Wholesale access and NGA

A review from first principles and a recommended new approach

June 2010

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Contents

1. Introduction and summary

1.1. Overview

This paper considers what fit-for-purpose wholesale access services might look like under NGA. The scope is quite broad, taking in both wholesale local access and wholesale broadband access markets. We conclude that the current approach to regulation, as characterised by the "ladder of investment", will no longer necessarily deliver sustainable and truly effective competition without damaging the climate for investment. Two changes are needed:

- **The focus of regulation must shift to the creation of fit-for-purpose active wholesale products which include elements of backhaul – *even in circumstances where competition may be viable based on passive remedies*.**
  This represents a change from promoting competition wherever it is viable, to promoting competition where it will be most effective. Active wholesale access services which include elements of backhaul will allow access seekers to share the benefits of scale and vertical integration with the incumbent, thus reducing the costs of competition. Effective competition requires that access seekers can control the network to a sufficient degree to be able to introduce new and innovative services. This level of control can be delivered through an appropriately designed active remedy – it requires neither access to passive NGA network elements, nor ownership of access and backhaul infrastructure.

- **New wholesale pricing structures must be introduced to allow access seekers to pay for a significant proportion of costs upfront in return for significantly lower recurring per line prices.**
  This would share risk between the incumbent and the access seeker, and so may help to improve the investment case for NGA. The new pricing would mirror the structure of high upfront costs and low per line charges experienced by those using passive remedies on the copper network, and so should help access seekers to compete on price as effectively as they do today.

The ladder of investment is a model of the development of competition which underpins the current approach to access regulation. In this model, access seekers enter the telecoms value chain using the least capital intensive methods because they begin without a customer base. This implies using wholesale access products which rely heavily on infrastructure and services provided by the incumbent. Then, as the access seeker grows its customer base, it climbs the ladder, progressively investing more heavily in its own network infrastructure, gaining by stages independence from the incumbent and more control over the design of its retail services.

Competition in which access seekers use their own infrastructure has many advantages, not least that it removes the benefits from vertical integration enjoyed by the incumbent, and limits their ability to discriminate to a small, but still vital, part of the value chain. However, there are costs to such competition both because access seekers duplicate part of the value chain, and because the incumbent incurs costs in providing wholesale access services.

These costs create tension between two of the main policy objectives behind access regulation: promoting competition and promoting investment. With the current generation copper network, where a significant proportion of investment is sunk, the goal of promoting

competition dominates. The introduction of NGA networks, alongside more general trends in the telecoms sector, tilt the balance between these objectives for the following reasons:

- **The costs of passive access are prohibitively high under most NGA architectures.** Under FTTC, passive access requires interconnect at the street cabinet, which is both expensive and operationally complex, and so likely to be worthwhile only in a very limited number of cases. With an FTTH PON network, the technology for wavelength access is not yet ready for commercial deployment, and the options for physical unbundling (at the splitter level) are even more impractical and expensive than under FTTC. Point-to-point FTTH networks can be unbundled, but may be uneconomic to deploy in the first place.

- **The benefits of passive access are reducing.** Increasingly, the defining characteristics of a telecoms service are specified by features of end-user devices alongside applications and content hosted in and beyond the core network. The access and backhaul infrastructure enables the services, and so is no less important, but it does not define them. This means that the ability to compete through innovation is much less directly linked to ownership and control of access and backhaul infrastructure.

- **NGA requires substantial and risky new investment.** The risk of the investment in NGA is material. The current approach to wholesale access pricing loads all of the demand risk onto the incumbent. This was justified in the copper world where the network had already been built, but a new approach which allows a greater degree of risk sharing is likely to be preferable given the current uncertainty over demand for NGA based services.

1.2. Structure of the paper

The following chapter discusses the issues associated with the introduction of NGA in more detail. This represents the problem statement – the reasons why a new approach to wholesale access is needed. We also consider the directional changes that are likely to be needed in response.

Chapter 3 then describes the range of possibilities for wholesale access products and pricing. It builds a simple model of the relevant wholesale inputs in order to explore the full spectrum of alternative wholesale access services, and recommends certain wholesale product parameters. Chapter 4 undertakes a similar exercise for pricing options, and again makes recommendations. Chapter 5 discusses some of the arguments for the status quo. Chapter 6 provides an illustrative offer reflecting the recommendations of the earlier chapters, and Chapter 7 summarises our conclusions. A glossary is available in Chapter 8.

Note that while the development of this paper was funded by Vodafone, the conclusions are the authors' own.

2. The changing trade-offs in a fibre world

NRAs have in general seen infrastructure competition as the ideal outcome. This has been the premise of the "ladder of investment" approach. The Irish NRA, ComReg, for instance, suggested in 2004 that:

> *"Using the 'ladder of investment' theory operators may gain critical mass using bitstream and move to full product differentiation and infrastructure competition through LLU."*[1]

This has led to a focus on passive access remedies deep in the incumbent's network, such as LLU. In many countries, prices for IP bitstream are maintained at an artificially high level in order to support the roll-out of LLU by giving a cost advantage to access seekers who reach a very large scale. The European Regulator's Group (ERG) recommended that NRAs ensure

> *"sufficient economic space between WLA and WBA … [in order to] create incentives for new entrants to further climb the ladder of investment, give assurance of protection against downstream price eviction, promote infrastructure-based competition".*[2]

This preference for deep passive access remedies has been based on a number of assumptions which either no longer hold, or become much less convincing under NGA. This chapter discusses three differences which call into question the preference for deep passive access products, priced on a per-line, per-month basis:

- First, the costs of duplicating network infrastructure under NGA means that passive access will often be prohibitively expensive
- Secondly, the benefits of duplicating infrastructure are diminishing as differentiation increasingly takes place at, and beyond, the edges of the network
- Thirdly, the business case for NGA is (in many regions) marginal and risky. This is in stark contrast to the safe returns on the legacy infrastructure. Thus investment incentives and the impact of the costs of competition become much more important

2.1. Passive access is likely to be uneconomic under NGA

LLU is based on access to passive copper lines. However, it is generally agreed that in most fibre architectures it will be much more challenging to provide access to passive network elements. We consider FTTC, PON and FTTH in turn.

In a FTTC network, the point of interconnection for passive access moves from the exchange to the street cabinet. This means much less space in which to co-locate equipment, and far fewer premises connected to each site. This will dramatically reduce the number of sites it will be viable for an access seeker to connect. It will also increase the cost of competition within covered areas, in particular, in areas where separate cabinet infrastructure has to be deployed to accommodate access seekers. An Ofcom study has found that sub-loop

[1] John Doherty, Chairman of ComReg speaking at the Global Symposium for Regulators in Switzerland in 2004

[2] *Report on ERG Best Practices on Regulatory Regimes in Wholesale Unbundled Access and Bitstream Access*, 2007, ERG

unbundling for an FTTC network will increase the cost of provision by a minimum of 34%.[3] In practice, this is not expected to be a widely viable model.

Physical unbundling for a PON can theoretically occur at the splitter level. Unfortunately, this would be even less financially viable than FTTC physical interconnection due to the greater number of sites to reach. Alternatively, an access seeker can receive the right to use a particular wavelength of light from the exchange to the customer's premises (roughly equivalent to the block of frequencies in a copper pair granted to an access seeker using SMPF). However, the technology to deliver such a service for the access network is still being developed, and has yet to be standardised. It is likely that it will be several years before the technology reaches sufficient maturity to become a viable option to support competition.

It is practical to unbundle a point to point FTTH network (and this is the approach in Switzerland and the Netherlands). However, FTTH is significantly more expensive to build than other fibre infrastructures. As a result, few incumbents are choosing to roll out networks of this type.

Moreover, under FTTH the effective aggregation points (i.e. the passive optical splitter where the traffic riding point-to-point fibres is aggregated into a single connection) are closer to the customer and therefore far more numerous than exchanges under copper. This in turn means that the number of customers at each interconnect point is lower, and therefore it is harder for access seekers to achieve the scale to justify building out to those points. In practice, it may only be the incumbent who has necessary scale - this has been the experience in the Netherlands, for instance.

The conclusion is that, in most cases, the costs of duplicating network infrastructure in order to reach the point in the network where passive access will be available will become too expensive. Therefore, in the majority of cases and in most geographic regions, active access is likely to be the only financially viable option.

2.2. The differentiation benefits of duplicating network infrastructure are diminishing

Control of its own infrastructure theoretically gives an access seeker the greatest ability to differentiate its products, primarily by specifying its own equipment. This has been an important factor in NRAs' preference for deep, passive interconnect. In the UK for instance, in 2006 Ofcom stated that:

> *"LLU is important for broadband development in the UK, because it offers the greatest opportunity for competitive operators to differentiate their products and prices versus BT and thus offers the greatest opportunity for innovation."* [4]

[3] *Review of the Wholesale Local Access Market*, Mar 2010, Ofcom, see Annex 9: Sub-loop unbundling. Under a scenario where the various communication providers (CP) deploy equipment in a shared cabinet, the cost of competition for one additional CP is 34%. This rises to 37% in the case of three additional CPs. Under a scenario where CPs deploy equipment in their cabinet, the costs of competition are much higher.

[4] Ofcom website, 2006, available at: http://www.ofcom.org.uk/media/mofaq/telecoms/bb_faq/

Deep passive interconnect still gives the greatest theoretical differentiation, but market developments are reducing the materiality of this benefit. The shift to NGA is likely to diminish it further.

Firstly, technical features such as connection speed have always been only one of several characteristics that consumers compare when choosing a service provider. For instance, a *Which* survey of broadband providers[5] in the UK considers speed, reliability of connection, price, customer service, ease of set up, contract term and price as the key attributes. Of these, only the first is clearly associated with technical choices which are not available to users of active access.

Secondly, bundling also reduces the relative importance of the technology of the access link as a source of differentiation, and it is become increasingly popular. For example, in Sweden, the number of bundled offers (the majority of which include broadband) rose by 20% in the first half of 2009 to account for approximately a fifth of all broadband subscriptions.[6] In Denmark triple-play subscriptions increased by 163% from 2008-2009[7] In the UK bundled offers already account for 24% of all broadband subscriptions.[8] NGA will accelerate this trend, since it allows ready incorporation of video.

Thirdly, widely available IP networks have enabled an explosion of innovation in edge devices and applications, which do not depend on control of network infrastructure. The range is vast, but includes everything from Skype to network-enabled games consoles to iPlayer and Hulu. Control of infrastructure still allows innovation, but its relative importance is now less, given the potential even for those without their own network to create new communications services. Ownership of certain infrastructure elements such as backhaul seems to provide very little advantage to innovation.

Fourthly, once in a fibre world the marginal benefit to consumers of increasing access line bandwidth is much smaller than either changes within the current generation network capability, or the shift to NGA. As Figure 1 shows, there is a substantial change in the user experience and supportable applications when moving from, for example, a throttled ADSL connection at 2Mbps (downstream) up to 8Mbps.

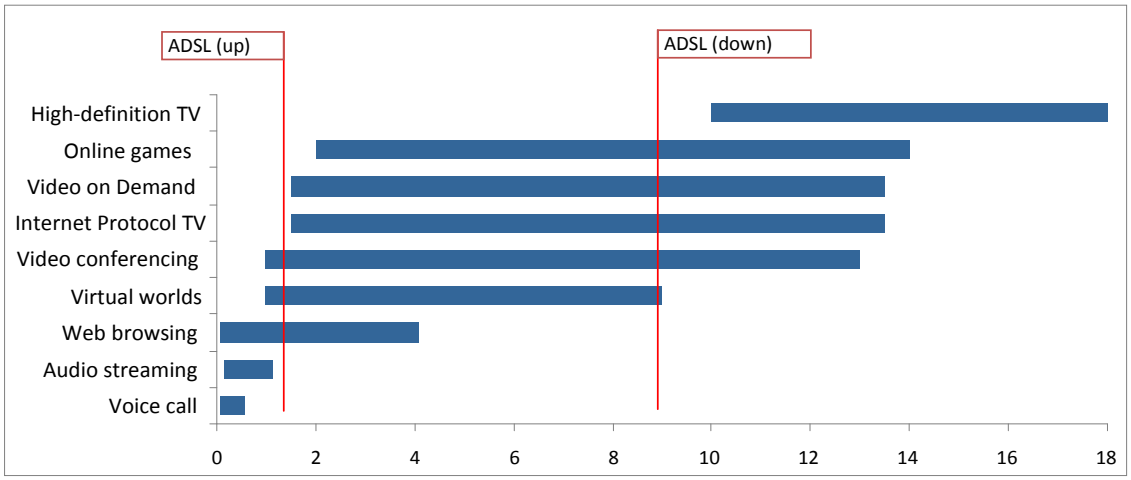
[5] Available at which.co.uk; subscription required

[6] *The Swedish Telecommunications Market First Half-Year 2009*, Nov 2008, PTS: based on a total number of bundled subscriptions of 887,000 and total broadband subscriptions of 4m

[7] *Presentation of the Telestatistics for the Second Half of 2009*, NITA

[8] Ingenious analysis of data in Ofcom's *Communications Market Report 2009*

Figure 1: Bandwidth requirements of selected digital content types in Mbps[9]



In contrast, once a customer is connected to a NGA network they will likely have a connection of at least 40Mbps. As yet, there are very few applications which require even greater bandwidth, and so the marginal benefit of increasing bandwidth beyond this is limited.

For these four reasons, we believe the importance of infrastructure-based differentiation is lower in an NGA world, and thus the argument for preferring infrastructure competition is weaker. (Note that we do not argue that technical network characteristics have become entirely irrelevant to differentiation, and we will later discuss how we believe they should be addressed in an NGA access product).

2.3. NGA business case is marginal and risky

The copper network represents a largely sunk and recovered cost for incumbents, without material risk. However, as is well understood, fibre networks are (mostly) still to be built, are expensive, and carry substantial investment risk (particularly in less densely populated areas) given the uncertainty over future demand. At present, there are few services that require the extra bandwidth, and most people are not prepared to pay any more than they do for the current generation broadband service. The weak business case is a particular concern given that high speed networks may bring substantial externalities ranging from telemedicine to home working.

This has a number of implications for the appropriate access regime, in order to both maximise roll out and support greatest adoption in covered areas. In particular it raises the following questions:

- How should risk be allocated between access providers[10] and seekers?
- How should risk be minimised?

[9] *Information Technology Outlook 2008*, OECD

[10] We use 'access provider' to refer to the owner/operator of the NGA network. In practice this will often be the incumbent, but it need not be. For instance it could be a new entity in which the government has an interest, such as NBNco in Australia, or it could be a consortium of carriers co-investing to build the NGA network. As such, the issues discussed in this paper are separate from issues of co-investment.

- How should the costs of competition be minimised?
- How can the maximum range of the demand curve be addressed?

2.3.1. Risk allocation between access providers and seekers

The standard approach to wholesale access product pricing means that access seekers bear little or no demand risk. They can buy access in discrete per-line units on a per line basis without upfront commitment. Even if a risk premium is added to the unit price, this is only effective if the access seeker actually buys the service. If demand never materialises, the access seeker does not bear any financial risk.

If the risk of the investment is substantial, this begs the question who should carry it – the access seeker, the access provider, or a mix of the two. (Of course, if risk is to be shared, so should the benefits).

Risk naturally should sit with the party best able to manage it. On the one hand, the access provider is hedged against market share risk – whichever downstream provider captures a particular customer, the access provider will benefit from the wholesale custom. (By contrast access seekers care very much about market share risk). On the other hand, the bigger overall risk to NGA is the total demand and the pricing consumers will bear. Retail providers are closer to the end users and should be in a better position to judge and influence overall demand. Moreover, they will have knowledge of retail product developments (riding on top of the NGA network) that are unknown to the access provider[11].

This suggests that risk should be shared between access seekers and providers, and in turn argues for considering access charges that are not simply based on a per-line charge, but have an element of fixed cost. OPTA has commented:

> *"The advantage of … a one-off fee is that a supplier of unbundled access to the local fibre loop recoups some of its investment in the first phase of the network, which heightens the willingness to invest. Ultimately, recouping the investment early on translates into a lower capital requirement over time and a decrease in investment risk."* [12]

Particularly if NGA providers are capital constrained, then the lower capital requirement under risk sharing can lead to wider roll-out. Such an approach would also mean that access seekers will face economic incentives closer to the true costs of provision, which will help drive efficient and sustainable actions.

2.3.2. Minimising the cost of competition

In the former world, the costs of providing deep regulated access services and the associated costs of competition did not have a significant bearing on access network investment by the incumbent, and were deemed worth bearing given benefits such as greater potential

[11] This is particularly true in the UK where the access provider, Openreach, is operationally separated from BT Retail. However, in all markets competitive retailers will be working on product offerings distinct from those known to the incumbent retail arm. In many markets offerings including TV might be an example

[12] *Policy Rules: Tariff Regulation for Unbundled Fibre Access*, 2008, OPTA

differentiation. As discussed above, we believe these benefits have weakened, and conversely the costs are more significant relative to the uncertain business case.

As mentioned, in most markets passive access is unlikely to be viable because of the huge number of interconnect points required. However, even an active product interconnected at the exchange carries a substantial cost of competition. Each connection point carries costs – facilities must be planned, secure collocation space established, tie cables installed, physical access enabled and so on. There is also asset duplication – the utilisation of assets at exchanges is likely to be lower if each access seeker is self-providing (as is the case with multiple DSLAMs under LLU). Finally there is ongoing additional opex, associated with parallel teams operating and maintaining similar assets, where a single team could have covered both at little extra cost. (Naturally the tradeoffs are a little different if the access seeker has already sunk costs to establish a presence at a particular exchange).

An indirect cost of competition (based on deep interconnect) is that it makes copper switch off (CSO) harder. If fibre replaces copper, there is the possibility of reducing the number of required exchanges, by moving to aggregation points closer to the core. However, if deep access NGA remedies have been preferred, then access seekers will be embedded at the exchanges, making it far harder to do without these premises

These costs of competition are not new or much greater under NGA (aside from the impact on CSO), but they are more important, because they are larger *relative to the underlying economics of access*. They represent an inefficiency which is likely to result in lower levels of welfare. This can take the form of reduced NGA coverage (since the business case is weakened), excess pricing (since these costs must ultimately be recovered from consumers) or reduced scope of competition (since competitors may only enable the largest exchanges). Each will result in reduced adoption and hence lower public and private value.

These costs are fundamentally associated with the number of interconnection points, and therefore suggest that access offers based around interconnect nearer the core may be preferable to deep access offers.

2.3.3. Addressing the demand curve

Clearly the business case for NGA can be improved if the number of households using the service is maximised, and this in turn means that retail prices must be enabled that suit those with a lower willingness to pay. However, if access seekers are to include in their mix of retail offers such lower prices, they themselves will need low marginal costs. While a commercial operator may happily serve customers whose revenue is below the operator's *average* cost, they are unlikely to want to serve customers whose revenue is below the operator's *marginal* cost.

This issue has an additional importance in the context of NGA, since in order to accomplish CSO a number of low revenue customers (such as those only using voice services) will need to be migrated to fibre.

In the copper world, an LLU-based approach does have lower variable costs than using IP Bitstream offers. There is a measure of fixed costs associated with establishing a presence at the exchange and backhaul to the core. (Medium term variable costs include the local loop, DSLAM occupancy and incremental backhaul bandwidth). By contrast the costs of IP

Bitstream are largely variable per customer. However, there is nothing inherent to IP Bitstream that means it need be priced in this way.

Of course, if the access seeker is to take an end-to-end product and still have low marginal cost, the access provider will need to recover its cost elsewhere – this implies a fixed element to the charges to access seekers. This, via a different route, is the same conclusion we reached above.

2.4. Conclusion

The principal conclusion of this section is that the current approach to wholesale access regulation, characterised by a focus on deep, passive access products priced on a simple per line basis, is unlikely to be optimal under NGA, and risks hindering investment. Instead active end-to-end products with an element of fixed cost should be the focus. However, this does not mean that other approaches should be excluded. For instance, an active last mile product could also be offered, for use by those who have already built out to a particular exchange. Our conclusion is that there should be a change in emphasis, not an absolute switch.

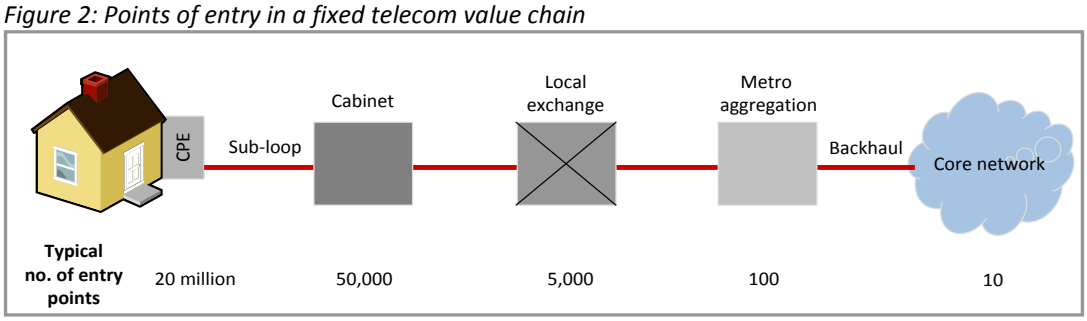
3. Options for wholesale access product configuration

This section sets out a range of options for wholesale access services – what, in theory, these services could look like. We start by distinguishing between two approaches: component access and assembled access.

3.1. Component and assembled approaches to access

Figure 2 below shows the potential points of entry in a generic fixed telecoms network, and gives indicative numbers of locations of the network nodes for a hypothetical network serving 20 million end-points. The precise numbers will vary from country to country but the relative proportions will be roughly the same.

Figure 2: Points of entry in a fixed telecom value chain



An access seeker could simply collect traffic which has been aggregated by the access providers at a small number of interconnect points in the core network. We refer to this as **assembled access**, since the access provider provides all of the elements in the wholesale access value chain and assembles them on behalf of the access seeker.

Alternatively, an access seeker could interconnect at network nodes closer to the customer. The supply of the remaining inputs (necessary to connect to the core) is then fully controlled by the access seeker, who could choose to source from a third party, from the incumbent, or by self-supply. We refer to this approach as **component access**. It covers a range of options depending on the precise point of entry into the value chain.

Note that component access is not the same as passive access. Indeed, component access solutions such as LLU typically incorporate both passive (e.g. local loop) and active elements (e.g. backhaul), and most proposed NGA component remedies are entirely active.

Figure 3: Active vs Passive, Assembled vs Component: sample products

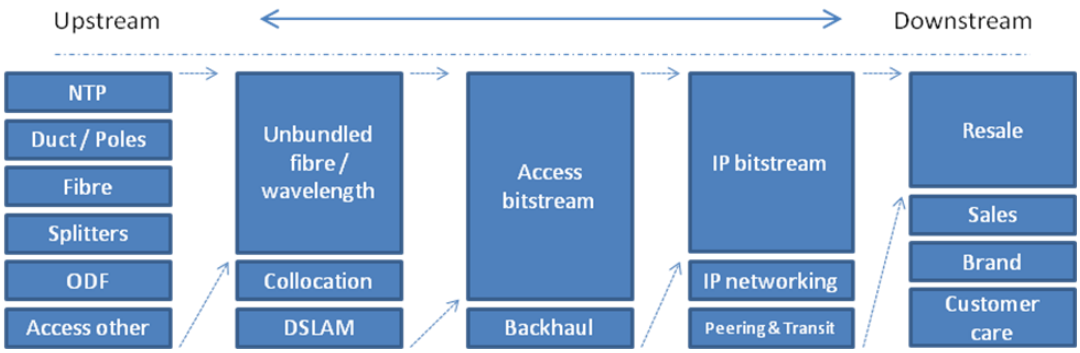
	Active	Passive
Component	• GEA[13] • Backhaul	• LLU • Dark fibre
Assembled	• IPstream	N/A

It is important to remember that both component and assembled access are produced by combining other intermediate inputs. Assembled access can be seen as a combination of various component access services, but equally, it could be viewed in terms of more 'raw'

[13] BT's Generic Ethernet Access – a fibre-based wholesale ethernet access product linking the end-user premise to the exchange,

inputs. Figure 4 shows some examples of the possible raw inputs and intermediate outputs in the value chain for fixed broadband access.

Figure 4: Typical inputs and outputs in the fixed broadband access value chain



BT's IPstream is an example of an assembled approach. It comprises of two elements, which must be brought together: EUA (end user access – the access bitstream component) and BT Central (the aggregated backhaul from exchanges to a point of interconnect).

3.2. Next generation assembled approaches

In chapter 2 we argued that in the fibre world there are several reasons to believe that an assembled approach might be preferable to a deep-interconnect component approach. However, if an assembled approach is to be prime, this raises the question as to how to design such a product such that it retains some of the advantages of a component approach.

One such advantage is retail product differentiation enabled by control of network elements. While we have argued that this advantage is waning in importance (section 2.2), it is nonetheless real. We now address whether this control requires physical network unbundling (i.e. based on component access), or whether it can be delivered through suitable levers over the configuration of an assembled access product (i.e. an end-to-end product but with specifiable elements such as backhaul quality).

If an access seeker is allowed to buy a range of wholesale inputs from the access provider, but each input is bought independently (i.e. as if each input were a separate product), then the access seeker would gain a significant degree of control over the final retail product specification. Many inputs are highly commoditised, and so regardless of where an access seeker sources an input from, its functionality is the same.

The LLU business model provides a good example. Often an access seeker using LLU only self-provides the DSLAM and its installation and maintenance. Collocation space, power, tie cables, and a range of ancillary services are all purchased from the incumbent, and backhaul may be too. However, since these components are all bought from the incumbent as separate products, the access seeker controls how the components are deployed and the proportions in which they are used. They are free, therefore, to choose the allocation of backhaul bandwidth per subscriber and to set QoS parameters. As such, the access seeker loses very little control over product design relative to a scenario in which these components are self-provided.

A logical extension of this argument is to suggest that the access seeker also outsources DSLAM functionality to the incumbent. All inputs relevant to wholesale broadband would then be purchased from the incumbent. This should not preclude control of key product defining characteristics such as backhaul bandwidth per subscriber and QoS parameters, and so the loss of control over product design would be minimal.

Thus there is the possibility of differentiation without taking a component approach. This is one reason why some regulators are now considering the benefits of 'configurable' active access products. For instance, the Body of European Regulators for Electronic Communications (BEREC) has been promoting the development of Active Line Access (ALA) bitstream products for NGA networks. In particular, BEREC recommends that ALA offers "should be as much as possible modular in order to allow the maximum freedom for alternative operators to define QoS and the configuration of their own retail services".[14]

3.3. Which network elements are most important to product differentiation?

The subsection considers which network elements are most important for an access seeker to control. For each element, we discuss if component access is necessary, or whether an assembled access product would be sufficient. It therefore looks at the potential for product differentiation which stems from control of various assets within the wholesale broadband value chain. This is of course within the constraint of making use of the access provider's access network – more fundamental differentiation is possible for those using completely different access networks, such as mobile broadband providers.

The table below summarises the relative contributions to retail product differentiation from the network components considered above. The first column shows the situation for an access provider who self-supplies all of the components. This is a useful reference point as it represents the maximum level of influence over retail product definition. The second and third columns then contrast this with the level of control over retail services for an access seeker using physical component access and using configurable assembled access.

Figure 5: Network components and the level of control afforded over retail services

Network component	Influence over retail services for access provider	Effective influence under component access	Effective influence under 'configurable' assembled access
CPE	*****	*****	*****
NTP	**	*	No changes possible
Physical medium	*****	*	No changes possible
Access network modem	***	***	*
Backhaul	****	****	****
Core network	*****	*****	*****
Collocation	**	**	*

[14] *Next Generation Access – Implementation Issues and Wholesale Products*, Mar 2010, BEREC

The most significant difference between component access and 'configurable' assembled access is the ability to install different access modem equipment. This element dictates access line speed, but it is easy to overestimate its importance. A great deal of emphasis has been placed on the ability of access seekers using LLU to install DSLAMs with ADSL2+ technology in advance of the incumbent. While it is true that some access seekers did follow this business strategy, the impact of ADSL2+ on customer behaviour appears to have been limited. As discussed in section 2.2, many factors other than line speed are important to buying decisions, and the marginal benefits of offering higher access line speeds is likely to decrease with the advent of super-fast broadband over NGA networks.

This difference aside, the table shows that configurable assembled access can provide almost all the control over product differentiation that comes with component access. CPE, core network and backhaul are the most important elements to control to enable differentiation. We assume that most competitors in the telecoms sector will continue to provide their own core network services, and as noted all access seekers can provide CPE regardless of access method.

Therefore, the most important question is whether equivalent control over backhaul, such as the ability to prioritise various traffic streams, can be achieved under assembled access as under component access. We believe that there is no fundamental reason why this should not be the case, and therefore we conclude that there need be no material loss of the ability to differentiate retail services in moving from component access to an appropriately configurable assembled access solution.

3.4. Finding the right level of granularity for assembled access

This section considers which wholesale inputs should be made available for independent purchase through an assembled access offer. The network elements discussed above represent one particular level of aggregation, but it would be possible to go much further. For example, separating out duct, fibre, street furniture, optical splitters, line cards and chassis, and so on. In addition, one could potentially separate out operational services such as provision and maintenance from the rental of network elements.

In some of these cases, access to the wholesale input under an assembled approach would merely add a transaction cost without adding to the ability to differentiate retail services. For example, the ability to buy a duct independently from the fibre used in that duct will add nothing to the access seeker's scope for differentiation. These two assets will necessarily be used in fixed proportions, and this proportion will be common to all who use the network. It would not be possible for one access seeker to choose a higher or lower proportion of duct to fibre than any other user of the network. Therefore, as far as product differentiation is concerned, there appears to be no reason to purchase the two elements as separate products (given that both products must be bought).

Equally, the ability to control every last element of another operator's network would create operational and security issues. Beyond a certain level of disaggregation, the cost of creating external levers is likely to outweigh the benefits of having those levers. Consider the ability to specify the physical route taken by a backhaul circuit. There are circumstances, for example in the business connectivity market, where such control will be important. However, these are highly specialist requirements that do not need to be catered for through a general network access capability designed primarily for residential and mass

market business services. To add this capability would significantly increase the cost of providing the service, which would then only benefit a very small minority. Instead such needs should be catered for by different products.

Service aspects can also be separated out as configurable element. Some wholesale products offer enhanced SLAs or expedited delivery. An access seeker might be able to choose a different level of operational capability for all lines, or on a per line basis.

For example, an access seeker might be able to pay upfront for 'pre-wired' installations, which would then result in cheaper and faster installations on a per line basis. Another example would be in offering different tiers of maintenance. Again, this function is generally offered, but on a per-line or per-event basis. If an access seeker were prepared to make a contribution upfront, it might be possible to segregate part of the engineering field force, and to create an enhanced service by paying for additional staff.

3.5. Conclusions

Aside from these options around separating operational capabilities, the main conclusion is that there are limits to the useful granularity of the elements within a configurable access solution. As noted above, backhaul quality is the most important network element to control as far as product differentiation is concerned.

It is for this reason that our example illustrative access product specification (described in chapter 6) is split into backhaul and access, with specific controls over the backhaul element. With this wholesale product structure, access seekers can chose to offer differentiated retail products, notwithstanding the fact that they are using an assembled offer.

4. Options for wholesale access product pricing

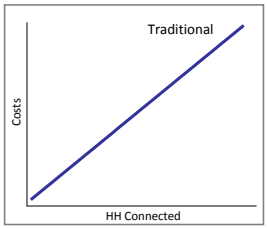
This section considers a range of options for wholesale pricing. We are primarily concerned with the structure of tariffs rather than their absolute level. Put another way, we consider options to recover the regulated cost base, rather than the size of that cost base[15]. However note the regulated cost base for an assembled offer will include elements such as backhaul – as such these elements will effectively be priced in on a opex plus regulated cost-of-capital[16] basis. This effective price may differ from current pricing for such services.

As discussed in section 2.3 there are good arguments for lower marginal costs of access, with an associated fixed cost. Such a structure is inherent to component access approaches (at least to some extent), but has not to date been used in assembled access offers.

4.1. Fixed/Variable pricing profiles

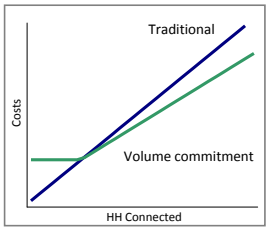
In practice, there is an infinite set of possible variations of fixed and variable pricing. In the following paragraphs we explore some examples.

Traditional



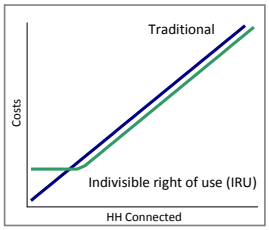
'Traditional' pricing is the most widely-practiced form of access pricing today. In the vast majority of cases a regulated fee is charged for each unit used. The cost curve for an access seeker is an upward sloping straight line reflecting the fact that cost rises in direct proportion to the number of households connected.

Volume commitment



The access seeker commits to buy a certain number of lines. In exchange for bearing some demand risk, units beyond this level are priced at a discount. The cost curve for an access seeker is flat up to the volume committed and slopes upward thereafter (but at a lower gradient as compared to traditional pricing to reflect the discount).

Indivisible right of use (IRU)

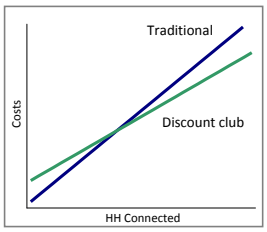


Access seekers pay an upfront fee for the right to access a fixed block of capacity. If this block is well-utilized, the resulting unit cost could be below the traditional tariff. The cost curve is an initially flat, then upward sloping line (parallel to the traditional tariff).

[15] While we discuss these proposals in the context of a regulated solution, we believe a similar approach could be appropriate for a commercially negotiated solution also

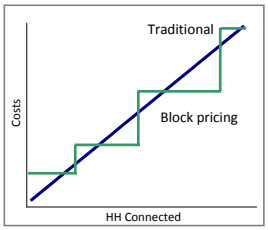
[16] The appropriate cost-of-capital may be lower for backhaul than for the higher-risk access element of the regulated cost base

Discount club



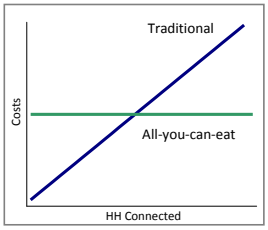
Under a discount club pricing structure access seekers pay an upfront or annual fixed fee in order to obtain a discount. The cost curve is upward sloping but at a lower gradient and higher intercept as compared to traditional pricing (reflecting the discount and initial upfront payment).

Block pricing



Similar to an IRU, a block pricing structure requires access seekers to purchase capacity in indivisible blocks. However, as the block size increases, the average unit cost decreases. This results in a stepped cost curve for the access seeker, and is analogous to the significant economies of scale in larger purchases of backhaul / private lines.

All-you-can-eat



Under an all-you-can-eat structure the access seeker makes a fixed payment in exchange for the right to consume unlimited capacity. The cost curve for such an access seeker is a flat line constant at the level of the fixed payment. In shape, this closely matches the cost curve of the access provider. Such structures have the potential to lead to savage price competition, and are challenging to price

Implicit in all the above structures is an assumption that wholesale pricing should be 'bottom up', in some way cost based. Alternatively wholesale charges could be 'top down', calculated on a retail-minus basis. Such an approach could provide great retail pricing flexibility, allowing the full demand curve to be addressed.

Nonetheless, we do not believe such an approach is appropriate. If the wholesale charges are based on the incumbent's retail offers, it begs the question what price should be paid for the access component of a retail offer for a competitor product not offered by the incumbent (say a pay TV offering). There would also be a difficult question as to what 'minus' was appropriate. For a pay TV offering, much more value is added by the access seeker than is the case for a simple consumer broadband offer, so these would need different 'minuses'. Finally, it is hard to imagine an access provider investing in NGA in a situation where its pricing was effectively controlled by its customers.

Each of these pricing approaches graphed above could apply to an assembled access product, or to individual components, and for individual components the appropriate choice may vary, since the long run cost drivers differ. The following table sets out the cost drivers for a number of different network components.

Figure 6: Network components and cost drivers

Network component	Volume units	Possible cost drivers	Long run Cost driver
NTP	Ports per line; Premises served	Network design	Number of lines served
Access cables	Individual cables;	Number of homes/premises passed; Network planning rules (which might be determined by the acceptable time to provision a new circuit)	Homes passed
DSLAM / access network modem	Number of chassis; Number of line cards; Backplane capacity; Number of simultaneous sessions	Number of subscribers; Types of services provided; Network planning rules; Spares policy;	Number of lines served
Backhaul	Bandwidth per aggregation point / per exchange / per DSLAM	Bandwidth required per user (which is a function of the retail services); Quality of service required Network planning rules (i.e. what allowance is made for growth in bandwidth demand and customer numbers)	Number of links; bandwidth required
Maintenance and repair	Number of staff Fleet vehicles Test and repair equipment	Number of homes/premises passed; Number of subscribers and types of service provided Quality of service required (function of attitude to risk) Demographics Network architecture	

While it is certainly possible to allocate all these costs out on a per-line basis, it is not necessary. In BT's IPstream for instance, the backhaul component is priced based on aggregate bandwidth.

We believe the access provider's costs should be recovered via a tariff that charges the access element on a part fixed, part per-line-used basis, and charges backhaul on a bandwidth basis. (Inherently this means the marginal costs to access seekers will be lower than a structure in which all costs are recovered through variable charges). This approach, equivalent to the 'discount club' described above, is the one we adopt in our illustrative access product specification (described in chapter 6).

This combination of fixed and variable tariffs could meet the objectives of risk sharing and lower marginal costs discussed above, though note that a fixed element in of itself does not ensure the reallocation of risk. For instance, the access provider would be unlikely to agree to a substantial discount for a volume commitment that represented (say) 25% of the expected volume of that operator. Such a commitment would in practice transfer very little risk to the access seeker, and thus would not 'buy' a worthwhile discount. This argues that the fixed cost element needs to be significant in order to be worthwhile.

4.2. Upfront versus ongoing tariffs

Wholesale access products have typically been sold on an ongoing (monthly) basis. This reduced the barriers to entry for access seekers by minimizing upfront capital requirements. It was also appropriate in a copper world, where the vast majority of the network was built long before competition.

Under NGA, the premise of long-sunk investment does not apply, and it might be appropriate to offer ongoing benefits in exchange for an upfront investment or commitment by access seekers. We have not included an upfront element in our illustrative wholesale offer, but believe such an approach is a credible option[17].

4.3. Consequences of fixed charges

Our illustrative approach does include a fixed charge per month, plus per line charges. This could be seen as one charge for network availability and one charge for usage (and in practice the former is the more significant driver of costs). This parallels the costs borne by access seekers using LLU – the costs to enable an exchange are largely independent of the number of lines.

As with LLU, this will have the consequence that larger players can achieve lower average costs, since the fixed costs will be spread over more customers. In turn this means all players will have strong incentives to drive for scale (which we believe is important given the market need to mitigate the demand risk of NGA). The significance of this scale advantage depends on percentage of total costs (including customer care, marketing and so on) that the fixed costs represent, and also on the degree of difference in scale between the various players. While the incumbent retail arm may have a scale advantage, it may be less significant in the fibre world because all players start from zero volumes (though incumbents may have a larger customer base to migrate), and because of the potential importance of other bundle elements (such as TV) in which some incumbents will be weaker than their competitors.

4.4. Conclusion

We believe that NGA assembled access charges should include a significant 'availability' charge, plus a per-used-line charge for the access element, whereas backhaul charges should be tied to required bandwidth. This will better reflect underlying costs, allow risk sharing and provide lower marginal costs to access seekers.

Note that such a structure need not replace a standard 'per line' approach – they can be run in parallel. However, for the reasons above, we believe the 'default' wholesale offer should be along these lines. (We note also that access seekers would be free to offer their own wholesale products based on reselling the access provider's wholesale offer).

[17] One option would be to give access seekers an early but time limited opportunity to buy 'interest bearing vouchers' for their future access needs. These would be financially denominated, non-transferrable, and would earn interest (in kind) at the same rate as the cost of capital used for the incumbent's return in the NGA tariff calculation. This would allow the incumbent to lay off some of the risk of the investment, since they would retain the purchase price of the vouchers regardless of future demand. In return, those access seekers willing to commit early would lower their costs (assuming their cost of capital was lower than the NGA rate).

5. The arguments against assembled products

As with most telecoms regulatory decisions, the choice between preferring an assembled or a component approach is not a black and white one. In this chapter we consider some of the arguments against preferring assembled approaches (in addition to those discussed elsewhere).

5.1. Gold-plating

Incumbents are often accused of 'gold-plating' their networks – over-engineering by providing multiple layers of redundancy, over-provisioning network spares, and so on. This approach tends to produce very high reliability and availability of services, but at a cost. Component remedies offer access seekers the opportunity to create functionally equivalent, but perhaps less reliable, services at a much lower cost, which allows them to sell at more competitive prices and target parts of the demand curve not previously served.

However, in practice if the choice is between an assembled product or the combination of an active line and backhaul from the incumbent plus limited access seeker equipment at the exchange, the access seeker is not a position to avoid much gold plate. Thus to the extent to which gold plating is a concern, we do not believe that assembled access makes it much worse.

5.2. Reduces dependence on incumbent

One of the key tenets of component access regulation has been that it reduces the scope of the incumbent's Significant Market Power (SMP). Component access remedies allow access seekers to limit their reliance on the incumbent to just those segments where the incumbent has enduring SMP.

As with goldplating, in practice there are limits to this benefit. Access seekers frequently remain reliant upon the incumbent for non-access products such as backhaul (where, at many exchanges, the incumbent may also have SMP). Even if the dependency is limited to access, this remains critical precisely because it is an unavoidable bottleneck in the value chain. A network is only ever as good as the weakest link, and so poor quality in the access portion of the value chain will translate into poor quality for the entire service.

5.3. Keeping the incumbent "in check"

One claimed benefit of component solutions is that they tend to reduce the scope and incentive for the incumbent to act in an anti-competitive manner: they keep the incumbent "in-check".

The scope for anti-competitive behaviour is reduced by the fact that the incumbent has less control (and access seeker has more control) under component access solutions of both pricing and product specification in downstream markets. There is therefore less opportunity to squeeze access seeker margins, or to force access seekers into a particular part of the product market (e.g. by gold-plating as discussed above).

In addition, the economic incentive for an incumbent to attempt to weaken the access seeker's business case is reduced by the threat of self-provision. For example, an access seeker currently using an assembled access service such as Telefonica's Regional and

National Wholesale Access in Spain or BT's Wholesale Broadband Connect in the UK can credibly threaten to move to LLU.

This argument does have some merit, and there is no question that a shift in focus to assembled products will likely result in the incumbent retaining SMP in backhaul longer than might otherwise be the case. However, we believe the reason that component access has been a powerful check on the incumbent is not as a result of anything inherent to its nature, but rather because it has been the product of regulatory focus. In the copper world regulators (outside the US) have, in pursuit of the top rung of the ladder of investment, placed great emphasis on LLU offers, and gone to considerable efforts to make sure they were attractive.

In other words it is not LLU that has kept the incumbent in check, but the "most regulated access product". Consequently if NRA attention were to shift to assembled offers, it is likely that these would become as effective a constraint on the incumbent as LLU has been.

That said, operational separation has been a powerful regulatory tool to ensure FRND[18] in countries where it has been applied, and assembled offers fall awkwardly across the operational boundaries of access seekers such as Openreach.

5.4. Reduced regulatory burden

A parallel argument to the idea that component access solutions keep the incumbent in check is the idea that they reduce the regulatory burden. By (supposedly) doing away with the negative consequences of the incumbent's access SMP, there is less need to regulate other parts of the market. The regulator can focus on the relatively simple passive access element.

While this may be valid in the copper world, in the fibre world (as we have argued elsewhere), passive access offers are not generally viable, so the regulator will be dealing with the additional complexity of active offers in any case.

It is plausible that a carefully regulated active last mile product will reduce the regulatory requirement on an active end-to-end product more than vice versa. However, as we believe that interconnect at the exchange is anyway suboptimal, we do not believe that less rigorous regulation of last mile access is a significant loss.

[18] Fair, reasonable and non-discriminatory

6. An illustrative 'assembled' offer

To illustrate the principles we are recommending, in this chapter we describe a sample offer consistent with those principles. However, we emphasise that this is just one of many offers that would be consistent.

6.1. Offer specifications

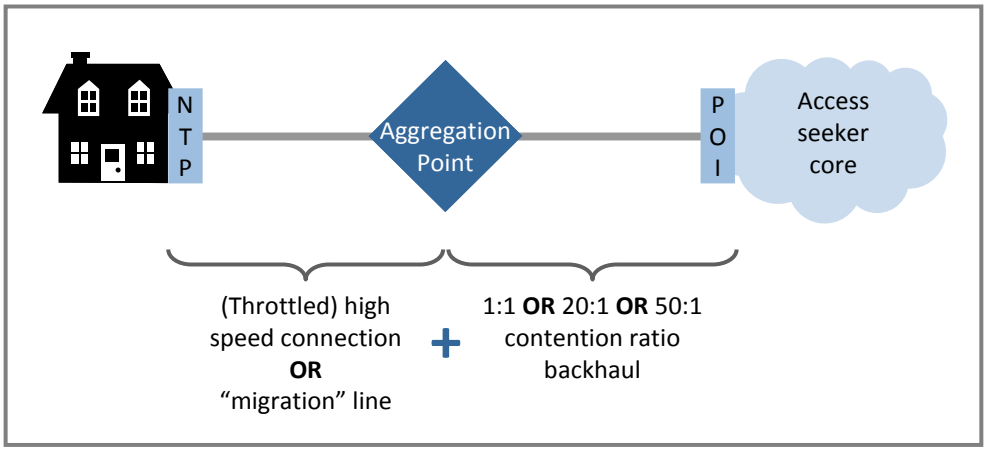
We believe key attributes and commercial terms could be as shown in Figure 7. Note that detailed technical specifications are beyond the scope of this paper, and in particular the treatment of backhaul quality issues should be taken as conceptual rather than literal.

Figure 7: Features of an example assembled offer

Aspect	Description
Scope	End-to-end connection from NTP to PoIs in the core
Access segment	Defaults to highest available local speed, though access seeker can specify that it be throttled back 'Migration lines', capped at 4Mbps, are also available (to support migration of basic broadband customers from the copper network)
Backhaul segment	Shared and aggregated between all users of the access service, but available with guarantees over at least 3 levels of QoS
Network management	Components underlying the end-to-end connection managed by access provider
Pricing (backhaul charge)	Postalised 'per Mbps' pricing, with notional bandwidth calculated based on access link speed, throttling factor, and excess use factor within each QoS level offered. Price per Mbps based on aggregate demand, not that of single access seeker. See below for discussion of the 'excess use factor'
Pricing (access participation charge)	A fixed fee of 10% of the access provider's in-scope costs, levied on each access seeker making use of any high speed lines (but not charged to those only making use of migration lines). Terminable at three years' notice
Pricing (access line charge)	For high speed lines (whether throttled or not), a per line per month charge set at approximately half the standard, fully loaded cost. See below for more detailed discussion For migration lines, a per line per month charge set at a small premium to current LLU tariff (to allow for incorporation of cost of equipment at the exchange)

Diagrammatically, this offer can be represented as follows:

Figure 8: Structure of an example assembled offer



6.2. Offer rationale (non-price terms)

This offer is intended to have the following advantages:

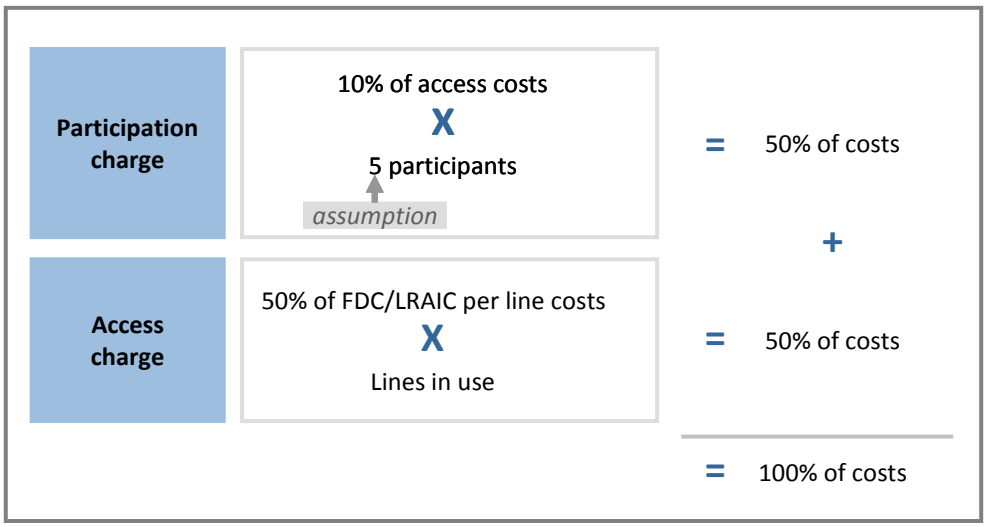
- By keeping CPE out of scope, it allows differentiation around this element
- By allowing throttling, it enables further differentiation in the offers to end consumers, allowing attractive offers to those with lower willingness-to-pay without precluding extraction of greater value from those with higher WTP
- By offering 'migration lines' at a relatively low tariff, existing DSL customers not willing to pay for higher speeds can nonetheless be migrated to the fibre platform, supporting copper-switch-off
- By removing 'per exchange' issues for access seekers, allows all access seekers to push NGA demand across the entire coverage area and broadest competition
- By allowing the access seeker to specify more or less backhaul for a given access customer, it allows differentiation on the key element that is in scope
- By somewhat limiting the range of backhaul options, it allows for meaningful traffic aggregation across access seekers, avoiding appreciable cost-of-competition

Note that a potential flaw of shared backhaul (of a given contention ratio) is that heavier users could cause congestion to lighter users. For instance, an access seeker offering television services might much more intensively use their access bandwidth, and by extension use a disproportionate amount of backhaul of a given contention ratio. To address this, an 'excess use factor' could be applied to increase the notional bandwidth for which charged to that access seeker. This would be triggered if (exceptionally) a threshold level of network-wide 95th percentile traffic was exceeded

6.3. Offer rationale (price terms)

As discussed in earlier chapters, 100% of the access network cost is typically allocated out across lines on a fully variable basis. The intent of the above structure is to instead split costs roughly 50/50 between a fixed element and a variable element, though in the base case still allowing full cost recovery by the access provider.

Figure 9: Access provider access cost recover in the Base Case



As with any regulated price (indeed as with any price) there is the possibility of under- or over-recovery of costs depending on how reality varies from the assumptions that drove the price setting. In this price structure one key assumptions for the base case is the number of access seekers paying the fixed participation charge (at 10% of in-scope costs). The access provider will 'over recover' if there are more than five, and conversely underrecover if there are fewer than five. This gives the access provider an incentive to ensure that smaller players are not driven out of the market, thereby creating an incentive for FRND behaviour. Similarly there will be over-recovery if the actual number of lines exceeds the expected number (as is the case in 'traditional' fully variable pricing).

All access seekers would have marginal access line costs 50% lower than they would have under a standard tariff, allowing much greater retail pricing flexibility. However, in exchange they accept demand risk, since if volumes are low they may be unable to recover their participation charge.

Backhaul charges to an access seeker under the example offer are likely to lower than they would be in a component approach, where the access seeker would be provisioning their own (smaller) pipes at each exchange, rather than sharing a portion of a larger pipe. While this likely reduces the access provider's revenue per Mbps, the access provider will of course be capturing all the revenue associated with backhaul, rather than sharing it with alternate long haul providers at certain exchanges.

7. Conclusions

The introduction of NGA creates a need for a different approach to wholesale access product and pricing. In particular:

- The costs of duplicating network infrastructure under NGA means that passive access will often be prohibitively expensive.
- The benefits of duplicating infrastructure are diminishing as material differentiation takes place at, and beyond, the edges of the network.
- The NGA business case is marginal and risky.

In combination, these factors mean that a simple carry-over of the wholesale access approach applied to the copper network may produce a suboptimal result in the fibre world. We believe that the approach for fibre should incorporate the following recommendations:

- Regulators should shift their focus from component to assembled offers (although not necessarily to the exclusion of the former).
- Assembled access must allow the access seeker to control the prioritisation of traffic in the backhaul network – this is vital to give the access seeker the flexibility to innovate and develop new retail services without having to request bespoke features from the access provider.
- Pricing (for both component and assembled offers) should include both fixed and variable elements. This would create lower marginal costs for access seekers willing to pay upfront or commit to certain volumes, and would distribute the investment risks of NGA more evenly between the access provider and the access seeker.
- Time-limited opportunities that offer advantages to those players willing to commit at the time of the investment decision may be appropriate, capturing the inherent uncertainty regarding demand and investment

8. Glossary

Passive	A network element or service without electronics to enable it to carry data – for instance dark fibre or a copper loop without a line card or DSLAM
Active	A network element or service capable of carrying data, such as backhaul or GEA
Component approach	An approach whereby an access seeker separately procures the various elements of a connection from the end-user to the core, potentially from the incumbent, a third party network operator or by self-provision. Incumbent LLU plus self-provided DSLAM plus incumbent backhaul would be an example
Assembled approach	An approach whereby all elements of the connection from the end-user to the access seeker come as part of a single service from the access provider. This service may be on a 'one size fits all' basis, or configurable. BT's IPstream is an example of the assembled approach
Configurable	A feature of an assembled approach, whereby the access seeker is able to specify elements of the assembled service provided by the access provider – for instance, the quantum of backhaul bandwidth per access line
Deep interconnect	Interconnection at the exchange (or cabinet) rather than closer to the core. Typically feature of the component approach, in which access seekers generally have their own equipment at exchanges

9. About the authors

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