benchmark operators and in defining a methodology that provides objective results.

Applying CCA based on a direct approach, i.e. revaluation based on price quotes for replacement equipment, may inherently adjust for any inefficiencies which result in the unit acquisition cost being above an efficient level. However, such an approach will not adjust for inefficiencies arising from unnecessary assets being purchased.

5.6.2 Bottom up approaches

Under a bottom-up approach, rather than taking information on the asset base from the regulated operator, cost models are based on a hypothetical efficient operator. The level of demand is taken as given and engineering assumptions are used to estimate the number and type of assets required. These are combined with estimates of the acquisition cost of these assets and asset lifetimes to estimate allowable revenues.

The main advantage of this approach is that it provides a direct estimate of the efficient asset base rather than attempting to adjust the regulated operator's asset based for inefficiencies. However, this approach relies on a number of assumptions including the relationship between demand and network dimensioning and the appropriate technology choice. Models are necessarily reductionist, simplifying complex investment decisions made over time to a series of rules which approximate these decisions. This means that the model may not provide an accurate reflection of the operating conditions faced by operators and may inaccurately estimate the level of efficient costs. Bottom-up models risk being biased downwards.

A hybrid approach reconciles costs estimates derived using a top-down approach with those derived using a bottom-up approach. This approach attempts to minimise the disadvantages associated with each of the approaches. However, where there are differences between top down and bottom up approaches, it may be difficult to determine whether these are due to inefficiencies inflating the top down estimates or inaccuracies in the bottom up estimates.[44]

5.6.3 Determination of efficient capital expenditure

Under approaches based on rolling forwards a RAV, it may be impossible to compare the valuation directly to any external benchmark. Instead, regulators will wish to ensure that any additions to the RAV reflect efficient expenditure and where necessary exclude inefficient expenditure.

If the efficient level of investment is forecast within the framework of a multi-year price control and this is used to update the RAV during the price control, this provides incentives for the regulated operator to minimise capital expenditure as this would lead to a higher than forecast rate of return on a smaller than forecast asset base.

At the end of the price control period, the regulator can then compare the regulated company's the out turn capital expenditure with the regulator's forecast in order to improve the forecast for the next price control period. The degree to which the RCV should reflect actual expenditure rather than forecast expenditure will depend on the incentive structure for the regulated company, with an

44 This assumes the bottom up estimates are lower than the top down estimates. Conversely, if top down estimates are lower it is likely that any discrepancy will relate to inaccuracies in the bottom up model as generally actual costs will not be below an efficient level.

approach giving greater weight to forecast expenditure potentially providing stronger incentives to minimise actual expenditure.

Annexe 2: Asset costing approaches for price controls

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towerhouse consulting

Wholesale pricing for next generation access networks

A new approach

Towerhouse Consulting LLP

29th March 2011

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1 Executive Summary

There is little doubt that the introduction of next generation access ('NGA') networks is changing the economics of fixed telecoms service provision. And, whilst the prospect of faster broadband and new services is to be welcomed, there is a risk that the effectiveness of competition in this sector will be weakened by the change in cost structure. This paper argues for a new approach to wholesale pricing for network access services to ensure that competition continues to be as effective as possible, and to extend the benefits of competition to the widest range of consumers.

In order to create the best chance of having effective competition over the widest possible area, and the greatest scope for innovative competition, we argue that NGA bitstream[1] services must meet two criteria:

- they must allow Communications Providers (CPs)[2] to control the technical characteristics of network services; ***and***
- the recurring per line charges should form a relatively small proportion of the total charges to a CP.

Pricing in this manner effectively shifts the bitstream service further upstream, and means that CPs will be able to compete more effectively. It is therefore unlikely that incumbents will introduce such pricing voluntarily. Regulatory pressure will therefore be needed to ensure that this form of pricing is made available.

Competition will often stimulate innovation. It can be the driving force to encourage the evolution of services to meet the diverse needs of consumers. However, this process is predicated on the ability of competitors to create new services to offer to consumers. This is a well-rehearsed argument in the world of telecoms regulation. It forms one of the principle justifications for local loop unbundling remedies, and for the primacy of physical unbundling remedies to access NGA networks. Equally, it underpins the need for NGA bitstream services to replicate the technical control characteristics of physical unbundling.

The argument we set out in this paper rests on the idea that innovative service differentiation is a function of both technical characteristics *and* price. Fixed telecoms services are increasingly sold in bundles, and in this environment competitive differentiation relates to the manner in which a bundle is priced almost as much as the substance of the constituent services.

Therefore, not only do competitors require the ability to specify technical characteristics, they also need to be able to adopt a range of different retail tariffs. This implies a need for relatively low per-line marginal costs[3]. This cost structure exists for incumbents and other operators who own access network infrastructure,

[1] We will use 'bitstream access' as a generic / collective term to refer to both wholesale broadband access services which include shared (and aggregated) backhaul *and* so-called active access services which tend not to include aggregated backhaul.

[2] For simplicity, we refer to downstream competitors of the incumbent as CPs throughout the paper.

[3] That is, the change in costs associated with selling a fixed-line service to a new customer.

and to a lesser degree for LLU operators. In contrast, it does not tend to exist for competitors using bitstream. This has certainly contributed to the fact that competition based on bitstream has been less effective than LLU. Across the EU, almost three times as many competitor broadband lines are provided using LLU compared to bitstream[4].

1.1 The need for bitstream access to NGA networks

In discussions about wholesale access to NGA networks, regulators have indicated a preference for physical unbundling (or passive access) remedies. Wherever they are viable, we agree that such remedies provide the most robust platform for competition. However, there are always regions in which population density dictates that passive access is uneconomic, and the introduction of NGA networks will tend to increase the number of areas in which this is the case.

The following table summarises the economic feasibility and the technical and practical feasibility of passive access under different NGA network architectures relative to LLU over the current copper network.

Architecture / technology	Economic feasibility	Technical and/or practical feasibility
Current gen copper	◕	●
FTTC	◔	◑
FTTH: GPON	◔	◔
FTTH: P2P fibre	◕	◕
FTTH: WDM-PON	◕	○

Table 1.1: feasibility of passive access under various network architectures

FTTH networks based on point to point fibre have similar characteristics to the current generation network, and therefore would be suitable for unbundling. In contrast, there is little prospect of wide scale adoption of physical unbundling of (or passive access to) FTTC and GPON networks. WDM-PON networks appear to offer considerable potential for highly efficient forms of access which provide excellent levels of technical control. However, this technology is still in the early stages of development, and so cannot currently be relied upon to provide the foundation for competition in the fixed telecoms sector.

[4] Based on the most recent ECTA broadband scorecard (September 2009), there were 11.4 million broadband lines provided using bitstream or resale, but 30.9 million provided using LLU. See http://www.ectaportal.com/en/REPORTS/Broadband-Scorecards/Broadband-Scorecard-2009/.

In the long term, one of these technologies may start to dominate, but for the foreseeable future a range of different architectures are likely to exist – including substantial areas where the network is yet to be upgraded. This diversity, in conjunction with the costs of passive access, will lead to a growing demand for bitstream services. If competition is to be effective *throughout* national markets, and not just in pockets where passive access is viable, then bitstream services will need to create much greater scope for competitive differentiation than they have in the past. The *structure,* and not just the level*,* of bitstream prices will play a critical role in determining whether such differentiation will be economically viable.

1.2 The importance of price structure

The structure of a wholesale access tariff is often the most significant determinant of the cost structure for CPs. Changes in this tariff structure can therefore have a significant impact on a CP's competitiveness. This effect is distinct from the impact of the (average) *level* of wholesale charges.

Competition based on LLU has tended to be more effective than that based on bitstream. It has allowed CPs to create new products, and to offer genuinely new pricing and service bundles. This ability stems from the fact that LLU gives CPs independent control over the technical characteristics of the access service. However, the ability to offer new pricing and service bundles is also a function of the cost structure of relatively low per line recurring charges which LLU generates for CPs. As a result, where CPs serve customers outside their LLU footprint, they often charge significantly more for very similar services[5].

Changes to tariff structure alone can shift the location of a wholesale product in the value chain. Figure 1.1 below shows part of the fixed telecoms value chain. Starting at the left hand side, an operator who owns the network infrastructure end-to-end and self-provides all elements of the service will incur costs according to all the various raw inputs required (civil infrastructure, network equipment, staff costs, IT costs, etc). Many of these will be fixed with respect to the addition of a single new customer in the short run, although not necessarily fixed when considering the addition of large number of customers over a longer period of time.

As one moves to the right, and considers the business models of CPs entering the value chain further downstream, the inputs are less 'raw' having already been processed further upstream. These upstream inputs tend to be priced on a variable basis, and hence the cost structure for CPs operating at this level within the value chain has relatively less fixed, and more variable, cost. In the extreme, we have resale in which the cost structure generally mirrors the retail price structure, and hence is almost entirely variable.

[5] See section 2.4 below for examples.

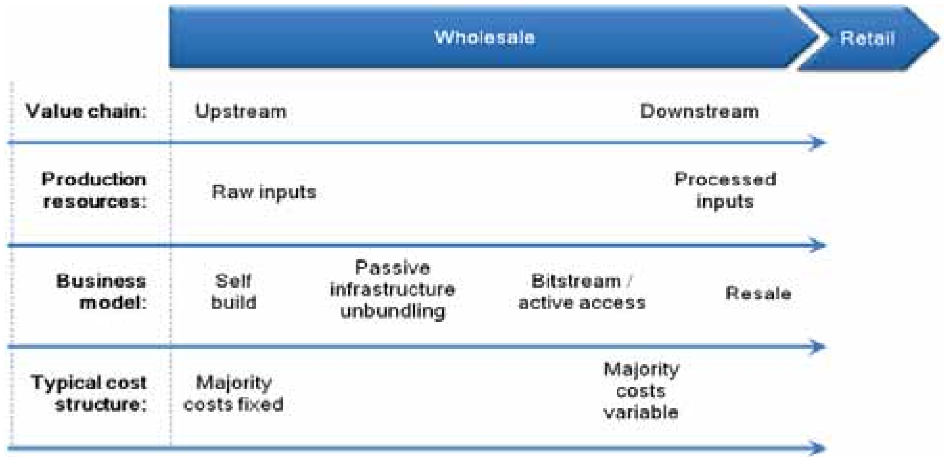

Figure 1.1: price and cost structure

The more that pricing reflects the cost structure of the underlying raw inputs, the further upstream that product will tend to lie. This effect is independent of the ability to control the manner in which the underlying inputs are used[6].

Just as being further upstream adds to the ability to control retail product specification, it also adds to the ability to control retail prices. The reason for this is that there are very few business strategies which support pricing below marginal cost. Recurring per line charges are generally the most significant element of a CP's marginal costs. The level of these charges therefore sets an effective lower limit on the rental element of retail pricing. A relatively low per line recurring charge therefore creates greater scope for pricing innovations[7].

This is important for a number of reasons. The willingness to pay for NGA-based services varies considerably across the population[8], and will almost certainly change over time. Some consumers with niche demands are prepared to pay a premium today, but the majority appear to be happy to use current generation services[9]. As

[6] If a CP also has control over how the raw inputs are used, then the CP is effectively self-providing these inputs. We note below that this amounts to co-investment.

[7] This assumes some form of price discrimination – i.e. the lower price will not be made available to all customers, or on a permanent basis. If pricing is to be uniform over time and to all customers, then a profit maximising firm will only care about total average costs. The manner in which the costs are incurred is then only relevant to the extent that it affects total cost due to the time value of money.

[8] Ofcom recently carried out some consumer research which included an estimate of the willingness to pay for higher speed broadband. They asked consumers how much they would be willing to pay to double their existing broadband speed. The results were a highly skewed distribution. Over half of respondents were either unwilling to pay any extra or were unsure. A very small number were prepared to pay considerably more than their current fee. See, in particular, Figure 3.12 in http://stakeholders.ofcom.org.uk/binaries/consultations/wla/annexes/consumer_research.pdf

[9] For data on take-up of NGA-based services relative to availability, see chart on page 8 of "Super-fast broadband, Context and summary for Ofcom's consultations on the wholesale local access and wholesale broadband access markets". As the report notes (paras 2.21-2.22), the countries leading on roll-out and take-up of broadband tend to be those with significant government support for NGA networks. See, http://stakeholders.ofcom.org.uk/binaries/consultations/wla/annexes/context.pdf.

NGA-based services improve, and as consumer awareness of the benefits of these services increases, it is likely that more people will pay the premium.

Given these circumstances, it will be important for CPs to be able to offer basic access services at a relatively low price, and then 'up-sell' additional and enhanced services to customers. Without the stepping-stone of an attractively priced basic service, it will be difficult to generate the momentum needed to shift the new services from niche interest into the mainstream[10]. Equally, the fact that CPs can attract a wider audience to connect to the network is socially beneficial since this will help to bridge the so-called 'digital divide'.

1.3 Virtual LLU pricing

In line with the principle of cost orientation, we propose a structure for NGA[11] bitstream pricing which approximates the use of resources required to produce the service. Our suggestion is that CPs using a bitstream service with this price structure would incur costs in roughly the same manner as an operator who uses LLU today. A CP would therefore pay for the following wholesale service elements independently:

- service enablement - to create the ability to serve customers in a particular geographic area - through a one-off set up charge and a semi-fixed fee which recurs every few years[12];
- backhaul rental through a regular recurring charge per unit of backhaul per local exchange area served; and
- rental of customer access lines through a regular recurring charge.

We refer to the proposal as 'virtual LLU pricing'. There are many parallels with the 'virtual unbundling' remedies being discussed by a number of National Regulatory Authorities (NRAs)[13]. These have focussed on the technical characteristics of bitstream services, and the ability of CPs to control the network. We fully support these proposals, but add requirements for a price structure which generates a relatively low marginal cost for the CP[14]. This would be simple to adopt, and would help to make competition more effective.

[10] One of the reasons for this is network effects: it is important for networked services to reach as wide an audience as possible (including those relatively less willing to pay) since each additional subscriber increases the value of the service to all the existing subscribers.

[11] The proposal would apply equally well to bitstream based on the current generation network. However, we focus on NGA bitstream because it is likely to be the only viable option for CPs in many circumstances.

[12] The frequency of the charge would be determined by the asset life of the transmission and switching equipment used for the service. So, for example, it might be 5 years for active fibre equipment.

[13] For further details see section 4.3.

[14] In the context of our proposed pricing structure, technical control can be seen as the ability to use the various inputs in different proportions: for example, adopting a different ratio of backhaul bandwidth to lines served.

2 The importance of wholesale tariff structure

2.1 Introduction

Towerhouse Consulting LLP has been commissioned by Vodafone to consider the need for a new approach to wholesale pricing for access to NGA networks. The problem to be addressed is as follows:

- The economics of wholesale network access changes with the introduction of NGA. The result is that passive infrastructure access, equivalent to LLU, will not always provide a viable platform for competition. Therefore, competitors will increasingly need to rely on bitstream services. Unfortunately, to date, competition based on bitstream has been relatively ineffective with the most successful CPs (by market share) using LLU.
- LLU has allowed CPs to offer a much wider range of services, and packages of services, at attractive prices. Part of this is due to the ability to dictate the technical characteristics of the service. However, the flexibility to offer innovative retail tariffs, which has helped to drive the take-up of new services, stems from the fact that LLU creates a relatively low per line marginal cost for CPs.
- In contrast, bitstream pricing tends to be structured like retail services, with most of the cost to the CP coming in the form of a per line recurring charge. This restricts the range of profitable pricing strategies that a CP can adopt, and ultimately limits the effectiveness of competition based on bitstream.

The solution proposed in this paper is an obvious one: to change the structure of bitstream pricing to reduce per line recurring charges, and to introduce or increase other charges which do not vary directly with the number of lines to ensure the incumbent can recover its efficiently incurred costs.

2.1.1 Outline of the paper

The rest of this chapter discusses the importance of the structure of wholesale tariffs as distinct from the general, or average, price level. Then, in chapter 3, we introduce and assess two options for wholesale price structure which would create a lower marginal cost for CPs. The first is an arbitrary shift from recurring per line charges to a standing charge which recurs every few years and is chosen to ensure no change in revenue for the incumbent. This serves to illustrate the importance and influence of price structure as distinct from price level, and therefore to demonstrate the type of changes required in any practical solution.

The second option is a price structure which reflects the consumption of underlying resources, and can therefore be seen as an example of cost orientation. We concentrate on one specific example in which the underlying resources are those which would be used by a CP purchasing a physical unbundling solution such as LLU.

In the penultimate chapter we consider proposals by the European Commission and by a number of NRAs in relation to the issue of access to NGA networks. In particular, we ask whether the EC NGA Recommendation would permit our proposed pricing structure. Finally, we offer some conclusions and recommendations for regulators considering wholesale access to NGA networks.

2.2 Cost structures through the fixed telecoms value chain

Per line charges generally represent a very large proportion of the total payment from the CP to the incumbent for wholesale access. In contrast, a CP incurs costs according to a variety of different drivers for the parts of the service which they self-provide.

Under self-provision, each input[15] used has its own cost characteristics and its own relationship to the number of customers served. The following table describes the four possible relationships between the number of lines and the required volume of the input. It also defines three general cost categories according to these relationships: variable, semi-fixed and fixed.

<table>
<tr><th>Relationship</th><th>Description</th><th>Example</th><th>Cost category</th><th>Proportion of unbundling costs</th></tr>
<tr><td>One-to-one</td><td>An additional unit of the input is required for each additional line.</td><td>Access line to the customer</td><td>Variable</td><td>40% - 60%</td></tr>
<tr><td>Indirect - fixed proportions</td><td>An additional unit of the input is required after a certain number of lines, i.e. the input has a fixed capacity.</td><td>Active electronics</td><td>Semi-fixed</td><td rowspan="2">10% - 30%</td></tr>
<tr><td>Indirect - variable proportions</td><td>Additional units of the input are required as the number of lines increase, but the capacity of the input is variable - to be determined by a managerial choice.</td><td>Backhaul</td><td>Semi-fixed</td></tr>
<tr><td>None</td><td>The volume of the input is essentially fixed relative to the number of lines served[16].</td><td>Some overheads</td><td>Fixed[17]</td><td>10% - 30%</td></tr>
</table>

Table 2.1: possible relationships between input volume and lines served

[15] Inputs could be physical assets such as civil infrastructure, electronics, buildings, vehicles; non-physical assets such as software, licences; or human capital such as engineering, managerial input, customer support, etc.

[16] Assuming at least one line is served.

[17] Fixed cost does not imply a one-off cost. These may be costs which the CP incurs on a regular basis, but the size of the cost does depend on the number of lines served, i.e. it is fixed relative to the number of lines served.

The final column shows an estimated range for the proportion of costs incurred by a CP using physical unbundling. The figures are based on a study[18] by WIK Consult of the costs of various NGA network architectures, and our analysis of the difference between retail prices and unbundling costs[19]. The fixed and semi-fixed costs are annualised and averaged across a volume of lines based on a CP with a market share of around 20%.

The proportion of variable costs would be much higher for a CP using a bitstream service for which pricing was predominantly based on per line charges,. More generally, the greater the proportion of inputs that a CP self-provides, the lower the proportion of costs which are likely to be variable. Therefore, as a CP climbs the "ladder of investment" and builds out its own infrastructure closer to the end user premises, their cost structure changes from one that is predominantly variable to one that is predominantly fixed and semi-fixed. This trend is shown in figure 1.1 above.

It is clear, however, that this trend is driven largely by the choice of bitstream tariff structure. It is not inherent in the nature of the wholesale bitstream service or the underlying cost structure, and therefore can be changed relatively easily.

2.3 The importance of wholesale tariff structure

Wholesale tariff structure can have a significant impact on the ability of CPs to compete by restricting the range of profitable pricing strategies which they can adopt. The argument is simple:

[18] http://www.vodafone.com/content/dam/vodafone/about/public_policy/position_papers/vodafone_report_final_wkconsult.pdf

[19] At figure 3-12, the WIK report shows the modelled cost structure of a fibre unbundler with 20% market share within a less densely populated urban area. In this scenario, the fibre access charge represents 57% of total annualised costs for the CP. For bitstream access from the local exchange this rises to 65%. These figures are derived from detailed modelling of the costs of a greenfied build NGA network.

This leads to some of the highest costs, both proportionately and in absolute terms, in the access network. Therefore, we have also looked at the proportion of costs for LLU operators today. We have considered the UK market. We assume that the market is reasonably competitive in areas where LLU is viable, and therefore current retail prices provide a good approximation for total costs on a per line basis (including a return on capital, i.e. a profit margin). We consider bundles of broadband and telephony line rental, and ignore introductory discounts and special offers.

The (non-discounted) rental price per month for these services is around £20. For examples, see http://www.broadbandchoices.co.uk. Excluding VAT, CPs therefore receive revenue of around £16 per line per month which we assume to be an approximate total economic cost of providing the service. The costs for LLU MPF line rental are currently £89.10 per year (£7.43 per month). This works out as 46% of total costs.

For a final point of comparison, we consider CPs in the UK providing the same telephony and broadband package using wholesale access products from BT. They will most likely use IPStream and WLR (details and pricing available from www.btwholesale.com and www.openreach.co.uk respectively). The current price per line per month for these services is £6.43 and £8.49 respectively, giving a total of £14.82 per month. We should note that this is not directly comparable with the assumed £16 total cost since that was based only on areas where LLU is viable. IPStream and WLR offer national coverage. If we perform the same analysis of retail pricing but in rural areas we find that the market price is closer to £30 per month. Assuming this price is indicative of total economic cost (and we should be less confident in this assumption since the market is less effectively competitive in these areas), then the wholesale access charges represent somewhere over 60% of these costs.

- Selling at a price below marginal cost results in a loss of money on each sale. In general, therefore, a CP will not sell telecoms services with a monthly recurring charge below its recurring per line wholesale cost.
- If a CP finds that it is selling to some customers at a price below marginal cost, it will clearly try to reverse the situation. This could be by selling additional services, but by far the simplest, cheapest and most certain method will be to either raise the price or terminate the service to these customers.
- As a result, the recurring per line element of wholesale charges sets an effective lower limit on a CP's retail pricing.

On the assumption that wholesale access service prices match the simple rental-per-line structure of retail pricing, then CPs who enter the value further downstream and rely more heavily on the incumbent's infrastructure are restricted in the range of profitable pricing strategies they can adopt. The relatively high recurring per line charges that they face imply a relatively high minimum retail price level.

Despite the simplicity of this argument, there has been very little direct analysis of wholesale price structures by regulators. The reason is perhaps that upstream remedies, such as physical unbundling, tend to deliver the beneficial cost structure of low recurring per line charges as a by-product of the fact that CPs have to self-provide more network infrastructure. Therefore, because physical unbundling remedies currently provide the foundation for competition, there has been little imperative to understand the beneficial effects of changing wholesale pricing structure.

Alternatively, one might argue that as long as the average price a firm charges is above its average costs it will be profitable, and therefore it is the average cost and price level that is important. This is likely to be true in industries where average cost is roughly the same as marginal cost. However, for industries such as telecoms which incur significant fixed costs, then average cost[20] is usually[21] higher than the marginal cost. In these circumstances, there are many profitable and sustainable strategies in which the firm would sell to some customers, some of the time, at a price below average cost. For example, telephony line rental has traditionally been priced below average cost, with higher margins on calls making up the shortfall in costs.

In contrast, there are very few circumstances in which selling below marginal cost will be rational:

- On the expectation that prices will rise. This may be the case when a product is first introduced, for example. In order to build market awareness, a firm might offer very significant introductory discounts.

[20] We should note that 'average cost' in the presence of fixed costs from durable assets implies an assumption about the length of time it will take to recover the cost of durable assets.

[21] Short run marginal cost may spike temporarily, for example where the addition of one extra customer implies the need for increased backhaul capacity. However, once the capacity is installed, short run marginal cost will revert to its usual position below average cost.

- On the expectation that costs will fall. A firm may decide to sell at a loss to help build market share and thereby achieve economies of scale which drive reductions in marginal costs.
- In order to drive sales of a related product which has a profit margin greater than the loss on the sale of the first product. For example, printer and toner cartridges; razors and razor blades.
- As an anti-competitive practice. For example, a firm may wish to force a new competitor out of the market, or ward off threatened entry, by selling at a loss.

There are two points to note. First, all except the linked sales option are temporary strategies. Secondly, the strategies make most sense in the context of the sale of goods where there is a one-off transaction. Therefore, the total loss associated with a sale below marginal cost is a fixed, known quantity. In contrast, telecoms services are rented over a period of time. Under these circumstances, the total loss associated with an additional sale where the rental price is below the marginal recurring cost depends on the period of service. That is, selling below marginal recurring cost in telecoms creates an open ended financial liability.

Our proposal is to create a lower marginal cost for CPs by reducing per line recurring wholesale charges, but increasing other charges to compensate the incumbent for the loss of revenue (or to otherwise ensure that the incumbent can fully recover its efficiently incurred costs). It is easy to accept that a lower marginal cost generally creates more pricing flexibility, since it would usually be indicative of lower average total costs. However, in our proposal, the lower marginal cost is only achieved by incurring much high fixed and semi-fixed costs.

Therefore, in order to isolate the effects of changes in total average costs, we must consider two scenarios in which total average costs are the same, and so the reduction in marginal cost in one of the scenarios is exactly offset by higher fixed and semi-fixed costs.

Assuming total average costs are the same, it may seem reasonable to believe that the manner in which the costs are incurred is irrelevant as the level of marginal cost in each scenario will not affect the range of profitable pricing strategies for a CP. However, this is only true to the extent that total cost stays the same regardless of the commercial decisions taken by the CP. In reality, a CP’s pricing decisions will affect total costs, and so cannot be ignored. For example, if a CP’s chosen strategy calls for a price below marginal cost, then it can increase its profits easily by increasing price or withdrawing service.

Consider the following example: in a competitive market, a CP can sell a basic broadband service for €10 per month, and can offer a premium TV services as an optional extra for €5 per month. Given this pricing, it will achieve demand of 1 million broadband lines, and 100,000 of these customers will take up the TV service. We consider two cost scenarios shown in table 2.2 below.

	Scenario 1	Scenario 2
Marginal cost of broadband (per month)	€9.80	€10.20
Marginal cost of TV (per month)	€2	€2
Fixed costs (per month)	€400,000	€0
Profit given pricing of €10 and €5 (per month)	€100,000	€100,000

Table 2.2: two cost scenarios

Given the same pricing strategy of €10 for broadband and €5 for TV, a CP would achieve the same volume and would make the same profit under each scenario. However, it is easy to see that scenario 2 is implausible. Even if there is the prospect of profitability in the future through the sale of the high margin TV service, the CP is unlikely to sell the basic broadband service to 900,000 customers at a total loss of €180,000. A simple strategy for increasing profits would be to increase price to these customers, or to terminate their services. In reality, the ease and immediacy of this strategy is likely to outweigh the possibility of gaining higher profits in the future from up-selling the optional TV to the customer base.

The conclusion is that lower marginal costs create the opportunity to adopt a wider range of profitable pricing strategies – even when total costs remain the same. With this in mind, we should note that our proposed changes to the structure of bitstream tariffs are not equivalent to discounts. The objective of a discount scheme is to reduce total average costs. As we have just seen, there are benefits to having a lower marginal cost even if total average cost remains the same. However, we should also note that in moving to a price structure where CPs pay more upfront, there is a transfer of risk from incumbent to CP. As such, a discount may be justified to reflect the reduction in the incumbent's costs[22]. Discounts are discussed further in section 4.2 below in relation to the EC NGA Recommendation.

2.4 Retail price innovation and consumer benefits

Having established that a price structure which generates low marginal cost will create greater scope for innovative retail pricing, we next consider why this is important for competition and consumers. There are a number of reasons, but in essence these amount to the fact that greater flexibility over retail pricing will mean that the market can serve a greater proportion of potential demand. Willingness to pay for NGA based services is likely to vary widely across the population. Therefore, for any given price, there will be some customers who are prepared to pay a little more, and some who will not buy the service until the price falls.

[22] i.e. to the extent that the incumbent's costs include an allowance for risk, these costs will reduce if some of that risk is transferred to a CP.

If a CP can structure its retail packages such that those willing to pay a little more do so, then they can also price slightly lower to attract currently unserved consumers whilst maintaining or increasing their profits. There are a number of strategies which would help achieve this aim, all used in the market today for current generation broadband, and involving some combination of price discrimination and product differentiation. Examples are introductory discounts, and bandwidth or download limits. Product differentiation such as download limits will, in many cases, make little difference to costs, but will allow the CP to vary prices for essentially the same service. For example, many customers would prefer to pay a little extra for a larger download limit than they really need for peace of mind. Therefore, two customers can make exactly the same use of the network, and so cause the same level of cost, but will pay a different price for the service.

The key is that each customer served generates a positive margin: even the low rental payments more than cover per line recurring wholesale charges. Each customer is therefore making a positive contribution to the recovery of the fixed and semi-fixed costs.

There is evidence of this effect from the market today. Where LLU operators offer services nationally, then they generally offer more competitive pricing and more comprehensive packages of services in areas where they can use their own network rather than the incumbent's[23]. For example, the CP 'free' in France sells its basic broadband service for €29.99 per month in LLU and fibre areas, but €35.98 elsewhere[24]. TalkTalk in the UK offers broadband packages outside its LLU footprint, but charges £15.32 per month extra.[25]

The ability to adopt innovative price structures will be particularly important in the NGA world. We expect that a large number of NGA-based services will be sold as an addition or enhancement to a basic line rental service. This type of bundling already dominates current generation broadband markets. For example, in their most recent consumer research in the UK, Ofcom found that,

> *for many consumers, buying a bundle was a good route to trying out a new service for the first time. This indicates that bundling may well be a driver of take-up of broadband and pay-TV services.*

[23] This is subject to the following caveat. Retail pricing and packages are of course influenced by a variety of factors. In terms of cost, LLU operators specifically target areas where the average total cost of provision is lower. Therefore, if retail prices are differentiated on a geographic basis, one would expect them to be higher outside LLU footprint areas.

[24] Current prices from www.free.fr

[25] See www.talktalk.co.uk for details. For more examples from the UK, see Annex 8 from Ofcom's "Review of the wholesale broadband access markets 2010". See http://stakeholders.ofcom.org.uk/binaries/consultations/wba/summary/wbacondoc.pdf.

> *[...] 45% of people with pay-TV did not have this service before subscribing to it within a bundle. Similarly, 40% of people with fixed broadband in a bundle did not have this service before.*[26]

Initially, when consumer awareness of NGA services is low, willingness to pay is likely to be low. However, in time, this will change. It is therefore important that CPs can attract customers to their network with relatively low priced basic or initial offers, and then be able to up-sell additional services in the future.

From a macroeconomic perspective, the effect of more connections to NGA networks is that there will be greater interest in developing services which require the additional functionality that these networks provide. In turn, more and better services will attract more consumers to the new networks. There is, accordingly, a positive feedback loop between the number of consumers connected to NGA networks and the development of new services. This is an example of a network effect: each additional connection adds to the value of all the existing connections to the network.

Finally, the ability to target parts of the demand curve which are not currently served clearly helps to bridge the digital divide. Ensuring that there is a low threshold to join the network is perhaps the most important tool in tackling this policy issue.

[26] Page 62, *The Communications Market 2010*, Ofcom. Available from http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr10/?a=0

3 Options for achieving lower marginal cost

This chapter explores two options for achieving a lower marginal per line cost for CPs: an arbitrary change in price structure which keeps revenue constant for the incumbent; and a pricing model which replicates the cost structure faced by CPs using LLU. A comprehensive assessment of alternative pricing structures is beyond the scope of this paper. Therefore, our conclusions are directional rather than absolute: we believe that the proposals made would be an improvement, but even better options may well exist.

3.1 'Pure' virtual pricing

We begin by considering a simple bitstream service provided by an incumbent consisting of access, backhaul and all the relevant associated facilities to ensure end-to-end connectivity between a point of handover[27] to the CP and the customer premises. This section considers the impact of a reduction in the recurring per line charge for the service, whilst maintaining total revenue for the incumbent by increasing other wholesale charges.

We assess the following two price structure scenarios under the assumption that volumes are growing constantly.

a. high-per-line-charge: in this scenario, all the incumbent's revenue comes from a recurring per line charge; and
b. low-per-line-charge: in this scenario the per line charge is lower, and the shortfall in revenue is made up through a semi-fixed charge which recurs every 5 years.

For any given volume, moving from the high- to the low-per-line-charge scenario implies a loss of revenue for the incumbent. This difference in revenue gets larger as volume increases. Therefore, we need to know the volume of lines in order to calculate the semi-fixed charges and ensure that revenue remains the same under the two scenarios.

Figure 3.1 below shows the incumbent's revenue profile under the two scenarios. We have assumed constant growth in the volume of lines. The size of the semi-fixed charge is set to ensure that total cumulative revenue is the same under each scenario after every 5 years.

[27] The location of the point of handover is not important to the present discussion – it could be close to the customer premises or in the core network.

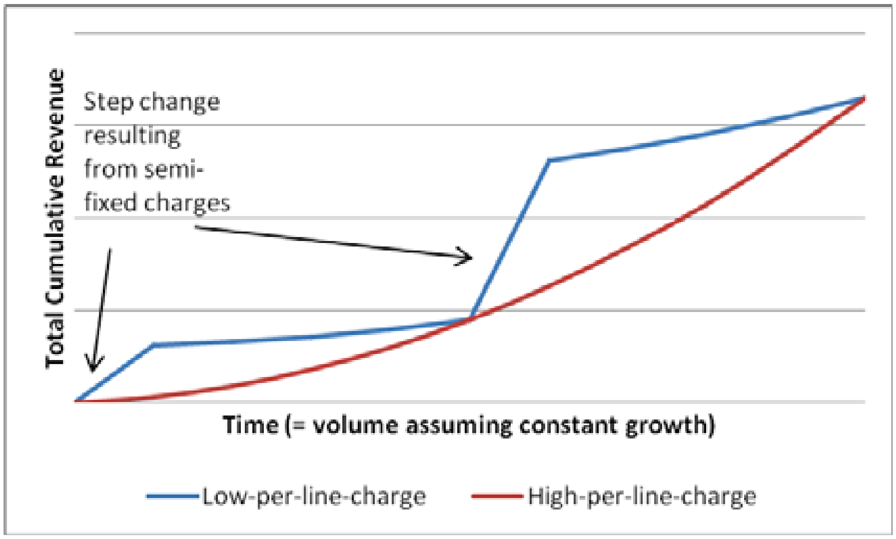

Figure 3.1: cumulative incumbent revenue under low- and high-per-line-charge scenarios

Under high-per-line-charges, the incumbent's revenue is dictated entirely by the number of lines sold. Under the alternative scenario, the revenue profile changes, but by assumption the cumulative amount of revenue collected by the incumbent is the same. The only difference is that CPs pay, and the incumbent receives, a lump sum[28] on a periodic basis. Therefore, the total revenue received by the incumbent shifts from the smooth function of volume (shown in red) to a lumpy function of volume and time (shown in blue).

We now consider the impact of moving from the high- to the low-per-line-charge scenario for the CP and for the incumbent.

3.1.1 Impact on the CP

At first glance, the CP appears to be worse off under the low-per-line-charge scenario. At every moment before the end of each 5 year period they have paid more in total to the incumbent. In particular, they have been required to pay a significant amount of money upfront. As such, there is a transfer of risk from the incumbent to the CP[29].

However, the CP benefits from a lower per line marginal cost, and can therefore adopt a much wider range of profitable pricing strategies. This increases the scope for competition on the basis of innovation and differentiation. In particular, it opens a potentially vital business strategy of attracting a large customer base through a relatively low line rental, and then 'up-selling' higher margin services[30].

[28] This size of the lump sum depends on the forecast volume. In the example shown we have assumed constant growth in the volume of lines, and therefore the lump sum increases.

[29] We need to be careful about assessing risk and uncertainty using our current model since we have implicitly assumed perfect foresight in order to assure ourselves of revenue equivalence at the end of each 5 year period.

[30] For further discussion, see section 2.4.

The upfront costs associated with the change in price structure may be seen as a barrier to entry by creating economies of scale, and will therefore prevent some CPs from competing. To some extent this is true, but as we have seen, there is a reward associated with incurring the increased upfront costs and risks. This is very similar to the issues faced by a CP considering moving up the "ladder of investment".[31]

There are two other points to note in relation to this argument. First, one can make the upfront costs less of a hurdle by ensuring that the relevant charges are sufficiently granular. For example, if the bitstream service offered access on a regional basis, a CP could choose to build up to full national coverage gradually, and therefore would not have to incur all the upfront costs in one go. This would mirror the approach taken by LLU operators in building their networks.

Secondly, given that the effect of the change in price structure is to shift the bitstream service further upstream, it would enable the creation of a secondary wholesale bitstream or resale market. Therefore, if there is demand from smaller scale CPs, the market should create additional downstream wholesale services which can be priced on a traditional per line basis.

3.1.2 Impact on incumbent

The revenue profile for the incumbent is shifted such that money is received sooner. Therefore, holding everything else constant, this reduces the risk associated with recovering the costs of providing the service. However, we must accept that in reality, everything else would not stay constant.

Perhaps the most significant impact on the incumbent would be that, as noted above, the new price structure would enable CPs to offer a wider range of retail tariffs. In other words, it would make CPs more effective competitors by giving them greater independence to choose a retail tariff which does not match the bitstream pricing.

From this perspective, the incumbent has some control over a CPs retail pricing under the high-per-line-charge scenario. In effect, the higher the recurring per line charge (as a proportion of total bitstream charges), the less scope there is for a CP to adopt different pricing, and therefore the greater the level of influence of the bitstream charges on retail pricing. In moving to the low-per-line-charge scenario, the incumbent loses some of this control.

A second issue for the incumbent is cost recovery. In the low-per-line-charge scenario, the incumbent's revenue becomes less sensitive to the volume of lines, but much more sensitive to the number of CPs. Small changes in the number of CPs can cause very large changes in revenue. Therefore, the potential variability of the incumbent's revenue increases.

Similarly, given that there is uncertainty over the future volume of lines, one cannot dimension fixed and semi-fixed charges to guarantee revenue equivalence. If a CP sells a smaller number of lines than expected, then the average revenue per line for the incumbent will be higher than the high cost scenario; but if the CP sells more than

[31] This is not surprising since we have proposed the change in price structure in order to better match the cost structure of the underlying network assets.

expected, then average revenue per line will be lower. This is shown in the figure 3.2 below.

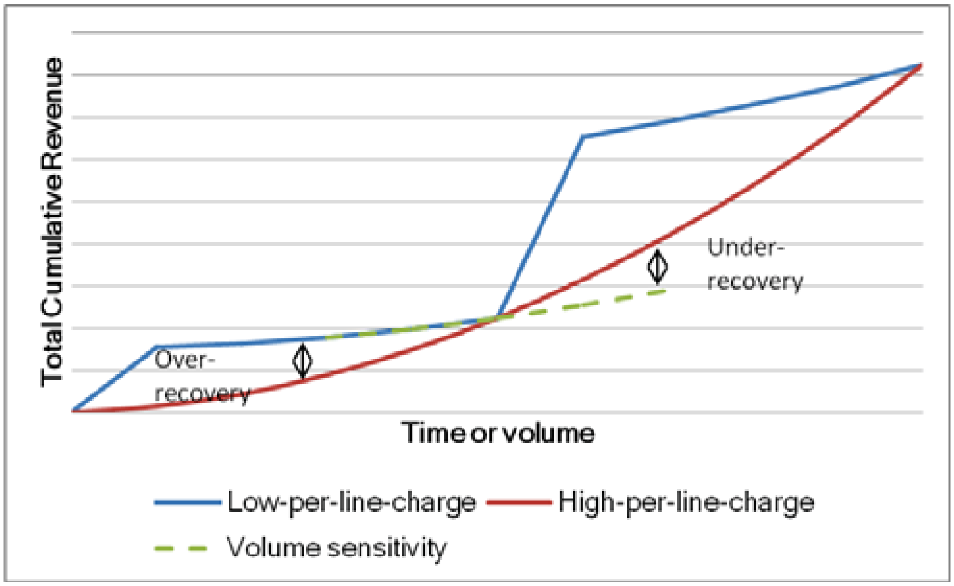

Figure 3.2: over- and under-recovery of revenue relative to the high recurring charge scenario

Risks of over- and under-recovery are an unavoidable feature of the telecoms industry given the largely fixed nature of costs. A variety of volume and timing assumptions are required whenever fixed costs are recovered through simple per line recurring charges. These volume forecasts concern not only the number of customer lines to be served in the future, but the relative amounts of all the various inputs required to produce the service. If any of these volume forecasts turn out to be wrong, then revenue will not match cost. These complexities and uncertainties are intrinsic to the process of setting regulated prices: the regulator must try to verify all these costing assumptions to ensure that future revenues do match costs.

One of the advantages of moving away from a price structure in which most costs are recovered through per line charges is that it reduces the sensitivity of cost recovery to the volume of lines. In a sense, the low-per-line-charge scenario is an example of greater cost orientation in pricing – to have a structure for the prices which more closely matches the manner in which underlying costs are incurred. This idea of pricing to match resource use is explored further in the following section. From the perspective of cost recovery, it can mean that the risks of under- and over-recovery are reduced.

3.1.3 Impact on competition and investment

A final point to note is that the increased competitive intensity associated with the change in price structure may be seen as damaging to long term investment prospects. In the sense that CPs gain access to lower marginal costs without investing more in physical assets, it may appear as if they are less committed to the long term prospects for the market. The counter argument is that although CPs are not investing in their own physical assets, they are making a similar financial commitment through the upfront payments. In a very real sense, the CPs are investing in the physical assets of the incumbent[32].

Equally, to the extent that upfront payments represent underlying costs (which is the basis of the option discussed in the following section), the risks of short-termism are no different from those based on competition via unbundling today. Ultimately, a CP must recover its fixed costs to be profitable. The more significant the fixed (and semi-fixed) costs, the greater the risks to a CP of an average price level closer to marginal costs. As a result, we believe that the proposed increases to charges to compensate for lost revenue will tend to offset the risks of short-termism: a very low marginal cost will only be achieved if the CP invests a very significant amount upfront.

3.2 Pricing to match resource use

In this section we consider how a change in wholesale price structure to deliver lower marginal costs to CPs can be justified on the basis of matching the use (and cost) of resources[33]. As discussed in the previous chapter, the production of a fixed telecoms service requires a range of different inputs. With bitstream services, many of these inputs are preassembled, and their respective costs are recovered through a simple per line charge. The alternative we now explore is for a CP to pay for some of the underlying inputs separately, and according to the manner in which they are used.

3.2.1 A model of virtual LLU pricing

In matching wholesale prices to underlying costs, we must decide on the level of granularity of the costs. That is, how far up the value chain should we look to determine cost structure? The closer we get to the raw, unprocessed inputs, the higher will be the proportion of fixed costs. Given the relative success of copper LLU, we believe that a good starting point is to consider the cost structure faced by an LLU operator. Therefore, we first define a stylised model of the costs incurred by a CP using LLU assuming they rent backhaul capacity from the incumbent or a third party. We consider only the most significant drivers of cost:

- line rental and connection;
- one off costs associated with enabling the provision of service from an exchange – DSLAM capex and installation, backhaul installation and one-off collocation costs;
- recurring costs driven by the number of exchanges enabled – backhaul rental (also driven by choice of backhaul bandwidth), space and power rental; and
- common recurring costs (i.e. driven by the provision of service *per se*) - operating and maintenance, systems interface costs, overheads.

Ultimately, we want to generate a price structure for NGA bitstream which creates the same cost structure for a CP as that of a copper LLU operator today. Clearly, the

[32] See section 3.2.2 on the relationship between the proposed change in pricing structure and co-investment.

[33] As previously noted, this can be seen as an argument for genuinely cost oriented pricing, i.e. pricing which genuinely reflects the cost of resources used in the production of the service.

network components will be different for NGA bitstream, but if we abstract sufficiently, NGA and the current generation network share the same cost drivers for components which perform the same function. This is shown in figure 3.3 below, which applies these LLU costs categories to a generic network architecture. The passive access element could be a physical fibre, a combination of dedicated fibre and wavelength (as in GPON), or the copper sub-loop in the case of FTTC. The location of the aggregation point can therefore vary depending on network architecture.

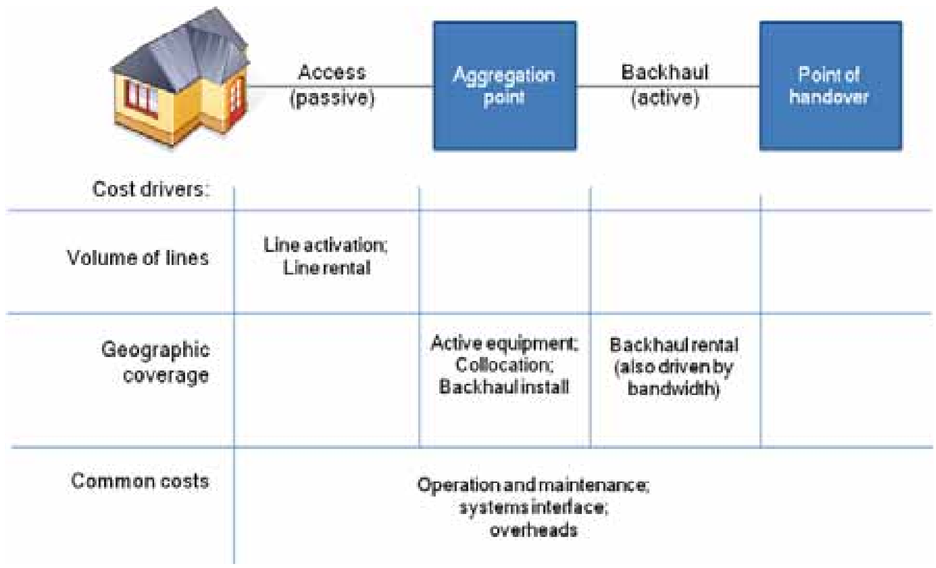

Figure 3.3: cost drivers in bitstream access provision

With these broad categories of cost in mind, we can now map the costs to a specific price structure for bitstream. Pricing will consist of a combination of fixed and recurring charges relating to the number of aggregation areas served, the amount of backhaul bandwidth (per aggregation area), and the number of lines served. Common costs will need to be recovered through a mark-up to these prices. In the interest of achieving a lower marginal cost for the CP, and matching the underlying cost structure, we would suggest that such mark-ups are not applied to the recurring per line charges.

Under our proposal, a CP would pay separately for all the items listed in table 3.1 below. As a result, the line rental element of the bitstream charge would be a much smaller percentage of the total, resulting in a relatively lower marginal cost to the CP. Equally, since the incumbent receives revenue in a manner which more closely reflects the way in which costs are incurred, the risk of under-recovery should be reduced. In essence, there is a transfer of risk from the incumbent to the CP, which may help to justify NGA investments.

	Per line	Per aggregation area served	Bandwidth per aggregation area
Fixed	Connection	Installation	*None*
Semi-fixed	*None*	Active equipment capex	*None*
Recurring	Line rental	Power and colo; maintenance and repair	Backhaul

Table 3.1: elements of the proposed charging structure

A final point to note is that, thus far, we have not assumed that the CP actually controls the relative proportions in which the underlying inputs are used. They merely pay for them on a different basis. In order to generate control over technical characteristics, and therefore to create new services, it is vital that CPs are able to use the inputs in different proportions. The most obvious example is backhaul: in order to deliver services requiring greater reliability, such as voice services or video streaming, it is important that the CP be able to allocate additional backhaul bandwidth per customer line.

3.2.2 Relationship to co-investment

The idea explored in the previous section is that pricing should reflect the manner in which underlying costs are incurred. In the extreme, pricing could mirror this cost structure precisely: where there are fixed costs for the incumbent, a CP pays a one-off upfront fee; wherever the incumbent installs extra equipment, the CP pays a share of the costs; etc. This amounts to the idea of co-investment which has been discussed by a number of NRAs and was referred to in the recent EC recommendation on NGA networks[34].

Co-investment transfers a significant proportion of the risk associated with investing in NGA from the incumbent to the CP. As a result, the CP ought to benefit from a marginal cost which is similar to that incurred by the incumbent.

We can show the full range of options for wholesale price structure on the value chain chart introduced in chapter 1. The furthest upstream option is co-investment where the price structure matches the very high proportion of fixed costs associated with physical network infrastructure investment. Moving downstream, an increasing proportion of costs are distributed as depreciation charges and recovered through recurring wholesale per line charges. As the proportion of cost recovered through per line charges increases, the scope to offer differentiated retail pricing reduces. Ultimately, a CP is simply reselling an identical product at a very similar price, but under a different brand.

[34] Commission Recommendation of 20 September 2010 on regulated access to Next Generation Access Networks, **2010/572/EU.**

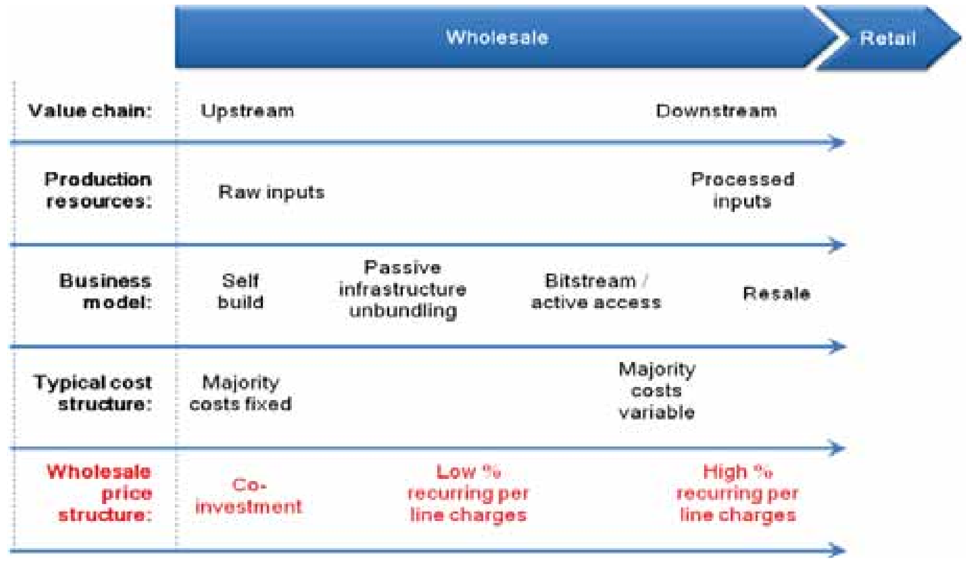

Figure 3.4: wholesale price structure and the fixed telecoms value chain

4 The debate so far

This chapter provides a brief overview of the proposed regulatory solutions to the issue of wholesale access to NGA networks. Throughout this paper we have assumed that investment in NGA will take place to some degree, and have focussed on the issue of access to these new networks. In addition to this issue, regulators have also been concerned with the incentives to invest in building NGA networks.

It has become clear from these discussions that there is a trade-off between promoting investment in NGA networks and promoting competition through regulated access to the networks. This trade-off creates uncertainty over the future course of regulation. In particular, proposals to create an environment more conducive to investment are taken to mean that competition will become weaker. Therefore regulators have been keen to stress that they will continue to support competition.

We believe that our proposal for a different structure for bitstream pricing can help to balance the trade-off, and therefore help to reduce regulatory uncertainty, by creating additional options for wholesale access. Pricing structure is more flexible than product design and the location of physical points of access. This makes it possible to create additional rungs on the ladder of investment. This helps to create options which both support effective competition *and* maintain (or even improve) incumbent incentives to invest. Therefore, we position our proposal as an addition to, rather than replacement of, the existing NRA proposals.

In the following section we provide a review of the economics of access to various different types of NGA network. In light of this, we consider the EC NGA recommendation, and then discuss some of the proposals from NRAs for virtual unbundling services.

4.1 The economics of NGA access

At the conceptual level, there are four basic designs for NGA networks:

1. Fibre to the cabinet
2. GPON - fibre to the home
3. WDM PON – fibre to the home
4. Point to point fibre to the home

Table 1.1 in the executive summary shows the economic and technical feasibility of physical unbundling under these network architectures relative to LLU. Under FTTC and GPON, the physical location where a CP would need to connect to the network in order to unbundle passive network components lies very close to the customer premises. The economics of access in these circumstances are roughly equivalent to unbundling exchanges in sparsely populated areas in current generation networks: costs are high relative to the number of potential customers, and therefore duplication of infrastructure by a number of competing CPs is not financially viable. Therefore, under these network architectures, it is likely that bitstream products will be required to support competition in many areas.

WDM PON technology holds out the prospect of wavelength unbundling. Wavelengths represent uncontended bandwidth, and provide a good approximation to (and for many uses, indistinguishable from) a physical fibre connection. Wavelengths can, in theory, be 'unbundled'. That is, a single wavelength representing pure uncontended bandwidth to a single customer can be handed over to a CP, leaving the CP to specify the services running over the connection almost without constraint.[35]

However, the technology is still in its infancy with standards yet to be agreed. It is therefore likely to be some time before it becomes a genuine option for real world deployment.

From the perspective of a CP currently using LLU, point to point FTTH provides the closest equivalent to the current network architecture and the possibility of a smooth transition to the new network. Point-to-point fibres are likely to terminate at, or in the vicinity of, the local exchange, and can be unbundled in a manner equivalent to the copper network.

Without doubt, the option of fully unbundling point to point fibre is likely to deliver the most robust forms of competition. It would generate least disruption to the business model of established competitors, and it delivers perhaps the greatest scope/opportunity to engineer competing services to the desired specification. As shown in the recent WIK-Consult study[36], P2P FTTH networks do not necessarily cost significantly more to build than PON networks.

However, from a practical perspective, few incumbents are actually planning to build P2P FTTH networks for the residential sector. Even those planning to use this technology will not deploy it everywhere. Our conclusion is that under almost all realistic NGA roll-out scenarios there will be significant demand for bitstream services to support competition.

To date, bitstream services have had little success in enabling effective competition. As a result, regulators have adopted one, or both, of two positions:

- that regulation should intervene to help improve the business case for physical unbundling; and/or
- that bitstream services should be improved to allow CPs to compete more effectively by ensuring that bitstream shares the technical characteristics of passive infrastructure access.

The EC recommendation, considered in the following section, sits very much in the former category; and the virtual unbundling proposals from the Austrian, Danish and

[35] Furthermore, since the wavelength can be transmitted without material degradation of signal considerable distances (and with appropriate regeneration, can be transmitted for vast distances), WDM creates the possibility of genuinely 'virtual' physical unbundling – that is, the CP would gain access to the network in a manner that was functionally very similar to physical unbundling, but be able to do so remotely. The physical proximity of the CP to the customer would have no bearing on the functionality of the access connection.

[36] *Op. cit.*

UK NRAs in the latter. Our proposal can be seen as an extension of the second position to cover pricing: bitstream pricing should ensure that CPs face a structure of costs as-if they were using physical unbundling.

4.2 European Commission Recommendation on NGA networks

The recent recommendation focuses heavily on passive infrastructure access as the optimal solution. It requires that NRAs consider requirements to mandate access to[37]:

a. Underlying civil infrastructure such as duct and poles;

b. The terminating segment in the case of FTTH;

c. The entire fibre loop in the case of P2P FTTH; and

d. The copper sub-loop (in FTTN/FTTC deployments).

In addition, the recommendation suggests that, if permissible under national laws, the SMP operator should be required to deploy multiple fibre lines in the terminating segment and additional duct capacity to cater for demand from other operators[38].

The recommendation implies that active access remedies are relevant only to market 5 – that for wholesale broadband access. Here, the EC notes the need for wholesale products to reflect the full range of capabilities of the NGA network in order to allow CPs to compete effectively. We interpret this to mean that such wholesale products (which we have referred to as bitstream services) should allow a CP to control the technical characteristics of the service, such as the bandwidth allocated per user.

Annex 1 of the recommendation provides detail of how cost orientation should be implemented for the pricing of both passive and active access products. This concentrates on the issue of the appropriate allowance to make for investment risk. The recommendation is that a risk premium should be added to the cost of capital to take account of a variety of factors which contribute to the uncertainty of investment in NGA networks.

The final part of the annex deals with price discounts based on term or volume commitments. The conclusions are that such schemes are acceptable to the extent that the discount reflects *only* the reduction in the average cost per line which results from a transfer of risk from the incumbent investor to the CP[39].

We conclude that there is nothing in the EC recommendation to prevent the adoption of the pricing model proposed in this paper. In fact, given that this form of pricing implies a greater proportion of upfront payments, it would have a similar effect to a volume/term commitment scheme, and therefore could result in a reduction in the risk of the incumbent's investment. As such, and in accordance with Annex 1 of the Recommendation, this may justify a discount (i.e. a reduction in the *average* price level). However, it is important to stress that our proposal does not equate to a discount scheme.

[37] For more detail, see paras 13-30.

[38] Paras 16 and 21.

[39] Sections 7 and 8 of Annex 1.

4.3 Virtual unbundling

Three NRAs, in Austria, Denmark and UK, have now either proposed or implemented wholesale access remedies which are virtual versions of physical unbundling. The basic premise is that physical unbundling provides the greatest level of control for CPs, but that a significant degree of control could be provided using active access products. Therefore, in areas where physical unbundling is not economically viable, the incumbent should introduce ‘virtual unbundling’ services which try to replicate the levels of control that a CP would have achieved if they were physically unbundling. Our analysis focuses on the first of these proposals: Ofcom’s analysis of the UK wholesale local access market[40].

Ofcom concluded that in many areas passive infrastructure access was unlikely to support effective competition. As a result, Ofcom considered in some detail what an active wholesale access service would need to look like in order to support effective competition given the current market conditions in the UK.

Ofcom concluded that, given BT’s roll-out plans and the current deployment of network infrastructure by LLU operators, that competition in the UK would be best served by a virtual unbundling product[41]. They therefore defined a conceptual service, referred to as VULA (Virtual Unbundled Local Access)[42]. VULA is designed to replicate the control that LLU operators have over technical characteristics of the service, and therefore to match the scope to compete that LLU has created for CPs. In this regard, Ofcom note that,

> *the most effective way to support the development of downstream competition would be to provide significant scope for alternative providers to innovate and differentiate in how they package and deliver services.*[43]

[40] See http://stakeholders.ofcom.org.uk/consultations/wla/

[41] In the statement to the Review of the wholesale local access market, October 2010, Ofcom writes (para 1.26):

> *At this point, we consider that VULA is likely to be the main basis for NGA competition over BT's network, to supplement the continuing effectiveness of LLU, over at least the next four years. Our economic analysis suggests that VULA is very likely to be the most cost-effective NGA remedy and the remedy most likely to emulate the level of competition currently delivered by LLU.*

[42] This is first discussed in the consultation to the Review of the wholesale local access market, March 2010. http://stakeholders.ofcom.org.uk/binaries/consultations/wla/summary/wlacondoc.pdf

At paragraph 1.19 Ofcom states that:

> *The intention is that VULA would provide access to the NGA network in a way that is similar to how LLU provides access on the CGA network. However, rather than providing a physical line, VULA would provide a virtual connection that gives OCPs a dedicated link to their customers and substantial control.*

[43] Para 8.10, statement to the review of the wholesale local access market

In order to generate this scope to innovate, Ofcom describe a number of characteristics that a VULA service should have[44]:

a. Local access – the point of interconnection should be physically close to the end user premises.
b. Service agnostic – the access should not be specific to any service – it should simply provide access to bandwidth.
c. Control over access in terms of QoS – it should allow CPs to control the way in which packets are prioritised and therefore allow CPs to offer services which require different levels of QoS.
d. Uncontended between subscriber and point of handover – despite being provided over shared infrastructure, the bandwidth should be uncontended.
e. Control of CPE – the CP should be able to specify the equipment used in customer premises.

Broadly speaking, there is consensus around the fact that a wholesale service with these characteristics would create enough control to allow a CP to differentiate its services from a technical perspective. In the Austrian version of virtual unbundling, there is an additional requirement that CPs should be able to create multicast services.

In terms of VULA pricing, Ofcom concluded that BT should be allowed to price as they see fit given the early stage of development of the market, and because the price would be constrained indirectly by competition from both NGA services from Virgin Media and current generation access services[45]. As a result, they did not consider the structure of VULA pricing in any detail[46].

The question we now address is whether the pricing a VULA service is likely to deliver a low marginal cost per line to CPs. We expect that it would, but only to the extent that the 'local' requirement ensures that the service covers only a small amount of infrastructure (from the aggregation point to the customer premises in the terms of figure 3.3 in the previous chapter). Equally, given that this is perhaps the most expensive part of the network and the part which is the focus of NGA investment, there may still be a considerable rise in the per line element of charging relative to LLU on the copper network.

For this reason, it is important to note that the change in pricing structure that we argue for is not dependent on bitstream services being provided 'locally'. Part of the

[44] For further details, see, for example, paras 7.231-7.248 in the consultation to the Review of the wholesale local access market.

[45] However, Ofcom did note that BT would still be subject to *ex post* Competition Law regulation, and they did impose a requirement that VULA prices (and other terms and conditions) be fair and reasonable.

[46] They do note, however, in the market review consultation, that they believed it would be appropriate for BT to test a number of different price structures such as tiered pricing whereby different quality levels or bandwidths are priced at different levels. See, for example, paras 7.252-7.253, *op. cit*.

purpose of this paper is to explain that the choice of pricing *structure* for bitstream services can be made independent of the underlying network. Therefore, we believe that a bitstream service could have all of the requirements listed above without being provided locally, but would then need to be priced with an appropriately low per line recurring charge. The local requirement is likely to create an effective ceiling on the per line element of charges, but this perhaps does not go far enough to create a low marginal cost for CPs, and ensure effective competition.

5 Conclusions and recommendations

Price regulation of wholesale access serves three potentially conflicting purposes:

a. to protect against the abuse of monopoly power through excessive pricing;

b. to promote competition; and

c. to encourage investment.[47]

In practice, regulated prices are usually set at some measure of average total cost. Assuming these costs are 'efficiently incurred', pricing at this level will ensure that the incumbent cannot make excessive returns, and efficient downstream competitors should be able to run financially viable operations. This covers objectives a and b, and c to the extent that it refers to investment in downstream markets. There is potentially a trade-off between the achievement of these objectives and encouraging investment within the regulated market. If it is difficult to achieve 'efficiency', then it will be difficult to make a return on investment. Hence, one can argue for slightly higher prices in order to fulfil objective c.

In light of this trade-off, it is difficult to make an unambiguous case for any particular pricing model. Therefore, we set the following criteria to enable an objective assessment of our proposed alternative wholesale pricing structure, but acknowledge that to some extent our recommendations reflect a judgement as to the relative merits of promoting competition and investment.

The two most important criteria are:

- Cost recovery: the regulated incumbent should be allowed to recover all relevant costs which have been efficiently incurred (and *only* costs which have been efficiently incurred). Costs should include a reasonable return on the capital employed, and where appropriate this should be adjusted to account for the risk associated with the relevant investment.
- Effective competition: the pricing of the wholesale access service should enable CPs to compete effectively (with the downstream operations of the incumbent). Effective competition implies the ability to create and deliver new services with pricing which attracts customers.

[47] These three objectives are derived from Article 13 of the Access Directive (2002/19/EC) which concerns a NRA's remit to impose price controls. It states that price controls may be needed where market conditions indicate that lack of competition might allow an operator "to sustain prices at an excessively high level, or apply a price squeeze, to the detriment of end-users." It also notes the importance of investment, stating that NRAs "shall take into account the investment made by the operator and allow him a reasonable rate of return on adequate capital employed, taking into account the risks involved." It goes on to require that any price regulation "serves to promote efficiency and sustainable competition and maximise consumer benefits."

In addition to these two key criteria, it would be beneficial (but not essential) if pricing were to have the following attributes.

- Risk sharing: there are potential benefits in allowing CPs to share in the risk of investment in NGA networks – both in terms of promoting competition and investment.
- Technology/network architecture neutral: there are likely to be a variety of different technologies and network designs in operation for the foreseeable future (including the current generation network). It is therefore important that future wholesale products and their pricing be applicable to a wide range of these different networks.
- Indifferent to demographics: in an ideal world, a wholesale access product and its pricing would be sufficiently flexible to allow a CP to use it to serve an entire country – despite the wide variations in local conditions.

We assess the proposed price structure against these criteria in the sections below.

5.1 Cost recovery and risk sharing

In moving away from revenue which is almost entirely dictated by the volume of lines to revenue which is a function of a range of different volumes (such as the number of CPs, the amount of backhaul used, amount of equipment installed, etc), expected revenues become more sensitive to changes in volume. At first, this appears to represent an increase in risk for the incumbent. However, assuming pricing can be tied more closely to underlying costs, the risks to cost recovery may actually reduce. In essence, there is a transfer of (retail) demand risk from the incumbent to the CP[48], as the incumbent is able to pass through some of its fixed costs as they are incurred rather than having to wait until retail demand materialises.

In addition, to the extent that bitstream services are offered (and priced) on a geographically disaggregated basis, the volumes which drive revenues will tend to be larger. This will tend to reduce the sensitivity of total revenue and cost recovery to discrepancies between expected and actual volume. For example, if CPs paid a fee to enable the provision of service on an exchange by exchange basis (for example, to cover costs for access transmission/switching equipment), this would clearly create much more granularity in revenues relative to a fee to enable services nationally.

Therefore, with suitably designed prices, it should be possible to ensure that cost recovery for the incumbent is at least as effective as it is under traditional bitstream pricing.

[48] As we have noted, in the extreme, if prices fully match cost structure then we have something equivalent to co-investment. This clearly involves a significant transfer of risk.

5.2 Effective competition

There is often little scope for meaningful differentiation of basic access services in telecoms, and therefore innovation is more likely to be driven by the bundle of services offered to the consumer and the pricing of this bundle. Therefore, the *structure* of prices of the various elements of the bundle takes on extra significance, and the ability to change this structure becomes an important aspect of innovation.

The main argument that we put forward in this paper is that the per line recurring wholesale charges set an effective lower limit on retail pricing. Therefore, to enable innovative retail pricing, which has been a key feature of LLU based competition, bitstream pricing should be structured to match the relatively low recurring per line charges faced by LLU operators today. This implies increasing, or introducing, charges which do not relate to the number of lines served.

It could be argued that there is a risk that the increased upfront charges will act as a barrier to entry and therefore curtail competition. Whilst it is undoubtedly true that higher upfront payments will create economies of scale, and imply greater risks for CPs, this is merely a reflection of the structure of underlying costs. Paying higher fees upfront simply mirrors the risks associated with investment in physical network infrastructure. In the case of our proposed pricing structure, the benefit to the CP of making this financial commitment is access to a lower marginal cost, and the ability to compete more effectively.

In effect, the change in pricing structure moves the wholesale product further upstream. As such, another counter to the risk of reduced competition is that it would allow CPs to create wholesale products which sit further downstream and are priced on a per line basis.

Finally, the flexibility over the size of the shift to upfront fees means that it is possible to fill gaps in the ladder of investment where the network architecture implies a big jump from one rung to the next. For example, the investment required for sub-loop or GPON unbundling is often prohibitive, whereas traditionally priced bitstream services generally leave little scope for competition. An alternative priced bitstream service may still require considerable upfront investment, but the level can be adjusted to ensure competitive entry is viable.

5.3 Network and demographic indifference

One of the advantages of bitstream is that it can be neutral to the underlying design of the network in a way which is not possible for physical access remedies. At least in terms of the presentation of the service to the CP, bitstream does not have to vary between different access network architectures. It may be that pricing ought to change to reflect the differences in the underlying network, but as we have shown above, the idea of paying for different network elements according to the incumbent's cost drivers is a general one. It applies regardless of the design of the network, and therefore it should always be possible to design a price structure which results in low recurring per line charges to CPs.

Equally, it is possible to change the design of the bitstream service to ensure that it is viable across a wider range of demographics than has traditionally been the case. One of the key determinants of financial viability of an access method is the cost of backhaul. In densely populated areas, it will be possible for CPs to purchase dedicated backhaul capacity. Whereas in other areas, shared backhaul bandwidth will be the only option. There is no reason why a suitably designed bitstream service should not offer both options; and crucially, that the shared backhaul offer be priced on a similar basis (for example, rental per amount of bandwidth per exchange) to dedicated backhaul.

5.4 Recommendations

We believe that the pricing proposal outlined in this paper would help to ensure that bitstream services can be used to support truly effective competition over NGA networks. However, the threat of increased, or more effective, competition is likely to mean that incumbents do not choose to offer this form of pricing voluntarily. Therefore, we recommend that NRAs include pricing structure as part of the assessment of cost orientation requirements for bitstream services. Ultimately, we believe that where passive access remedies are not viable, NRAs should mandate bitstream access with a price structure that delivers low marginal cost to CPs.

We view this as the sole regulatory remedy required in these areas in the access/broadband value chain. That is, no further remedies would be required downstream. Demand for wholesale access services priced on a traditional per line basis would be served by CPs using the regulated bitstream service. This is analogous to areas where competition based on passive remedies is effective and therefore regulated bitstream access is no longer required.

It should be noted that the proposal is compatible with a retail minus approach to price regulation. However, retail minus tends to imply a wholesale tariff structure which maps onto that found in retail markets – i.e. precisely what we are trying to move away from. It is important to remember that retail minus is simply a method of setting the price *level,* with the 'minus' chosen to reflect the costs of efficient downstream operations. Although it is much simpler, and therefore more transparent, to use retail minus in the context of a wholesale tariff structure which matches the retail price, it is not necessary.

Similarly, one potential concern with the proposed approach is that it would create additional complexity for regulatory bodies trying to prevent margin squeeze since a simple comparison with retail prices is no longer possible. Such simple tests are certainly not possible for the majority of today's upstream remedies such as LLU, and our proposal is ultimately to make bitstream pricing look more like that of an upstream remedy. From this perspective, the design and application margin squeeze tests will be no more difficult than they are today.

In conclusion, we believe that the best chance of having effective competition over the widest possible area, and the greatest scope for innovative competition, will be delivered by requiring bitstream services which meet the following two criteria:

- they must allow CPs to control the technical characteristics of network services; and
- the recurring per line charges should form a relatively small proportion of the total charges to a CP.