OFFICE OF COMMUNICATIONS

Business Connectivity Market Review

Review of the retail leased lines, wholesale symmetric broadband origination and wholesale trunk segments markets

Consultation

Publication date: 17 January 2008

Closing Date for Responses: 27 March 2008

Contents

Section 1

Summary

Introduction

1.1 This consultation document sets out the preliminary conclusions of our review of the retail and wholesale markets for leased line services in the UK. The present review supersedes the Leased Lines Market Review carried out by Ofcom in 2003/04 (the 2003/04 Review), the findings of which were set out in a statement published in June 2004[1].

1.2 This review has been carried out in accordance with the requirements of the regulatory framework for electronic communications networks and services which came into force on 25 July 2003. The framework is based on five EU Communications Directives and is aimed at reducing entry barriers and fostering effective competition to the benefit of consumers. Ofcom has also taken the utmost account of the EC Recommendation on relevant product and service markets, an updated version of which came into effect in November 2007[2], and the EC Guidelines on market analysis and the assessment of SMP.

Overview of findings

1.3 Leased lines, or private circuits as they are also known, provide dedicated transmission capacity between customer sites, which can be used to carry voice and data traffic. Retail sales of these services in the UK are estimated to be worth approximately £1bn a year.

1.4 Wholesale leased lines are also used by Communications Providers (CPs) as inputs to their retail services. These may take the form of complete circuits connecting two or more end-user sites, or partial private circuits (PPCs) connecting customer sites to points in the purchasing CP's network. PPCs can in turn be made up of 'terminating segments', which are currently defined as running from a customer site to a Tier 1 node in BT's network, and 'trunk segments', which typically run over longer distances between Tier 1 nodes. Terminating segments are also known as Symmetric Broadband Origination services. These wholesale inputs may be used to provide retail leased lines or other retail services such as Virtual Private Networks.

1.5 Leased lines play an important role in business communications in the UK. They are a key building block in the communications networks on which UK businesses depend, and which are central to the effective functioning of the economy. It is therefore of considerable importance that the markets for these services operate effectively, and deliver the services which businesses require in a timely, efficient and cost-effective manner, based where possible on active competition between service providers.

[1] http://www.ofcom.org.uk/consult/condocs/llmr/statement/

[2] See EC Recommendation on relevant product and service markets in the communications sector susceptible to ex ante regulation at http://ec.europa.eu/information_society/policy/ecomm/doc/library/proposals/rec_markets_en.pdf

1.6 The 2003/04 Review found that there were separate markets for two broad types of leased line service: 'Traditional Interface' (TI) services, which include analogue circuits and digital circuits using SDH and PDH[3] transmission; and 'Alternative Interface' (AI) services, which use other methods of transmission, notably Ethernet. Separate markets were also identified for TI circuits with different bandwidths and, at the wholesale level, for terminating and trunk segments.

1.7 This review has focused on the leased lines markets which are currently subject to ex ante regulation, following findings of market dominance in 2004. Those markets include the retail market for low bandwidth TI leased lines, the wholesale markets for low and high bandwidth TI terminating segments and the AI market for terminating segments at all bandwidths. In each of these markets, Kingston Communication ('KCOM') was found to have Significant Market Power (SMP) in the Hull area, and BT was found to have SMP in the rest of the UK. BT was also found to have SMP in the UK market for trunk segments. Based on these findings, a range of SMP obligations were imposed on BT and KCOM, including obligations to supply, requirements not to discriminate unduly between customers, requirements to publish prices terms and conditions, and in some cases price controls.

1.8 Our review has been based on a programme of market research[4], the findings of which are summarised in Annex 9, extensive discussions with industry stakeholders and user groups, data supplied by CPs in response to formal information requests and desk research and analysis of publicly available information. We have also taken account of the discussion document on geographic markets published by Ofcom in March 2006 and the stakeholder responses thereto[5].

Markets outside the Hull area

1.9 In broad terms, we have found that since the 2003/04 Review, the progress made towards more effective competition has varied considerably by market. On the plus side, the evidence indicates that there has been a significant increase in competition in the markets for some higher bandwidth wholesale services. We believe that, outside the Hull area, a separate market now exists for wholesale AI services at bandwidths over 1Gbit/s and that this market is effectively competitive. We also consider that 155Mbit/s TI terminating segments now form part of the wholesale market for 'very high bandwidth' TI services, and that this market is effectively competitive outside the Hull area. In view of these findings, we propose that SMP regulation should no longer apply to these services.

1.10 In addition, we believe that a separate wholesale market now exists for high bandwidth (34/45Mbit/s) TI terminating segments in the Central and East London Area (CELA), which is made up broadly of the central London congestion charging zone and Docklands. Our analysis indicates that this market is effectively competitive and that, as a result, BT's provision of the relevant services should no longer be subject to SMP regulation.

1.11 But while deregulation appears to be warranted in some markets, progress towards greater competition is far less evident elsewhere. BT continues to have a very

[3] Synchronous Digital Hierarchy and Pleisynchronous Digital Hierarchy

[4] The full independent end user market research report is published alongside this document on the Ofcom website.

[5] see Discussion Document of 28 March 2006 and Summary of Responses, published on 14 November 2006, at http://www.ofcom.org.uk/consult/condocs/disagg/.

strong position in the retail market for low bandwidth TI leased lines, its market share having increased from 78% in 2002/03 to 80% in 2006. We believe that BT's continued dominance in this market is linked to certain deficiencies in the way in which upstream wholesale services are provided to competing CPs, which make it more difficult for them to replicate BT's retail offerings. These deficiencies were described in Ofcom's April 2006 statement on replicability (the Replicability Statement)[6], and have not yet been fully remedied by BT. Until those matters have been resolved, our view is that any steps towards deregulation in the low bandwidth retail market would be premature.

1.12 We are nevertheless of the view that, once the existing weaknesses in the wholesale regime have been fully addressed, the retail market for low bandwidth services should be prospectively competitive. In this context, we note that this market has been removed from the EC list of markets in which ex ante regulation is likely to be required[7]. With this in mind, we propose that the SMP obligations imposed on BT in the retail market for low bandwidth services should apply for a fixed period of four years. Unless a further market review has been completed within that time, the proposed obligations would fall away at the end of the four year period.

1.13 Some end users and user groups have expressed concern about the possibility that BT may seek to withdraw legacy services – notably analogue and low bandwidth TI circuits – prematurely as it rolls out new services based on its 21st century network. There is also concern that BT may increase the retail price of analogue services, of which it is now effectively the sole supplier.

1.14 In order to address these concerns, we propose to require BT to continue to support existing analogue and low bandwidth TI circuits for the duration of the 4-year review period. In addition, BT has indicated that it is prepared to give a set of voluntary undertakings that it will continue to supply new analogue and sub-2Mbit/s retail circuits until 2011 or earlier if, subject to industry agreement and consent by Ofcom, the underlying platform is closed at an earlier date; that it will not increase its prices for analogue services more quickly than the rate of inflation (RPI-0%) for a period two years following the publication of the LLMR statement i.e. from 2008 to 2010; and that it will commit to a further two-year cap, the level of which would be agreed with Ofcom prior to 2011. We believe that these undertakings should provide a reasonable level of assurance for consumers of legacy services but would welcome stakeholder views on this issue.

1.15 BT also remains dominant in the wholesale market for low bandwidth TI terminating segments, its share of which increased to an estimated 89% in 2006. Our analysis indicates that BT has a position of entrenched dominance in this market, which warrants continued regulation, and we propose to retain broadly the same set of obligations as is currently applied. Amongst other things, this will involve extending the existing PPC charge control, which is due to expire at the end of September 2008, out to 2012. We propose to consult separately on the details of the new control.

1.16 Several industry stakeholders have argued that PPC prices are currently too high, partly because the revenues from PPC sales to BT's downstream business have been understated in the regulated accounts, and the charge control may therefore

[6] http://www.ofcom.org.uk/consult/condocs/busretail/statement/

[7] See EC Recommendation on relevant product and service markets, op cit.

be more generous than the reported profits would suggest. These arguments will be examined fully in the consultation on the new charge control.

1.17 Our analysis indicates that BT has SMP in the market for high bandwidth TI terminating segments outside CELA and the Hull area. BT's share of this market was 45% in 2006 and has changed little since the last market review. We propose to retain broadly the existing set of SMP obligations in this market.

1.18 We have found BT to have SMP in the market (outside Hull) for low bandwidth AI terminating segments at bandwidths up to and including 1Gbit/s, with a market share of 72%. This market has been expanding rapidly in recent years and is expected to continue growing as CPs deploy next generation networks using Ethernet technology. Our analysis indicates that BT has a position of entrenched dominance in this market, which is unlikely to be eroded in the foreseeable future. Effective regulation will therefore be of critical importance, if the potential benefits of technological progress are to flow through to business users.

1.19 Some stakeholders have argued that BT's wholesale ethernet services have had a number of shortcomings which have impeded the development of fair and effective competition in downstream markets. Their concerns relate to a range of issues, including delays in rolling out more efficient backhaul services based on WDM technology, poor service quality, an inflexible approach to product migrations, high charges and restrictions on the use of space in exchanges, and possible over-pricing of some circuit types.

1.20 To some extent, we believe these concerns are justified. In response, we have pressed BT to give firm commitments for the roll-out of ethernet backhaul products based on a new national backhaul network using WDM technology. We expect to consult on these commitments following the completion of this market review. We have also consulted on a new Service Level Agreement/Service Level Guarantee (SLA/SLG) regime for BT's wholesale Ethernet services[8], which would be implemented via a Direction issued under the relevant SMP condition.

1.21 Regarding space in exchanges, we propose to define exchange accommodation used primarily for the termination and/or aggregation of wholesale leased line products as technical areas related to the markets for terminating segments in which BT has SMP. As a result, the provision of space will be subject to the same SMP conditions as the associated leased line services, including charge controls where applicable.

1.22 In relation to pricing, the 2003/04 Review decided against the imposition of a charge control for wholesale ethernet services because the market was at that stage nascent, and there was a risk that a charge control woud impede its development. The market is now far more mature, and we believe that a charge control should now be added to the existing SMP conditions. This will help to ensure that the efficiency benefits of technological progress flow through to consumers in the form of lower prices, whilst enabling BT to earn a reasonable return on its investment, allowing for the risks involved. It will also enable us to examine more fully the arguments raised by some stakeholders, that some of BT's wholesale ethernet services are over-priced.

1.23 Our analysis indicates that BT continues to have SMP in the market for trunk segments, with a market share in excess of 60%. This is perhaps contrary to

[8] http://www.ofcom.org.uk/consult/condocs/slg/

expectations, as this market was regarded as prospectively competitive in the 2003/04 Review. The market has also been removed from the recently updated EC list of markets considered likely to require ex ante regulation. However, we note that BT continues to earn very high returns in this market (the return on capital employed was 59% in 2006/07) and has not de-averaged its prices by geography or route. In addition, our analysis shows that BT continues to have market shares in excess of 40% on almost all major trunk routes, and suggests that high trunk prices have helped to push retail charges for TI leased lines above the levels found in most European countries. There is little evidence that the profitability of BT's trunk services has been subject to increased competitive pressure.

1.24 Given these circumstances, we propose to retain the existing SMP remedies in the trunk market, and also to impose a charge control on BT's trunk services, the details of which will be subject to a separate consultation.

Markets in the Hull area

1.25 The development of competition in the Hull area has also varied by market. We have found that KCOM no longer has SMP in the retail market for low bandwidth TI services, and therefore propose to remove ex ante regulation from that market. On the other hand, our analysis indicates that KCOM has SMP in the wholesale markets for TI and AI terminating segments at all bandwidths. In these markets, we propose to retain broadly the same set of obligations as currently apply in the wholesale markets in which KCOM has SMP.

1.26 The most significant difference is that we believe consideration should be given to a voluntary undertaking on the price of TI terminating segments, as an alternative to the imposition of a cost orientation obligation or a charge control. KCOM has indicated that it would be prepared to give an undertaking that the price of its TI terminating segments would not increase more quickly than the general rate of inflation (RPI-0%) over the next four years. Our preliminary view is that such an undertaking would provide a reasonable safeguard against monopolistic pricing behaviour, but we would welcome stakeholder views on this issue.

1.27 If we conclude that the proposed undertaking is sufficient, we would propose to withdraw the cost orientation obligation which currently applies to KCOM in these markets. The cost orientation condition requires KCOM to maintain a cost accounting system, the costs of which are likely to be passed on in some form to consumers, and the benefits of which appear to have been very limited. In our view, the acceptance of a voluntary undertaking would provide an opportunity to reduce the burden of regulation, in accordance with our statutory duties under the Communications Act.

Dark fibre in the access network

1.28 One of the issues that has arisen in the course of this market review is whether BT should be required to provide dark fibre in the access network (i.e. from a business customer site to the Local Serving Exchange), as a means of promoting more effective competition in the downstream markets for leased lines.

1.29 In our view, this issue merits some consideration, for three reasons. Firstly, as discussed above, in several of the leased lines market under review, the amount of progress made towards a more competitive market has been very limited in the past four years, and that more radical options may therefore be worth considering. Secondly, a dark fibre access remedy would represent an intervention at the

deepest layer in the infrastructure at which competition is likely to be feasible, and would therefore be in line with the principles set out in the Telecoms Strategic Review. Thirdly and most importantly, several CPs have argued strongly that such a remedy would enable them to compete more effectively against BT, on quality of service as well as on price, and would allow them to offer service innovations which at present are not possible.

1.30 At this stage we have only given preliminary consideration to this option. Our initial view is that a dark fibre access product would fall under the definition of an Electronic Communciation Network and that Ofcom would therefore have the power to impose a requirement to provide such a product, following a finding of SMP.

1.31 We have also considered whether such a requirement could be imposed as a remedy in the wholesale markets for terminating segments, or whether it would be necessary to carry out a separate market review of the upstream market into which a dark fibre access product would fall. Our preliminary view is that a separate market review is likely to be necessary.

1.32 Ofcom is aware that a market review would be a major exercise, and would raise a number of complex issues, for example, over the definition of the market, the nature of any possible access obligation, compatibility with existing regulations, the impact on investment incentives, the pricing of the access product and consistency with Ofcom's regulatory principles.

1.33 It is also not clear that BT would have SMP in the relevant market. Even if the market were defined to include only access to business premises, fibre is used to support a wide range of downstream services, many of which are provided into competitive markets. It is possible that no CP would be found to have SMP, or that a CP other than BT would be found dominant.

1.34 Above all, it would be necessary to consider whether the benefits for consumers of mandating the provision of a dark fibre access product, in terms of improved competition and market development, would outweigh the costs of implementation, taking account not only of the impact on the markets for leased lines, but also of possible effects on other downstream markets.

1.35 Notwithstanding these issues, we believe that it is appropriate to initiate the debate over the possibility of regulating the provision of dark fibre in the access network, as a means of stimulating more effective competition in the markets for leased lines. We would welcome stakeholder views on whether this option should be explored further, whether it is likely that BT or any other provider would be found to have SMP in the relevant market and whether the benefits of mandating a dark fibre access product would outweigh the costs.

EC Recommendation

1.36 Ofcom is aware that two of the markets in which we propose to apply ex ante regulation have been removed from the second edition of the EC Recommendation on product and service market susceptible to ex ante regulation. The markets concerned are the retail market for low bandwidth leased lines (outside the Hull area) and the wholesale market for trunk segments.

1.37 The explanatory note accompanying the Recommendation (the Explanatory Note) states, however, that National Regulatory Authorities (NRAs) may be able to regulate markets which differ from those identified in the Recommendation, where

this is justified by national circumstances. Ofcom also notes that BT is currently subject to SMP regulation in these markets and that a further market review is required in order to determine whether ex ante regulation is still warranted. As Ofcom's preliminary conclusion is that BT still has SMP in these markets, we consider the imposition of appropriate ex ante remedies to be consistent with the requirements of the EC framework, and those of the Communications Act 2003.

1.38 The Explanatory Note also refers to three criteria which the Commission considers should be met if ex ante regulation is to be imposed on markets not identified in the Recommendation. The criteria are that a market should be subject to high and non-transitory entry barriers, that it would not tend towards effective competition without ex ante regulatory intervention and that competition law by itself would be insufficient to address the market failure.

1.39 Whilst Ofcom does not believe that the passing of these criteria constitutes a legal requirement for the imposition of regulatory obligations, it considers that these criteria are met in the case of the retail market for low bandwidth leased lines and the wholesale market for trunk segments. In the case of the former, the evidence indicates that BT's retail services are not yet technically and commercially replicable by its competitors and that its market share is persistently high, having increased marginally to 80% in 2006. In the case of the latter, our SMP finding reflects BT's persistently high market share and high level of profit in this market, as well as the existence of economies of scale and other factors which impede market entry and expansion. In both cases, Ofcom considers that a reliance on competition law alone would not be sufficient to promote the development of effective competition.

Market definition

Retail markets

1.40 In terms of product markets, our analysis suggests that:

- analogue leased lines and low bandwidth digital TI leased lines continue to fall within the same market;
- TI and AI leased lines are in separate markets;
- retail leased lines and Virtual Private Network services are in separate markets;
- leased lines and broadband services continue to fall in separate markets;
- the boundary between high bandwidth and very high bandwidth TI leased lines has changed since 2004, with 155Mbit/s circuits now falling in the very high bandwidth market;
- there are now separate markets for low bandwidth AI circuits, at speeds up to and including 1Gbit/s, and high bandwidth circuits, above 1Gbit/s; and
- the markets for leased lines do not include WDM services.

1.41 In terms of geography, our analysis indicates that separate geographic markets exist for retail low bandwidth TI leased lines in the Hull area and the rest of the UK. We do not consider that the 'rest of UK' market should be further sub-divided by geography.

1.42 In the light of the above, we propose to define:

- a retail market for low bandwidth TI leased lines, including analogue and digital SDH/PDH circuits at speeds up to and including 8Mbit/s, in the Hull area; and
- a retail market for low bandwidth leased lines, including analogue and digital SDH/PDH circuits at speeds up to and including 8Mbit/s, in the rest of the UK.

1.43 We do not reach a formal conclusion on the definition of any other retail markets for leased lines, as for higher bandwidth TI and AI services this review is focused on wholesale markets.

Wholesale markets

1.44 In many respects, our proposed wholesale market definitions reflect the findings of the retail analysis referred to above. In addition, our review of wholesale markets indicates that:

- separate markets do not yet exist for access and backhaul wholesale leased line products, although this may occur in the future if the use of disaggregated access and backhaul products continues to grow;
- wholesale services used to support Unbundled Local Loop (LLU) and Radio Base Station (RBS) backhaul services still fall within the markets for terminating segments; and
- other forms of "core" connectivity such as broadband conveyance do not constrain the pricing of the trunk segments used for leased lines and therefore fall in separate markets.

1.45 Our analysis also suggests that separate markets continue to exist for trunk and terminating segments. However, we propose to change the existing boundary between these markets. Instead of defining trunk segments as wholesale leased line circuits between Tier 1 nodes in BT's network, we believe it would be more appropriate to define them as wholesale leased line circuits between a specified list of aggregation nodes, aligned broadly with major urban centres. The proposed list of aggregation nodes is set out in section 6 and is based on consideration of the location of BT's Tier 1 network nodes, the pattern of demand for retail leased line services and the deployment of network resources by major CPs.

1.46 In our view this approach would better reflect differences in the economics of network provisioning for trunk and terminating segments, and in the competitive conditions relating to their supply. It would also have the benefit of making the market definitions independent of future decisions by BT regarding the structure of its network.

1.47 In addition, we have carried out a detailed analysis by postal sector of the extent to which competitive conditions vary by geography in each of the relevant wholesale product markets. The results of this analysis suggest that there is a separate market for high bandwidth TI terminating segments in the CELA. For other wholesale leased line products, the results suggest that, outside the Hull area, the relevant markets continue to be national in scope.

1.48 Based on our findings, we propose to define the following wholesale markets in the UK excluding the Hull area:

- a market for low bandwidth TI terminating segments at bandwidths up to and including 8Mbit/s;
- a market for high bandwidth TI terminating segments at bandwidths of 34/45Mbit/s in the CELA;
- a market for high bandwidth TI terminating segments at bandwidths of 34/45Mbit/s in the rest of the UK;
- a market for very high bandwidth TI terminating segments at bandwidths of 155Mbit/s and above;
- a market for low bandwidth AI terminating segments at bandwidths up to and including 1Gbit/s;
- a market for high bandwidth AI terminating segments at bandwidths above 1Gbit/s; and
- a market for trunk segments.

1.49 In addition, we propose to define separate markets for low, high and very bandwidth TI terminating segments and low and high AI terminating segments in the Hull area, the bandwidth breaks being the same as those found in the rest of the UK.

SMP assessment

Markets outside the Hull area

1.50 Our analysis indicates that BT has SMP in the following markets outside the Hull area:

- the retail market for low bandwidth TI leased lines;
- the wholesale market for low bandwidth TI terminating segments;
- the wholesale market for high bandwidth TI terminating segments outside the CELA;
- the wholesale market for low bandwidth AI terminating segments; and
- the wholesale market for trunk segments.

1.51 Our provisional conclusion is that BT does not have SMP in:

- the wholesale market for high bandwidth TI terminating segments in the CELA;
- the wholesale market for very high bandwidth TI terminating segments; and
- the wholesale market for high bandwidth AI terminating segments.

Markets in the Hull area

1.52 Our findings indicate that KCOM has SMP in the following markets in the Hull area:

- the wholesale market for low bandwidth TI terminating segments;

- the wholesale market for high bandwidth TI terminating segments;
- the wholesale market for very high bandwidth TI terminating segments;
- the wholesale market for high bandwidth AI terminating segments; and
- the wholesale market for high bandwidth AI terminating segments.

1.53 We do not consider that KCOM has SMP in the retail market for low bandwidth TI leased lines.

Remedies

1.54 Our preliminary conclusions on the SMP conditions which should be imposed on BT and KCOM, in the markets in which they have been found to have SMP, are summarised below.

Markets outside the Hull area – SMP conditions on BT

Retail low bandwidth TI leased lines

1.55 We propose the following:

- Obligation to provide: BT should be required to provide retail low bandwidth leased lines to third parties on reasonable request. This obligation should not apply to 8Mbit/s leased lines or to the supply of new analogue and sub-2Mbit/s digital services. The availability of the latter should be addressed through a voluntary undertaking, as described above;
- No undue discrimination: For all analogue and digital services at speeds up to and including 2Mbit/s, a requirement not to discriminate unduly in the provision of services; and
- Reference offer: for all analogue and digital services at speeds up to and including 2Mbit/s, a requirement to publish prices, terms and conditions, and to notify on the same day of entering into force any changes to those prices, terms and conditions.

1.56 In addition, Ofcom considers that a cost orientation obligation should apply to BT in relation to analogue leased lines. However, it is proposed that this obligation should only come into effect in the event of a failure to agree on voluntary undertakings in respect of the pricing of analogue circuits, or if BT should fail to comply with the voluntary undertakings it has given.

1.57 We propose that the obligations outlined above should apply for a fixed period of four years. If another market review has not been completed within that time, the obligations should fall away at the end of the period.

Wholesale low bandwidth TI terminating segments

1.58 We propose that BT should be subject to the following SMP conditions in this market:

- an obligation to provide Network Access

- a requirement not to unduly discriminate
- cost orientation and accounting separation obligations;
- charge controls, the coverage of which should include wholesale SDSL services and ancillary PPC services such as Excess Construction charges;
- a requirement to publish a reference offer;
- an obligation to give 90 days notice of changes to prices, terms and conditions for existing services;
- an obligation to give 28 days notice of the introduction of prices, terms and conditions for new services;
- a requirement to notify technical information with 90 days notice;
- obligations relating to requests for new network access; and
- a requirement to provide quality of service information.

1.59 We are inclined to the view that, when interpreting the no undue discrimination requirement, there should be a presumption that saw-tooth discounts are unduly discriminatory. This would mean that, in the event of an investigation into saw-tooth discounts, the burden would fall on BT to demonstrate that they had not had a material adverse effect on competition. The same interpretation would apply in the other wholesale leased line markets in which BT is subject to a no undue discrimination requirement.

Wholesale high bandwidth TI terminating segments outside the CELA

1.60 We propose the following SMP remedies in this market:

- an obligation to provide Network Access;
- a requirement not to unduly discriminate;
- cost orientation and accounting separation obligations;
- a charge control;
- a requirement to publish a reference offer;
- an obligation to give 90 days notice of changes to prices, terms and conditions for existing services;
- an obligation to give 28 days notice of the introduction of prices, terms and conditions for new services;
- requirement to notify technical information with 90 days notice;
- obligations relating to requests for new network access; and
- a requirement to provide quality of service information.

Wholesale low bandwidth AI terminating segments

1.61 Our preliminary view is that the following SMP obligations should be imposed on BT in this market:

- an obligation to provide Network Access;
- a requirement not to unduly discriminate;
- cost orientation and accounting separation obligations;
- a charge control;
- a requirement to publish a reference offer; and
- a requirement to comply with quality of service obligations.

Wholesale trunk segments

1.62 We propose that the following SMP conditions should apply to BT in respect of wholesale trunk segments:

- an obligation to provide Network Access;
- a requirement not to unduly discriminate;
- cost orientation and accounting separation obligations;
- a charge control;
- a requirement to publish a reference offer;
- an obligation to give 90 days notice of changes to prices, terms and conditions for existing services;
- an obligation to give 28 days notice of the introduction of prices, terms and conditions for new services;
- a requirement to provide quality of service information;
- requirement to notify technical information with 90 days. notice; and
- obligations relating to requests for new network access.

Markets in the Hull area – SMP conditions on KCOM

Wholesale low, high and very high bandwidth TI terminating segments

1.63 We propose to impose the following regulatory obligations on KCOM in these markets:

- a requirement to provide network access on reasonable request;
- a requirement not to unduly discriminate;

- a requirement to publish a reference offer; and
- a requirement to notify technical information.

1.64 In addition, we are inclined to accept KCOM's proposed voluntary undertaking not to increase the prices of its TI terminating segments by more than RPI+0% for four years following the completion of this market review. If KCOM were to fail to adhere to its voluntary undertaking, we propose that a cost orientation obligation would then be applicable and it would have to produce within six months of the breach a set of accounts that demonstrates compliance with the cost orientation and non discrimination obligations.

Wholesale low and high bandwidth AI terminating segments

1.65 We propose to apply the following SMP conditions to KCOM in these markets:

- a requirement to provide network access on reasonable request;
- a requirement not to unduly discriminate;
- a cost orientation obligation;
- a requirement to publish a reference offer; and
- a requirement to notify technical information

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Section 2

Introduction

Scope of this consultation

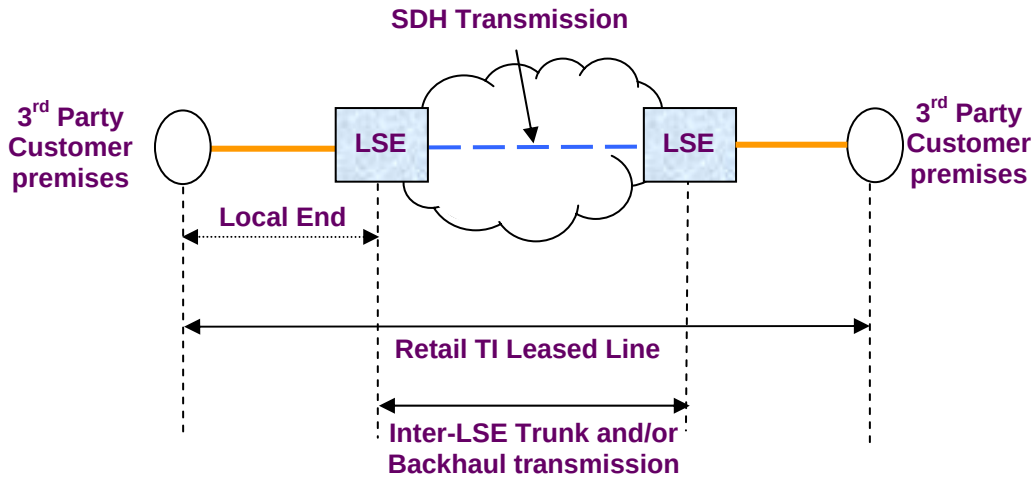
2.1 This consultation document considers the market(s) for the retail provision of leased lines, and the wholesale markets for the provision of symmetric broadband origination and trunk segments in the UK.

Services covered by this review

2.2 At the retail level, retail leased lines provide businesses with dedicated symmetric transmission capacity to carry voice and/or data traffic. These lines are used to build enterprise networks linking the various company sites, and enable all types of communications within an organisation.

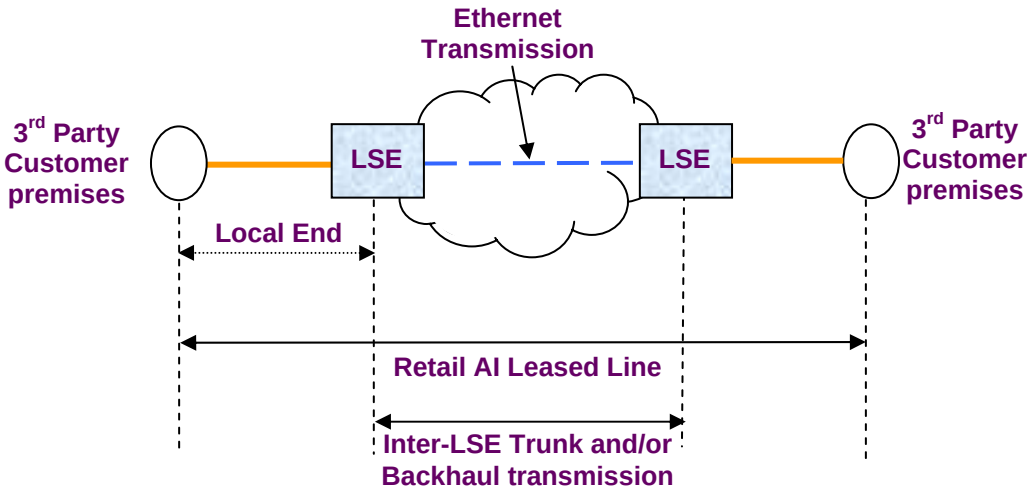
2.3 There are different types of retail leased lines. In this review we consider traditional interface (TI) and alternative interface (AI) (primarily Ethernet) leased lines, which are by far the most common types of leased lines used by enterprises in the UK.

Figure 1: Retail TI Leased Line



2.4 A retail Traditional Interface leased line provides dedicated symmetric transmission at a range of bandwidths between two 3rd party customer premises. The 3rd party customer premises are linked to the Local Serving Exchanges (LSE) via copper or fibre-optic pair local ends with SDH or PDH transmission being used to provide the link between the customer premises.

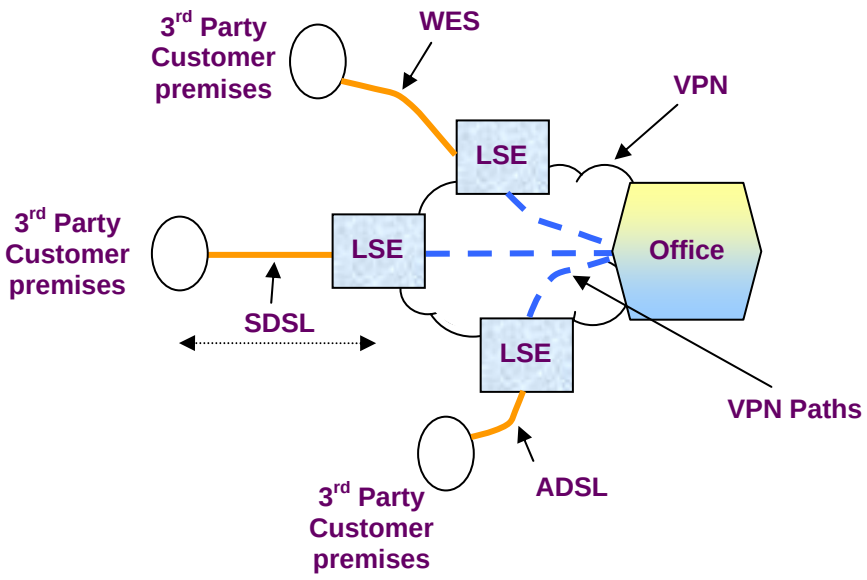
Figure 2: Retail AI Leased Line



2.5 A retail Alternative Interface leased line also provides dedicated symmetric transmission at a range of bandwidths between two 3rd party customer premises. In this case, The 3rd party customer premises are linked to the Local Serving Exchanges (LSE) via fibre-optic pair local ends with Ethernet transmission being used to provide the link between the customer premises. These services are often provided using dedicated fibre pairs from 3rd party customer premise to 3rd party customer premise.

2.6 Businesses in the UK also use other types of retail business connectivity services to cater for their communications requirements. The most widely used such services are Virtual Private Networks (VPNs).

Figure 3: VPN

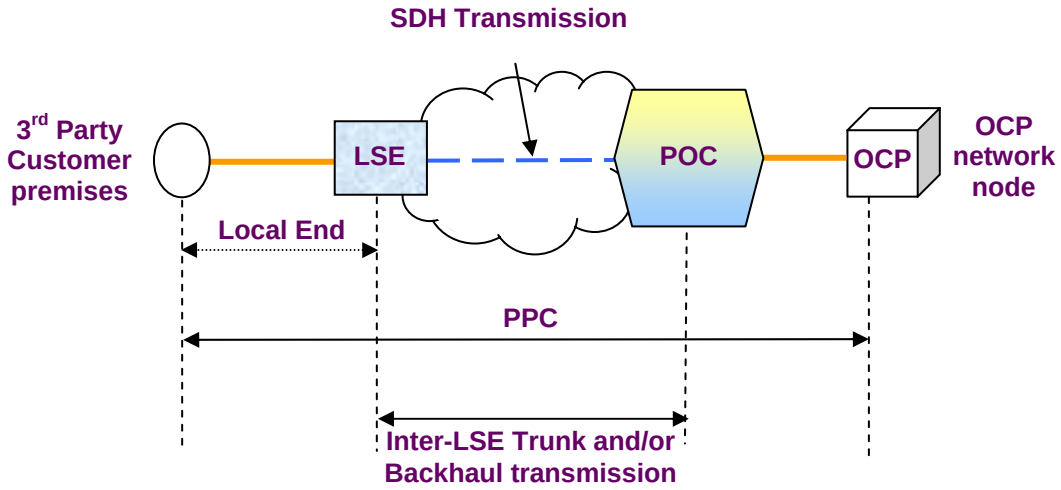


2.7 A Virtual Private Network typically links end-user premises to a central office in order that other offices or remote workers can access applications such as company Intranet or central database applications. A range of connection types are possible that range from ADSL access via the Internet for a remote worker to dedicated leased lines for satellite offices. The VPN is configured to enable each satellite site to have secure connections of varying bandwidths to the central office.

2.8 These services can use some type of wholesale leased lines in the access network, but can use also other wholesale access services, such as wholesale ADSL. The "core" transmission typically uses virtual paths across a core infrastructure shared with other services. VPNs can be of different types, depending on the characteristics of the infrastructures used in the access and core.

2.9 At the wholesale level, there are a variety of services that can be used an input into downstream retail TI and AI leased lines markets.

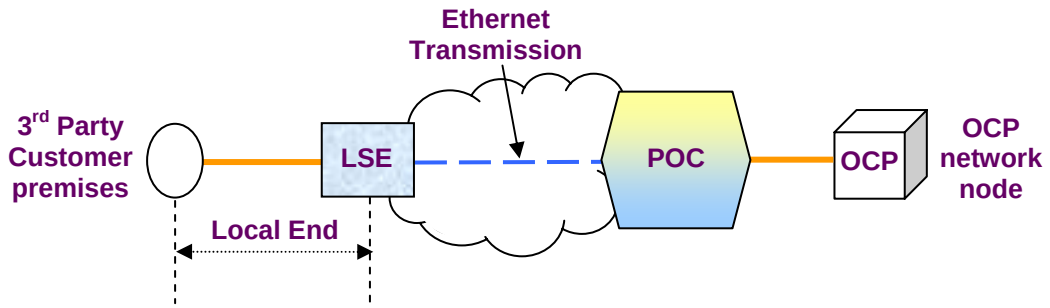
Figure 4: Partial Private Circuit



2.10 Partial Private Circuits (PPCs) are the most widely used wholesale leased line in the UK. PPCs provide dedicated symmetric transmission at a range of bandwidths between a 3rd party customer premise and an OCP's network via a Point of Connection (POC). The 3rd party customer premises are linked to the Local Serving Exchanges (LSE) via copper or fibre-optic pair local ends with SDH or PDH transmission being used to provide the link between the customer premises and the POC. A PPC can further be divided into a terminating segment and a trunk segments, with the latter providing connectivity between major aggregation, or trunk, nodes.

2.11 Increasingly important for businesses in the UK and abroad are wholesale Ethernet services. These services are available in a variety of different options, depending on whether the purchaser wishes to self provide some of the retail services using its own network, and what element it wishes to self provide.

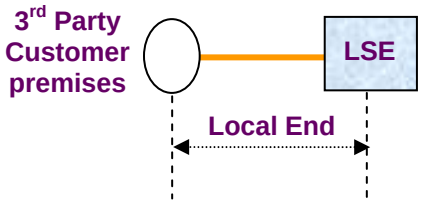
Figure 5: Wholesale Extension Service (WES)



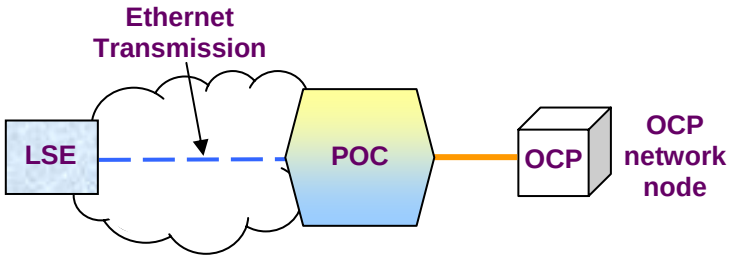
2.12 A Wholesale Ethernet Service (WES) provides dedicated symmetric transmission at a range of bandwidths between a 3rd party customer premise and an OCP's network node. The service is provided via a fibre-optic local end using Ethernet transmission and often includes transmission between the LSE and the OCP's POC provided using a dedicated fibre-optic pair.

Figure 6: WES Access (WES A) and WES Backhaul (WES B)

WES A



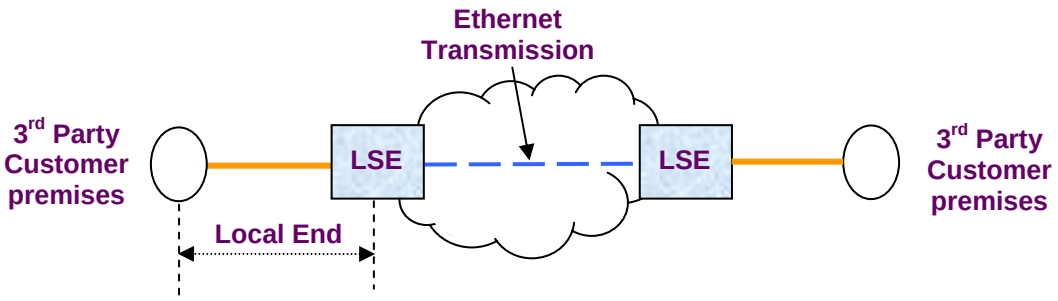
WES B



2.13 A WES Access (WES A) service provides dedicated symmetric transmission at a range of bandwidths between a 3rd party customer premise and a Local Serving Exchange (LSE). The service is provided via fibre-optic local ends using Ethernet transmission.

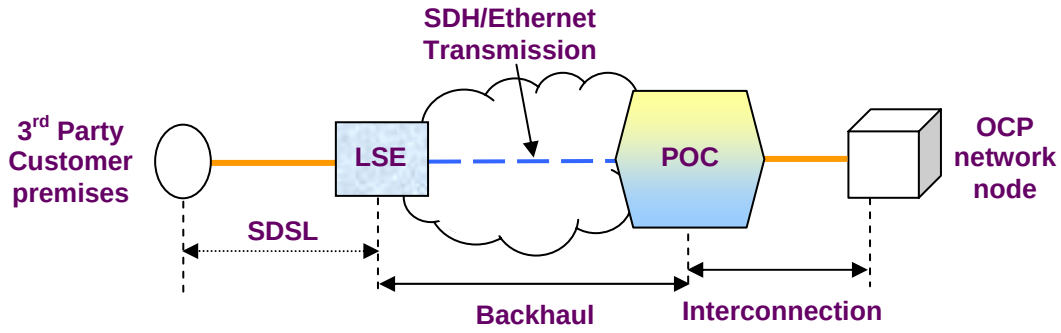
2.14 A WES Backhaul (WES B) service provides dedicated symmetric transmission at a range of bandwidths between a Local Serving Exchange (LSE) and an OCP's network node. The service is provided via fibre-optic local ends using Ethernet transmission.

Figure 7: Wholesale End to End Services (WEES)



2.15 A Wholesale End to End Service (WEES) provides dedicated symmetric transmission at a range of bandwidths between two 3rd party customer premises. The service is provided via fibre-optic local ends and fibre-optic main link between LSEs using Ethernet transmission.

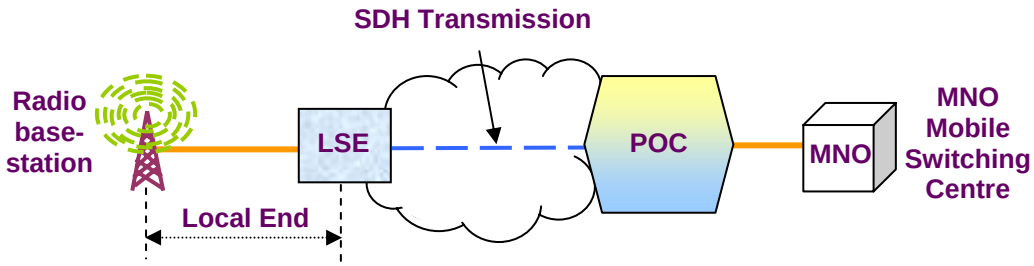
Figure 8: Wholesale SDSL



2.16 Wholesale SDSL provides symmetric transmission at a range of bandwidths between a 3rd party customer premise and an OCP's network via a Point of Connection (POC). The 3rd party customer premise is linked to the Local Serving Exchanges (LSE) via a copper pair local end with SDSL transmission being used to provide the link between the customer premise and the LSE of the customer premise and either SDH or Ethernet transmission being used to provide the link between the LSE and the CP's POC.

2.17 In addition, mobile operators in the UK use a particular wholesale leased lines product, namely Radio Base Station (RBS) Backhaul.

Figure 9: RBS Backhaul



2.18 An RBS backhaul circuit provides dedicated symmetric transmission at a range of bandwidths between a Mobile Network Operator's (MNO's) radio base station and the MNO's network via a Point of Connection (POC) at the MNO's Mobile Switching Centre. The base-station is linked to the Local Serving Exchanges (LSE) via copper or fibre-optic pair local ends with SDH or PDH transmission being used to provide the link between the radio base station and the POC.

Period covered by this review

2.19 In conducting this review, we have considered the level of competition and the level of regulation required to promote competition both now and on a forward looking basis. In doing so, we have taken the period for assessment as being the next four years. The next leased lines market review should therefore be carried out in 2012.

The regulatory framework

2.20 The present regulatory framework for electronic communications networks and services entered into force on 25 July 2003. The framework is designed to create harmonised regulation across Europe and is aimed at reducing entry barriers and fostering prospects for effective competition to the benefit of consumers. The basis for the regulatory framework is five EU Communications Directives (together "the Directives"):

- Directive 2002/21/EC on a common regulatory framework for electronic communications networks and services ("Framework Directive");
- Directive 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities ("Access Directive");
- Directive 2002/20/EC on the authorisation of electronic communications networks and services ("Authorisation Directive");
- Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services , ("Universal Service Directive"); and
- Directive 2002/58/EC concerning the processing of personal data and the protection of privacy in the electronic communications sector ("Privacy Directive").

2.21 The Framework Directive, the Access Directive, the Authorisation Directive and the Universal Service Directive were implemented in the United Kingdom on 25 July 2003 via the Communications Act 2003 ("the Act"). The Privacy Directive was implemented by Regulation which came into force on 11 December 2003.

2.22 Article 16 of the Framework Directive requires each national regulatory authority (NRA) to carry out an analysis of the relevant markets as soon as possible after the adoption of the Recommendation on relevant product and service markets or any updating thereof.

2.23 The Commission adopted the first edition of the Recommendation on 11 February 2003[9]. Ofcom carried out a review of retail leased lines, symmetric broadband origination and wholesale trunk segments in 2003/04 with the final statement published on June 2004 ("the 2003/04 Review").

2.24 The Commission has recently adopted the second edition of the Recommendation[10], under which some markets concerned in this review are no longer on the list of recommended markets[11]. In particular, the following two markets have now been removed:

- Retail market for low bandwidth leased lines; and
- Wholesale market for trunk segments of leased lines.

2.25 The removal of the markets from the list published by the Commission indicates that the Commission no longer presumes that, in principle, ex-ante regulation is warranted for these two markets. This does not mean, however, that NRAs are not in a position after an analysis of the relevant market and the finding of SMP to impose regulatory remedies in these markets, should the national circumstances justify such a step and whilst taking due account of the Commission's SMP Guidelines and Recommendation.

The market review process

2.26 Each market review is carried out in three phases:

- a definition of the relevant market or markets;
- an assessment of competition in each market, in particular whether any undertakings have SMP in a given market; and
- an assessment of the appropriate regulatory obligations which should be imposed where there has been a finding of SMP.

2.27 More detailed requirements and guidance concerning the conduct of market reviews are provided in the Directives, the Act, and in additional documents issued by the Commission, the European Regulators Group (ERG) and Independent Regulators Group (IRG). As required by the new regime, in conducting this review, Ofcom has taken the utmost account of two European Commission documents: the

[9] Commission Recommendation2003/311/EC of 11 February 2003 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communication networks and services.

[10] Commission Recommendation on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communications networks and services (Second Edition) (C(2007)5406 rev1).

[11] See the Annex to the Recommendation.

Recommendation and the "Guidelines on market analysis and the assessment of SMP"[12] (the SMP Guidelines).

2.28 The Commission identified in the first edition of the Recommendation a set of markets in which ex ante regulation might be warranted. As set out above, the Reccomendation has now recently been updated by publication of a second edition. The Recommendation seeks to promote harmonisation across the European Community by ensuring that the same product and service markets are subject to a market analysis in all Member States. National Regulatory Authorities (NRAs) can define relevant markets appropriate to national circumstances, provided that the utmost account is taken of the product markets listed in the Recommendation. In the United Kingdom, Section 79 of the Act implements this provision in relation to a determination of market power by Ofcom.

The SMP Guidelines

2.29 The Commission issued the SMP Guidelines in July 2002 which provide guidance on the assessment of the relevant markets and the designation that an operator has SMP in any given market. Oftel has produced additional guidelines on the criteria to assess effective competition based on the SMP Guidelines (see www.ofcom.org.uk/static/archive/oftel/publications/about_oftel/2002/smpg0802.htm) .

2.30 Ofcom, in conducting its analysis of the retail leased lines, wholesale symmetric broadband origination and wholesale trunk segments' markets, has taken the utmost account of both the Recommendation and the SMP Guidelines when identifying a services market and when considering whether to make a market power determination under Section 79 of the Act.

The 2003/04 review and the existing regulation

Retail markets

2.31 In the 2003/04 Review, BT was found to have SMP in the market for analogue and low bandwidth retail leased lines, comprising analogue and digital services of speeds up to and including 2 Mbit/s and 8 Mbit/s, provided over a traditional interface. This was the only retail product market in which SMP was found and hence in which remedies could be imposed. As a result of the SMP finding, the following remedies were imposed:

- an obligation to supply on reasonable request the minimum set of retail leased lines and to continue to supply existing 8Mbit/s retail traditional interface leased lines being provided on the date the conditions entered into force;
- a requirement not to unduly discriminate;
- for all leased lines in this market, a requirement to publish a reference offer (obligation to publish current prices, terms and conditions; and same day price notification); and
- a requirement to publish information concerning delivery and repair times.

[12] Commission guidelines on market analysis and the assessment of significant market power under the Community regulatory framework for electronic communications networks and services (2002/C 165/03).

2.32 In addition, Ofcom accepted from BT a voluntary undertaking not to increase the weighted average price of analogue and 8 Mbit/s leased lines by more than RPI before June 2006 or the implementation of the next market review, whichever is the earlier; combined with cost orientation and a cost accounting system to take effect only if BT breaches this voluntary undertaking;

2.33 For digital retail leased lines, Ofcom decided to rely on the increased competition expected as a result of wholesale regulation, in particular the price control on symmetric broadband origination PPC services, to constrain prices at the retail level.

2.34 In addition, Ofcom found KCOM (KCOM) to have SMP for the Hull area in the market for low bandwidth traditional interface leased lines, and imposed the following remedies:

- an obligation to supply on reasonable request the minimum set of retail leased lines;
- a requirement not to unduly discriminate;
- cost orientation and a cost accounting system;
- a requirement to publish a reference offer (obligation to publish current prices, terms and conditions); and
- a requirement to publish information concerning delivery and repair times.

Wholesale markets

2.35 The 2003/04 Review found BT to have SMP in the wholesale markets for low and high bandwidth TISBOs, AISBOs at all speeds, and trunk segments. As a result of the SMP findings, a series of regulatory obligations were imposed on BT:

- a general obligation to provide access on reasonable request;
- a requirement not to unduly discriminate;
- basis of charges obligations (cost orientation and a cost accounting system);
- price control (not for AISBO or trunk markets);
- accounting separation obligations;
- a requirement to publish a reference offer;
- an obligation to give 90 days notice of changes to prices, terms and conditions for existing traditional interface symmetric broadband origination services;
- an obligation to give 28 days notice of the introduction of prices, terms and conditions for new traditional interface symmetric broadband origination services;
- same day notification of changes to prices, terms and conditions for wholesale trunk segment products;
- a requirement to provide quality of service information;

- a requirement to notify technical information with 90 days notice; and
- obligations relating to requests for new network access.

2.36 BT is also subject to:

- a Direction under the general access condition to provide Partial Private Circuits (PPCs) at a range of bandwidths, Radio Base Station (RBS) backhaul link products, and Local Loop Unbundling (LLU) backhaul products, subject to specific terms and conditions;
- a Direction under the cost orientation condition covering pricing matters relating to PPCs and LLU backhaul; and
- a Direction under the quality of service condition to require specific information in respect of PPCs.
- a Direction under the general access condition to provide Ethernet-based LLU backhaul products, subject to specific terms and conditions; and
- a Direction under the cost orientation condition covering pricing matters relating to Ethernet-based LLU backhaul.

2.37 In addition, Ofcom found KCOM to have SMP in the wholesale low and high bandwidth TISBO markets, and the AISBO market at all speeds in the Hull area, and imposed the following remedies:

- a general obligation to provide access on reasonable request;
- a requirement not to unduly discriminate;
- cost orientation and a cost accounting system;
- requirement to publish a reference offer; and
- requirement to notify technical information with 90 days notice.

Purpose of this review

2.38 As outlined in the Summary, the market for leased lines in the UK has experienced some significant changes since the last review was completed. In particular, the Undertakings given by BT in 2005[13] have introduced commitments which apply to certain products sold in wholesale leased lines markets. In addition, the PPC charge control imposed through the last review will expire in September 2008, and we are required to carry out an assessment of the competitive conditions in the markets where the charge controls apply before we can remove or amend the charge controls. Finally, with most operators in the UK investing or planning to invest in NGNs, Ofcom considered that a new framework providing regulatory certainty for the next four years would help operators in the UK to plan for their NGNs investments.

[13] http://www.ofcom.org.uk/consult/condocs/statement_tsr/

2.39 We think therefore that this is a good time to carry out a market review of retail and wholesale leased lines in the UK.

2.40 The last review found that Ethernet services were just appearing on the market, but concluded that in the future those services would increase in importance, and eventually substitute the role of traditional interface leased lines in the UK. Our product market definition has set out to test, among other issues, whether such substitution has been occurring, and to what extent, and whether therefore the market definition from the last review needed to be updated.

8.27 In addition, the disaggregated markets consultation[14] found that there were potentially different geographic markets emerging in the UK for leased lines services. In this review, we have assessed the extent to which this is the case, and our proposed market definitions reflect our findings.

2.41 Communications providers had on many occasions told us that the competitive conditions since the last market review had changed, and that the regulatory framework for leased lines needed to be updated to reflect the new conditions.

2.42 We have set out with our SMP assessment to test whether the positions of dominance identified in the last review have been eroded, and the extent to which competition has developed in the markets under review. Our analysis of the remedies has set out, in the light of the SMP assessment, to consider whether and how the current regulatory framework for leased lines should be amended.

2.43 Ofcom is keen to receive stakeholders view on our approach and findings for the leased lines market as outlined in this document, and to engage in a debate during the course of the consultation period about the appropriate regulatory framework for leased lines in the UK for the next four years, to ensure that appropriate consideration is given to all stakeholder views.

Outline of this document

2.44 Sections 3-6 of this document outline our proposals with respect to market definition. Section 3 outlines our proposed retail product market definition for the leased lines market in the UK. Section 4 analyses the geographic boundaries of such product market(s). Section 5 outlines our proposed wholesale product market definition. Finally, Section 6 identifies the geographic boundaries for our proposed wholesale product markets in the UK.

2.45 Section 7 outlines our assessment of SMP in the markets identified. Section 8 outlines our proposals for remedies in those retail and wholesale leased lines markets in the UK where we have found SMP. When considering the appropriate level of regulation for each market where we have found SMP, we have conducted an Impact Assessment of the different options which have been considered when finalising our proposals for the appropriate level of regulation in each SMP market we have identified.

2.46 Section 8 also provides in the last sub section a short discussion about the opportunity to consider dark fibre in the access as a potential remedy for wholesale leased lines markets. A fuller discussion of this issue is presented in Annex 10.

[14] http://www.ofcom.org.uk/consult/condocs/disagg/summary/

Section 3

Retail product market definition

Introduction

3.1 Section 79(1) of the Act provides that, before making a market power determination, Ofcom needs to define the relevant markets in which to assess market power. In defining relevant markets, Ofcom is required to take utmost account of all applicable guidelines and recommendations issued by the Commission and to issue a notification of its proposals[15]. Once markets are appropriately defined Ofcom can then analyse the competitiveness of those markets and identify appropriate remedies (if any).

3.2 The purpose of this Section is to define the relevant retail and wholesale markets in which the assessments of market power are to be undertaken. Its structure is as follows: first, the Commission's approach to market definition is set out based on its applicable guidelines and recommendations. This is followed by a discussion of Ofcom's general approach to market definition which is consistent with that of the Commission. Next, definitions of the relevant retail market are considered insofar as they are logically prior to and affect wholesale market definitions. This provides a basis for the further analysis of markets in Sections 4-6.

Commission's approach to market definition

3.3 Ofcom has set out below some of the key aspects of the Commission's approach which Ofcom needs to consider when defining retail and wholesale [leased line] markets. This is primarily set out in the Recommendation and the explanatory memorandum (the "Explanatory Memorandum") to that document[16].

3.4 Recital 4 of the new Recommendation clearly states that the starting point for market definition is a characterisation of the retail market over a given time horizon, taking into account the possibilities for demand and supply-side substitution. The wholesale market is defined subsequent to this exercise being carried out. This approach is repeated in Section 3.1 of the Explanatory Memorandum and is set out below and followed by Ofcom.

3.5 Section 2.1 of the new Explanatory Memorandum also states that because market analysis is forward-looking, markets are defined prospectively taking account of expected or foreseeable technological or economic developments over a reasonable horizon linked to the timing of the next market review. Again, this is the approach followed by Ofcom.

3.6 Ofcom's product definition proposals are based on a forward looking view, taking into account reasonably available information on likely product market

[15] Ofcom is required under Section 79(4) of the Act to issue a notification of its proposals for identified markets. It is entitled, by virtue of Section 79(5) of the Act, to issue this notification with its proposal as to a market determination and with its proposals for setting SMP services conditions. This document includes such a notification in Annex 15.

[16] Commission Staff Working Document, Explanatory Note to the Commission Recommendation on Relevant Product and Service Markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council on a common regulatory framework for electronic communication networks and services (Second edition).

developments within the time horizon assessed in this review, as set out in the Introduction to this document, This includes the likely impact of those changes, if any, on our market definition proposals.

3.7 The Explanatory Memorandum goes on to state that market definition is not an end in itself, but a means to undertake an analysis of competitive conditions, for the purposes of determining whether *ex ante* regulation is required or not. Ofcom has adopted an approach by which this consideration is at the centre of its analysis.

3.8 Section 4 of the Explanatory Memorandum further states that retail markets should be examined in a way that is independent of the infrastructure being used, as well as in accordance with the principles of Competition Law. Again this approach is key to Ofcom's analysis. Ofcom's approach is based on a Competition Law assessment of markets and an assessment of the extent to which switching among services by consumers (demand-side substitution) or producers (supply-side substitution) could constrain prices, irrespective of the infrastructure used by the providers of those services, except where that may affect the ability or willingness of customers or producers to switch (for example because it affects the characteristics of the service offered.

Account taken of the EC Guidelines/Recommendations

3.9 In formulating its approach to market definition in the context of this market review, Ofcom is required to take the utmost account of all relevant guidelines and recommendations published by the Commission, including the Recommendation and SMP Guidelines.

3.10 In particular, in reaching its decision, Ofcom has taken the utmost account of the Recommendation. The second Recommendation identifies Market 6: wholesale leased lines as a relevant market at the Annex to the Recommendation. Market 6 is defined in the Recommendation as follows:

> *"Wholesale terminating segments of leased lines irrespective of the technology used to provide leased or dedicated capacity"*

3.11 Ofcom has given careful consideration to the Recommendation and considers that the approach to market definition adopted is consistent with the approach set-out in the Recommendation and the Explanatory Memorandum.

General approach to market definition

3.12 There are two dimensions to the definition of a relevant market: the relevant products to be included in the market and the geographic extent of that market. Market boundaries are determined by identifying constraints on the price setting behaviour of firms. There are two main competitive constraints to consider: first, to what extent is it possible for consumers to substitute other services for those in question (demand-side substitution); and second, to what extent can suppliers switch, or increase, production to supply the relevant products or services (supply-side substitution) in response to a relative price increase.

3.13 The 'hypothetical monopolist test' (HMT) is a useful tool often used to identify close demand-side and supply-side substitutes. A product is considered to constitute a separate market if a hypothetical monopoly supplier could impose a small but significant, non-transitory increase in price (SSNIP) above the competitive level without losing sales to such a degree as to make this price rise unprofitable. If such

a price rise would be unprofitable, because consumers would switch to other products, or because suppliers of other products would begin to compete with the hypothetical monopolist, then the market definition should be expanded to include the substitute products.

3.14 Throughout this Section, markets have been defined first on the demand-side. The analysis of demand-side substitution has been undertaken by considering if other services could be considered as substitutes by consumers, in the event of the hypothetical monopolist introducing a SSNIP above the competitive level.

3.15 Supply-side substitution possibilities have then been assessed to consider whether they provide any additional constraints on the pricing behaviour of the hypothetical monopolist which have not been captured in the demand-side analysis. In this assessment, supply-side substitution is considered to be a low cost form of entry which can take place within a reasonable time frame[17] (e.g. up to 12 months). The key point is that, for supply-side substitution to be relevant, not only must suppliers be able, in theory, to enter the market quickly and at low cost by virtue of their existing position in the supply of other services or areas, but there must also be an additional competitive constraint arising from such entry into the supply of the service in question.

3.16 Therefore, in identifying potential supply-side substitutes it is important that providers of these services have not already been included as existing suppliers of services included in the market as demand-side substitutes. There might be suppliers who provide other services but who might also be materially present in the provision of demand-side substitutes to the service for which the hypothetical monopolist has raised its price. Such suppliers are not relevant to supply-side substitution since they supply services already identified as demand-side substitutes. As such, their entry has already been taken into account and so supply-side substitution from these suppliers cannot provide an additional competitive constraint on the hypothetical monopolist. However, the impact of expansion by such suppliers can be taken into account in the assessment of market power.

3.17 Another factor that is sometimes an additional consideration in setting market boundaries is whether there exist common pricing constraints across consumers, services or areas (i.e. areas in which a firm voluntarily offers its services at a geographically uniform price). Where common pricing constraints exist the geographic areas in which they apply could be included within the same relevant market even if demand-side and supply-side substitution are not present. Failure to consider the existence of a common pricing constraint could lead to unduly narrow markets being defined.

3.18 Ofcom's approach also takes into account the SMP guidelines. In particular, paragraph 56 states that:

> *"According to established case-law, the relevant geographic market comprises an area in which the undertakings concerned are involved in the supply and demand of the relevant products or services, in which area the conditions of competition are similar or sufficiently homogeneous and which can be distinguished from neighbouring*

[17] See the SMP guidelines at paragraph 52 http://europa.eu/eur-lex/pri/en/oj/dat/2002/c_165/c_16520020711en00060031.pdf#search=%22Commission%20guidelines%20on%20market%20analysis%20and%20the%20assessment%20of%20significant%20market%20power%20under%22

areas in which the prevailing conditions of competition are appreciably different…".

3.19 Hence, subject to the relevant caveats above, where there are geographic areas where competitive conditions are sufficiently homogenous the definition of the relevant geographic market will include all of those areas within one market.

Relationship between the wholesale and retail markets

3.20 Ofcom is required to consider both retail and wholesale leased lines markets as part of its review. Whilst it is clearly necessary to define retail markets in order to assess the existence of market power at this level, it is also necessary to do so where, as here, the focus of the market review is primarily at the wholesale level. This is because the analysis of retail market definitions is logically prior to the definition of wholesale markets, because the demand for the upstream wholesale service is a derived demand, that is the level of the demand for an upstream input depends on the demand for the retail service. Hence, if the upstream input accounts for a sufficiently large proportion of the downstream price, the range of available substitutes at the downstream (retail) level will inform the likely range of substitutes for the upstream (wholesale) service. This is because a rise in the price of a wholesale service which is passed through in the price of one retail service will cause retail customers to switch to substitute retail products, reducing demand for the wholesale input.

3.21 In the current review it is therefore necessary to start by defining the retail market boundaries, as the demand for wholesale leased lines is ultimately derived from the demand for retail services for which those inputs are used. In some cases a wholesale leased line service may be used as an input to a number of markets that are defined as separate at the retail level (and potentially outside the scope of the retail leased line market). Ofcom therefore needs to take into account the possibility that wholesale products or services may be used as inputs to a number of downstream retail markets.

Relevance of existing regulation

3.22 When Ofcom conducts its analysis to define the relevant retail and wholesale markets it assumes that there is no SMP related regulation in place in the market being considered. To do otherwise would mean that the subsequent wholesale market power assessment would depend on a retail market definition that relied on a wholesale regulatory remedy arising from the finding of wholesale market power. This would be a circular and incorrect approach to market definition. Ofcom has therefore considered the demand-side and supply-side substitution possibilities at the retail level only if they are economically viable in the absence of regulation in the market being considered.

3.23 On the other hand it is appropriate at the wholesale level to take into account any regulation that is upstream of the markets being considered, as this upstream regulation has the potential to affect the competitive state of downstream markets; indeed this is generally one of the main intentions of the upstream regulation. For example, the availability of regulated LLU products could be used to provide symmetric DSL services and could potentially impact on operator's build or buy decisions regarding the particular retail products they provide and which may act as potential substitutes to leased lines services. An important element of the analysis

is therefore to identify any upstream regulation that may impact on retail or wholesale markets Ofcom is considering.[18]

3.24 In addition to regulation that exists upstream of the relevant market, regulation may also exist independently of any regulation arising from a finding of SMP in the relevant market. For example, BT Group plc agreed to offer Undertakings in lieu of a reference to the Competition Commission under Section 155(1) of the Enterprise Act 2002. The Undertakings sit alongside Ofcom's existing competition and regulatory powers and a number of aspects of the Undertakings exist independently of the review (i.e. some of the Undertakings agreed do not require a finding of SMP from this or other market reviews).

3.25 The Undertakings include the following key features:

- Establishment of Openreach as a new and operationally separate business unit, with a distinct brand identity, responsible for the local access and backhaul network.

- Openreach to support all communication providers' activities, including those of BT, on an exactly equivalent basis ('equivalence of input'). This means that all companies will benefit equally from the same products, prices and processes when they order, install, maintain and migrate connections for their customers.

- Offer universally available product and services. This includes use of BT Group plc's access network, the ability to offer line rental on an unbranded basis (wholesale line rental and unbundled local loops) and the use of transmission capacity from BT Group plc's exchanges to competitors' own networks (backhaul).

3.26 This means that relevant wholesale access and backhaul products should in principle be made available for the relevant BT wholesale services subject to equivalence of input requirements to enable communication providers to provide retail leased line services.

3.27 However, it is not necessarily the case that all aspects of the Undertakings would apply if Ofcom did not find SMP in leased lines markets. For example, the Undertakings refer to different cost orientation conditions for wholesale leased line products depending on whether SMP is found to exist for the services. The market definition process has therefore been conducted in the presence of currently operational BT Undertakings apart from any regulation or those parts of the Undertakings that would cease to apply in the absence of SMP.

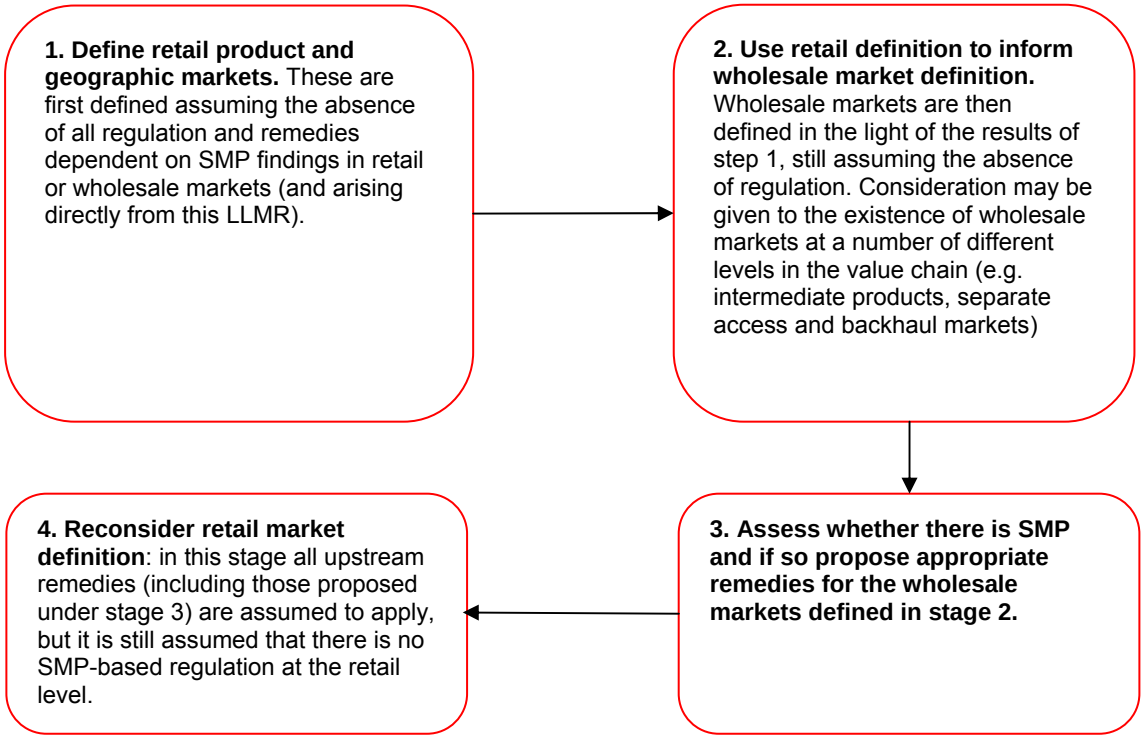
Sequencing of retail and wholesale definition and account taken of remedies

3.28 Earlier in this Section we outlined that retail market definition is logically prior to the wholesale definition. Furthermore, the market definition should be undertaken in the absence of SMP regulation, which is imposed through this market review. There is however a further step in the retail definition. The diagram below shows that the

[18] Ofcom recognises that any upstream regulations that may impact on the wholesale markets could be subject to further review during the period of this market review. In the event that regulation in those markets is revoked or modified, Ofcom will need to consider whether it is appropriate to conduct a further review of the wholesale market. However, the working assumption for the purposes of this review is that the existing regulations will remain for the period of this market review (i.e. over the next 4 years).

retail market definition is used to inform the definition of wholesale markets and identification of any markets upstream of the latter. Once the relevant analysis of SMP and remedies is considered at the wholesale level, it then follows that the retail market should be defined (taking appropriate account of remedies that have been proposed at the wholesale level).

Figure 10: Sequencing of market definition analysis



3.29 The "Stage 1" issues identified in Figure 10 above are addressed in this section and the following section (section 4, which considers geographic market definition). Stage 2 issues are considered in section 5 and Stage 3 issues in sections 7 and 8, which deal respectively with the assessment of SMP and remedies at the wholesale level. Stage 4 issues are considered at the end of this section.

Product and geographic market definition

3.30 In this section, Ofcom uses the approach set out above to define relevant retail product markets (as noted above, assuming the absence of regulation in the relevant upstream wholesale market or markets). For the product markets thus defined, Ofcom then considers the appropriate definition of retail geographic markets.

Retail market definition

Summary list of retail markets

3.31 In this Section, Ofcom proposes the following relevant product markets in the UK (including markets identified for the purposes of wholesale market definition, which is discussed in the next section):

- low bandwidth traditional interface retail leased lines (including analogue circuits and digital circuits at bandwidths up to and including 8Mbit/s);
- high bandwidth traditional interface retail leased lines (at bandwidths above 8Mbit/s up to and including 45 Mbit/s);
- very high bandwidth traditional interface retail leased lines (at bandwidths above 45 Mbit/s);
- low bandwidth alternative interface retail leased lines (at bandwidths up to and including 1Gbit/s); and
- High bandwidth alternative interface retail leased lines (at bandwidths above 1Gbit/s)

3.32 Ofcom proposes the same relevant product markets in the Kingston upon Hull area and has assessed any appropriate variations to take account of demand or supply conditions in the Kingston upon Hull area in the geographic market definition.

Retail product markets

3.33 In this section, Ofcom sets out its proposed retail product markets definition, which will then be used to assess geographic markets for those product markets and to inform the wholesale market definition.

3.34 The definition of retail services may include sales to system integrators and resellers who are not necessarily the final end-user but who act as intermediaries or provide wider value-added IT services over retail leased lines, where the leased line product they purchase is also (often, primarily) purchased by end users on similar terms. By contrast, wholesale services are taken to be sales between carriers, for example BT's sales of circuits to third parties with their own network presence.

3.35 Therefore the retail product market relates to any sales to end-user which may include businesses as well as system integrators and resellers.

Determining a starting definition for market review

3.36 As stated earlier, the Recommendation refers to wholesale terminating segments for leased lines as markets identified for the purpose of assessing SMP. In addition, in the last market review, Ofcom also imposed SMP conditions on retail leased lines up to 8Mbit/s and wholesale trunk segments.

3.37 In order to test whether particular products are in the same market, it is generally appropriate to start with a relatively narrow sub-set of services that reflect the core features or characteristics of the "market" under review and to test whether this starting definition should be widened. Ofcom needs to identify an appropriate starting point for its definition of retail services for leased lines to help identify products or services that might fall under the scope of this market review.

3.38 The SMP Guidelines propose that to do this it is appropriate to group together products or services by the same purpose (in terms of end-use/functionality) and based on this initial set of services apply the HMT to test for wider markets, as set out in paragraphs 44 and 45 of the SMP guidelines:

"NRAs should […] commence the exercise of defining the relevant product or service market by grouping together products or services that are used by consumers for the same purposes (end use)." (para 44)

3.39 In addition to services that need to be reviewed on the basis that they match the initial characteristics of leased lines services there may be a wider set of telecommunications services that fulfil the requirements of business users, albeit without displaying all of the characteristics associated with leased lines. Ofcom has labelled these services as "business connectivity" services (of which leased lines services would be a sub-set). Therefore, the market definition exercise will also need to consider whether these wider set of services might impose a competitive constraint on leased lines services.

3.40 Given that there are multiple leased line and business connectivity products to review, it is important as part of the market definition exercise not to start with too wide a market definition. If two products which are not sufficiently close substitutes are included within a single market, there is a risk of reaching erroneous SMP findings. This is because an increase in the price of one would not then be constrained by switching to the other, so a supplier of one product would similarly not be constrained by the presence of other firms supplying only the other product. In the case of leased lines, there are a number of products which share the basic characteristics of leased line services but which are sufficiently distinct from each other to fall into separate markets. For example, in the last market review digital SDH/PDH services were found to be in a separate market to Ethernet services.[19] Both digital SDH/PDH and Ethernet services were classed as leased lines but falling into specific traditional and alternative interface markets respectively.

3.41 If the market definition exercise started with a definition that sought to capture the common features of leased lines but without identifying the potential sub-markets this could potentially result in too wide a market definition. Ofcom has therefore sought to capture this in identifying as the appropriate "starting point" the initial products or services that could potentially be classified as leased lines services. Following identification of potential leased lines products and services, the analysis then selects one of those services (i.e. a more narrowly defined service) to consider whether the other identified leased lines products might impose a sufficient competitive constraint on each other such that they can be found to be in the same market. Ofcom has further considered whether the wider set of business connectivity services might impose a competitive constraint on some of these leased line services.

Initial leased lines starting point

3.42 In order to identify the services that might be classified as a leased line, it is first necessary to consider the key characteristics of leased line service. In the Commission's Recommendation it refers to leased lines as follows:

[19] These services have been defined in the Section 2 introduction and are further discussed as part of the retail product market definition below.

"Dedicated capacity or leased lines may be required by end users to construct networks or link locations or be required by undertakings that in turn provide services to end users. The key elements in the demand and supply for dedicated connections are bandwidth, distance and the location or locations to be served. There may also be qualitative characteristics because in some cases distinctions are still made between voice grade and data grade circuits."

3.43 Building on this description, Ofcom considers that the main distinguishing features common to any leased lines services are that they provide fixed point to point or point to multi point connectivity over dedicated capacity. This capacity should be capable of sending either voice and/or data messages from one site to another on a symmetric basis[20].

3.44 Based on the above there are three main products or service groupings that could potentially used to provide leased lines services:

- **Digital SDH/PDH leased lines**: allow the transmission of digital signals and are provided in a range of bandwidths referring to the maximum data rate that can be transmitted. Digital leased lines are typically offered at bandwidths ranging from 64kbit/s to 622Mbit/s (though higher bandwidths are possible).

- **Digital alternative interface leased lines**: also allow the transmission of digital signals but tend to rely on predominately Ethernet IEEE 802.3 interfaces.

- **Analogue leased lines**: allow the transmission of analogue signals typically in the frequency range 300 Hz to 3.4 kHz, although there are some, such as baseband circuits, that can be used to support a much wider range of frequencies.

3.45 Ofcom has used evidence available to it to test whether the above products (analogue, traditional interface and alternative interface services) are distinct leased lines markets based on prices and different characteristics of those services. However, rather than starting from the view that there is an "instrinsic" demand for analogue, digital SDH/PDH or Ethernet-based services, it has focussed on the underlying characteristics each service can deliver. Among the key characteristics identified are:

- **Contention** – A measure of whether a service provides dedicated capacity to an end-user or whether that capacity is shared amongst a number of end-users.

- **Latency/jitter** – A measure of delay and variation of delay in transmission over a transmission path.

- **Resilience** – A term that relates to the ability to provide an alternative route/path for transmission so enabling a higher level of protection against service failure.

- **Symmetry** – A term that relates to the transmit and receive data transmission rates of a service. If the service is symmetric then the transmit and receive data rates are identical. If the service is asymmetric then these data rates differ.

3.46 Each of the above services may vary in terms of certain characteristics and prices and consumers' demand for these services is generally likely to be related to the

[20] This will generally be for inter-site business connectivity from one of the user's sites to another, but may also include, for example, connections with major business clients.

trade-off between price and particular product characteristics that each service delivers. Ofcom has therefore used available information on the functionality and relative prices or products and services in assessing the likely demand-side responses of consumers.

3.47 Even if these services are found not to provide a constraint on each other, this analysis also needs to consider whether there may be breaks within each service grouping identified in terms of another characteristic (e.g. based on bandwidth).

3.48 Having considered whether the above leased lines products or services might constrain each other or whether other breaks might exist, Ofcom then considers a wider set of products and services, which were not included in the initial starting definition of leased lines but still provide a range of business connectivity solutions that might act to constrain some or all of the starting leased line products. These business connectivity services may be able to fulfil a sufficiently similar role to the initial leased line services identified above or be able to compensate for any differences via lower prices such that they provide a competitive constraint on leased line services. This might include business connectivity services such as Virtual Private Networks or broadband technologies which may be used to connect services between business sites.

3.49 In order to test whether any services falling into this wider "business connectivity" group should be included in the relevant market, Ofcom needs to consider the effect of service characteristics which consumers may value (to a greater or lesser extent) and which may differ between services. In particular, it needs to consider whether such differences may impact on their willingness to switch from any of the leased lines services to a wider set of retail business connectivity services. For example, where there are differences in quality, it is necessary to consider whether consumers are willing to trade-off quality for lower prices in a way which means that the services concerned are subject to a common pricing constraint. These steps in the product market definition analysis are set out in the following paragraphs.

Testing different product and services

3.50 The above discussion highlighted the starting point for Ofcom's product market assessment, testing first for competitive constraints between services that fall under "leased lines" description and then testing for competitive constraints arising from a wider set of business connectivity services. The specific order for the assessment of different retail products and services in the market is set out below:

1. Analogue versus digital SDH/PDH leased lines
2. Traditional interface versus alternative interface
3. Leased lines versus Virtual private networks
4. Broadband markets
5. Bandwidth breaks (for specific services)
6. Whether Wave Division Multiplexed-based retail services should be included in the markets for leased lines.

3.51 The remainder of this section sets out Ofcom's assessment of the markets for these services taking into account:

(1) The results of a survey of end users;

(2) Analysis of differences in relative prices and trends in usage; and

(3) Qualitative analysis of differences in the characteristics of the services.

Issue 1: Analogue versus digital SDH/PDH leased lines

3.52 The first issue within this retail leased lines market definition exercise is to assess whether there are two distinct retail markets for retail analogue and digital SDH/PDH leased lines. Ofcom has based its analysis on low bandwidth digital SDH/PDH leased lines only, as this speed is most relevant for comparative purposes when considering users with analogue circuits.

Technical definitions

Digital SDH/PDH leased lines

3.53 Digital leased lines may be either traditional interface or alternative interface. SDH and PDH circuits fall into the traditional interface category. Both systems are specified by internationally agreed ITU-T recommendations and are therefore standardised to assist with interoperability and ensure a vibrant market for the supply of conformant equipment. The plesiochronous digital hierarchy (PDH) is supplied primarily at line rates of 2Mbit/s (E1), 34Mbit/s (E3), 45Mbit/s (DS3) and 140Mbit/s (E4). The synchronous digital hierarchy (SDH) is primarily supplied at line rates of 155Mbit/s (STM-1), 622Mbit/s (STM-4), 2.5Gbit/s (STM-16) and 10Gbit/s (STM-64). SDH is designed to transparently carry PDH circuits as logical circuits within the SDH payload and therefore PDH interfaces are available for SDH equipment. It is also possible to deliver an aggregated group of PDH circuits using a single SDH physical interface, e.g. up to 63 separate 2Mbit/s logical circuits can be delivered using a single physical STM-1 interface (the remainder is used by the SDH overhead which contains a number of management and supervisory functions).

3.54 SDH and PDH circuits are used for a wide variety of connectivity purposes in both retail and wholesale markets. Higher bandwidth (i.e. SDH) circuits are primarily sold as wholesale inputs whilst lower bandwidth circuits (i.e. 2Mbit/s and, possibly, 34/45Mbit/s PDH) are primarily sold as retail products.

Analogue leased lines

3.55 Analogue leased lines are provided in two general forms:

- **Standard analogue circuits**: These services use an analogue-to-digital converter at either end of a 64kbit/s digital circuit to provide inter exchange transmission over long distances

- **Baseband analogue circuits**: These services use a copper pair and are provided within the same exchange area. There is no digital transmission involved with the service being provided over a dedicated point to point copper infrastructure.

3.56 Analogue leased lines are capable of supporting voice telephony and low speed data applications, at different capacities depending on the type of line and whether or not it goes through the PDH network. The potential capacity offered for data transmission is about 34kbit/s if modems are deployed on standard analogue circuits. Baseband analogue leased lines can be used to carry up to 2Mbit/s using DSL technology.

3.57 Analogue leased lines are used by large firms as well as by many small and medium-sized enterprises. In large firms, analogue leased lines tend in the main to be legacy installations, although some customers have indicated to Ofcom that their continued use of analogue leased lines is driven by cost. City institutions, for example, form a large group of analogue leased line buyers. A niche group of analogue leased line customers are those that use Baseband analogue lines within the "0207" London zone or within the same exchange which enables them to achieve 2Mbit/s capacity for data transmission. These Baseband lines are also used for example for permanently fixed phone link such as those used in supermarkets by taxi companies, which allow a customer to connect to the taxi company without dialling a number.

2003/04 Review

3.58 In the 2003/04 Review, Ofcom concluded that analogue retail leased lines were in the same market as digital retail leased lines and formed part of the retail traditional interface market. On the demand side, the substitution analysis showed that analogue and digital leased lines should be viewed as being in the same market because, on a forward looking basis, the price of digital leased lines is likely to constrain the price of analogue leased lines.

Market definition assessment

3.59 Ofcom considers below analogue against digital leased lines based on three broad areas:

- a qualitative assessment comparing functionality of analogue and digital services;
- demand-side substitution analysis: this compares the relative competitive price of analogue and digital PDH/SDH leased lines based on and the likelihood that a SSNIP on one service might be constrained by the other; evidence from Ofcom's end-user research; and assessment of switching costs; and
- supply-side substitution.

Qualitative assessment

3.60 In the 2003/04 Review[21], it was noted that there were no significant technical differences between analogue and digital leased lines, for the following reasons:

- It is straightforward to adapt an analogue leased line to transmit digital information and to adapt a digital leased line to transmit analogue signals; and

[21] http://www.ofcom.org.uk/consult/condocs/llmr/statement/state_note.pdf, paras A156 – A157

- 64kbit/s digital leased lines and analogue leased lines are provided using the same PDH technology in the core network with the only real difference being the equipment at either end of the local end.

3.61 There have been no changes affecting this technical similarity since the 2003/04 review.

3.62 An analogue leased line can be thought of as offering the equivalent of 40- 50kbit/s capacity[22]. Digital leased lines offer 64kbit/s or more. Among analogue leased lines the exception is Baseband circuits, which can be adapted with use of modems to provide digital leased lines with capacities of 64kbit/s to 2Mbit/s within the 020 7 area or within the same exchange.

3.63 Table 1 below summarises the features of analogue and digital SDH/PDH based on the key characteristics Ofcom has identified.

Table 1: Summary of functional comparisons between Analogue and Digital SDH/PDH

	Analogue	Analogue (Baseband)	Digital SDH/PDH
Bandwidth	34kbit/s	2Mbit/s	64kbit/s up to 2.5 Gbit/s
Contention	Dedicated	Dedicated	Dedicated
Latency/jitter	Medium	Low	Low
Resilience	Medium	Low	High
Symmetry	Symmetric	Symmetric	Symmetric
Distance	Not limited	limited to same exchange / 020 7 areas	Not limited

Source: Ofcom 2007

3.64 For users, the implication of the functional differences between an analogue and a 64kbit/s digital leased line identified is that, at a given price, the latter is likely to be preferred because it offers more flexibility in terms of voice and data usage. In other words, a digital line offers a higher quality of service than an analogue line. While a digital line guarantees 64kbit/s for data and can carry voice traffic if a digital phone is used, an analogue line guarantees voice but can only support speeds below 64kbit/s for data (typically 34kbit/s), and needs a modem to do so. An exception is Baseband analogue lines that can be used to carry up to 2Mbit/s using SDSL technology.

[22] Strictly an analogue (non-baseband) leased line offers a clear voice channel which is defined as being from 300Hz – 3400Hz (inclusive). Within the network this is converted to 64kbps PCM and transported digitally before being re-converted to the original analogue signal at the far end. The digital transmission rate is a function of the bandwidth limited voice channel and digital transmission over an analogue line requires the use of a modem (as would be used for voice). The maximum rate is therefore 33.6kbps (i.e. V.92); 56kbps is not possible as there are two A/D conversions which precludes the faster speed.]

3.65 Analogue leased lines (excluding Baseband lines) and 64kbit/s digital leased lines therefore appear to be at least potentially close substitutes, since they offer broadly equivalent functionality, although the digital product offers a higher quality service than the analogue. A 64kbit/s digital leased line is required in order to offer voice services. A pair of Baseband-type analogue leased lines within the 020 7 area or within the same exchange offer similar functionality to a higher capacity digital leased line, up to 2Mbit/s.

Demand-side substitution

3.66 To establish whether or not analogue is in the same market as digital (SDH/PDH) leased lines, Ofcom has based its analysis on low bandwidth digital leased lines, which potentially provide the closest potential substitute to analogue circuits. The demand-side substitution analysis considers whether digital leased lines would be likely to constrain analogue leased lines and vice versa. This is considered first by undertaking a comparison of relative prices and costs and then considering evidence from end-user research and possible switching costs.

Relative price comparisons

3.67 Ofcom has considered whether there are significant differences between the prices of retail analogue and digital SDH/PDH circuits. The rationale for making such price comparisons is that, if analogue and digital circuits were close substitutes, then it would be expected that their prices (in a competitive market) would tend to be similar. In general, in the absence of material differences between the prices of close substitutes, customers would generally tend to use predominantly the cheaper product and this would create pressure to bring prices into line. If prices did not converge, then demand for the more expensive product would fall, perhaps to the point where it was forced from the market. In contrast, the observation of significant differences in prices, which do not reflect quality differences, combined with significant demand for two products could suggest that they may not be sufficiently close substitutes to be subject to a common pricing constraint.

3.68 For analogue and digital services, rather than use actual retail prices, we have based our comparison on the underlying costs to BT of providing analogue and digital services as these should approximate to prices in a competitive market. The hypothetical monopolist test used in market definition is couched in terms of the ability of a hypothetical monopolist profitably to sustain prices above competitive price levels. However, where an undertaking has market power, it may operate in a market where the current price is substantially different from the competitive price. In these circumstances, actual retail price comparisons could potentially be an inaccurate benchmark from which to apply a SSNIP test.

3.69 In the absence of retail prices as the relevant competitive conditions, it is possible to use the prices of the wholesale inputs used to deliver that retail service as these should be reflective of the costs of providing that input. However, in the case of analogue services, no relevant wholesale product is available, as the retail market is almost entirely supplied by BT. Therefore, instead of relying on retail or wholesale price comparisons, Ofcom has considered differences at the competitive level based on a direct assessment of underlying costs. Relative cost differences should be reflective of competitive prices. This is because at the competitive level prices should be competed down to close to wholesale inputs costs (plus appropriate

competitive retail margin). This comparison of the costs of analogue and digital SDH/PDH is discussed in the following paragraphs.

Relative cost comparisons

3.70 Ofcom has considered below relative costs of analogue and digital SDH/PDH services. The comparison shows that analogue costs are not systematically lower than digital SDH/PDH costs since many analogue and low bandwidth digital leased lines run on the same network using the same technology. For example, BT can use identical main links and local access ends to provide either a 64kbit/s digital leased line or, by adding the appropriate modem equipment, a 34kbit/s analogue leased line.

The main link

3.71 When a retail customer requires a circuit longer than 15km, both main links for analogue and digital would be on the same Digital Private Circuit Network (DPCN). The cost of a 64kbit/s main link will thus be the same whether the circuit is analogue or digital.

Local access

3.72 For low bandwidth circuits relevant to this comparison, both local ends will be provided on copper (BT provides local access on copper for digital leased lines with a capacity up to 256kbit/s). The cost of the local access network will be the same or similar in both cases as both analogue and digital 64kbit/s leased lines can use one or two copper pairs.

3.73 There may be a slight difference in local access costs between analogue and digital local ends due to the different NTE deployed but this will be balanced to some extent by the need for A/D conversion equipment in the exchange in the case of analogue circuits. Analogue NTEs are estimated to cost in the region of £500 (uninstalled) and the price of Digital NTE is £437 to £714 based on BT wholesale charges for end-user premises. The differences in these costs would be less marked on an annualised cost for each service for a standard contract length of 3 years. Furthermore, the costs of other local access segments (such as digging and ducting) would be identical for both service types. These costs would be significantly more than those for NTE, particularly where the local ends are long.

3.74 Therefore, even where NTE costs vary, there are a number of other costs that would be the same for analogue and digital SDH/PDH local ends. And this latter category of costs would tend to dominate. The overall costs of the local ends will therefore be broadly similar in both cases, with the digital SDH/PDH ends unlikely to cost more than 10% above the digital local ends.

SSNIP based on cost comparisons

3.75 Based on the above cost comparison it should be expected that the price of an analogue leased line after a 10% SSNIP would be higher than that of a digital leased line. Because digital leased lines offer a higher quality than analogue leased lines, new end users could buy a digital leased line instead of an analogue leased line in response to a SSNIP. Thus digital leased lines might be expected to constrain the price of analogue leased lines and so low bandwidth SDH/PDH would be in the same market as analogue circuits.

3.76 So far, the above analysis has considered whether switching to SDH/PDH would constrain the price of analogue services. The functional comparison above suggests that switching to analogue would involve some reduction in service quality for most digital SDH/PDH users. However, analogue prices would still provide a constraint on digital SDH/PDH circuit prices sufficient for both to be included in the same market provided users are willing to accept this compromise in response to a SSNIP. This is most likely to be the case for users of 64kbit/s digital SDH/PDH circuits, since an analogue line can provide broadly equivalent "bandwidth". A user of a 64kbit/s digital SDH/PDH would need to buy a pair of modems to use with an analogue circuit in order to deliver functionality close to the SDH/PDH circuit.

3.77 However, the main purchasers of low bandwidth digital SDH/PDH leased lines generally buy a minimum of 2Mbit/s circuits. As analogue is constrained in its ability to provide the same speeds as digital services (i.e. baseband circuits with higher speed capabilities are only available for point to point connections within the same local exchange area), this might suggest that while analogue service can address demand for 64kbit/s services they would not be a close substitute for 2Mbit/s leased lines. However, analogue could still fall within the same market as low bandwidth SDH/PDH circuits through a chain of substitution including digital leased lines of different bandwidths[23].

3.78 As discussed under "Issue 5: Bandwidth comparisons" below, 64kbit/s SDH/PDH circuits are included in a single low bandwidth market for digital SDH/PDH up to and including 8Mbit/s through a chain of substitution. The discussion above suggests that a 64kbit/s SDH/PDH services is potentially constrained by analogue. Given the chain of substitution identified under Issue 5, higher bandwidth digital SDH/PDH are constrained by 64kbit/s digital circuits, which in turn are constrained by analogue circuits. Therefore, analogue circuits should be included in the low bandwidth SDH/PDH market through a chain of substitution.

3.79 In summary, the above comparison of relative costs suggest that, in a competitive market, the price of digital SDH/PDH leased lines would constrain the price of analogue circuits. Provided consumers are reasonably indifferent between the two (which is likely as functionality is similar). This suggests that competitive prices would be similar such that users seeking a new connection would consider switching to SDH/PDH leased lines in response to a SSNIP. Similarly, analogue circuits constrain the price of SDH/PDH circuits at low speeds (i.e. 64 kbit/s).

End-user research

3.80 Having considered the available price comparison data, we now turn to evidence collected from a survey of end-users carried out at Ofcom's request for this review. To provide further evidence on likely switching behaviour in response to price changes, Ofcom asked users of analogue and digital SDH/PDH circuits what their reaction would be to a SSNIP on their current (analogue or digital SDH/PDH) connection type.

[23] A chain of substitution may exist, for example where a customer would not substitute from product A to product C to avoid a SSNIP, but would substitute to product B. This may suggest that products A and B are in the same market but that products A and C are in separate markets. However, if there are customers who would substitute from product B to product C to avoid a SSNIP then this may suggest that products B and C are in the same market. Because of a chain of substitution between products A and B and products B and C, products A and C would be defined to be in the same market.

3.81 The full results of the end-user research in relation to our SSNIP analysis are set out in Annex 9. It is important to note at the outset that this research has a number of important caveats when it comes to interpretation of the results.

3.82 Although these survey results have been used to inform Ofcom's market definitions, the consumer survey results used to conduct the SSNIP tests in this note are suggestive rather than definitive. In addition to providing only limited forward-looking analysis, the consumer survey results remain subject to the important caveats as they are based on claimed behaviour as opposed to observed consumer behaviour and despite being based on relatively robust sample sizes they are subject to certain margins of error.

3.83 The information Ofcom has collected from customer surveys relates to claimed behaviour of consumers who are asked questions about their willingness to continue to use particular services given hypothetical price rises. In general, experience shows that when asked hypothetical questions, consumers tend to overestimate the extent to which they will take actions (i.e. switching away from a supplier in response to a price rise). Therefore, consumer survey evidence based on hypothetical questions may tend to be most useful in indicating the maximum extent to which consumers will react to different events.

3.84 In addition, the HMT is based on hypothetical price increases applied to competitive prices. If the markets being considered are subject to SMP then the current (contracted) price end-users are paying may be significantly above a competitive benchmark. On this basis, respondents may be more willing to switch to other products and services than if the contracted prices for their current service were set at a competitive price level.

3.85 When interpreting research results, care is also needed in particular for the following reasons:

- For some service groupings and questions there are small sample sizes which means that in some cases analysis of the results can only be indicative[24];
- some technologies may be able to offer a greater range of services and as such it may be that end-users find it difficult to isolate the service that is of interest, e.g. the leased line service may also include value-added managed IT solutions as part of the contract; and
- there may be other factors that influence consumer choice, such as whether they have an affinity to a particular service provider's brand which means that the consumer would be willing to pay a premium to access that brand if it is only available on a sub-set of technologies.

3.86 In its questionnaire design, we sought to overcome any potential research biases. For example, in relation to questions over whether end-users would consider switching, as a follow-up question, the questionnaire asked how likely they would be to switch in reality. This latter question was asked in light of some concerns that respondents' potential tendency to overstate their willingness to switch.

[24] In some cases this reflects the low overall population of respondents that used particular leased line services (e.g. ATM/Frame Relay). In addition, some questions were "nested" such that an initial question may yield multiple answers. Hence, even where initial sample sizes were quite high, because questions asked of a smaller sub-set of the original sample this sometimes resulted in insufficiently large samples for the follow-up questions;

Nevertheless, we have presented the following results as only one piece of evidence that we have considered alongside price/cost comparisons and other more qualitative evidence.

3.87 The table below shows respondents' stated willingness to switch in response to a SSNIP.

Table 2: Respondents' stated willingness to switch in response to a SSNIP

	% would consider switching	% likely to switch in reality
Analogue leased lines	61%	47%
Low bandwidth digital Leased lines	64%	42%

Source: Ofcom 2007

3.88 Table 2 shows that from the perspective of analogue users, almost two-thirds of analogue and low bandwidth digital SDH/PDH users would consider switching in response to a SSNIP. The questionnaire also asked respondents how likely they would be to switch in reality. In relation to this latter question, a lower number of analogue (digital SDH/PDH) users 47% (42%) would be likely to switch. Nevertheless, this level of switching is still relatively high and would be clearly above the so-called "critical loss", that is above the level likely to be sufficient to render a SSNIP unprofitable.

3.89 The critical loss calculation shows the change in demand at which a SSNIP would have a neutral effect on profitability. If the reduction in demand from a SSNIP is greater than the critical loss then the SSNIP will be unprofitable and vice versa. As the key output of the consumer survey is the likely change in demand (i.e. extent of consumer switching), the critical loss calculation is a simpler way of considering the results of consumer surveys and whether a SSNIP is likely to be unprofitable.

3.90 The "critical loss" is the percentage reduction in demand required in order for a SSNIP to be unprofitable. The impact of a SSNIP will have a number of offsetting effects, which the critical loss calculation seeks to capture. On the one hand, the customers switching away will result in a loss of revenue. On the other, a hypothetical monopolist would no longer incur costs of serving the customers that switched away. In addition, for those customers staying with the monopolist, it would receive additional revenue in proportion to the size of the SSNIP. For the purposes of the leased lines market review, Ofcom has calculated a possible range for the critical loss factor of 16 to 21 per cent (see Annex 8 for further discussion). Hence, if the reduction in demand in response to a SSNIP were above this range, the SSNIP would be unprofitable, with the implication that the market should be defined more widely than the focal product being considered. If the reduction in demand in response to a SSNIP were below this range, the SSNIP would be profitable and the focal product being considered may constitute a separate market.

3.91 The switching results for analogue and digital SDH/PDH in the table above would be clearly above the critical loss range. Therefore, such switching rates would be sufficient to yield a SSNIP unprofitable. In other words a hypothetical monopolist of either analogue or digital leased line would face sufficient constraint from users switching to other services. This would tend to suggest that the market is wider than analogue or low bandwidth digital SDH/PDH services alone.

3.92 As discussed above, from a functional perspective and price perspective, it would be appropriate to conclude that a digital SDH/PDH services is a close functional substitute to an analogue service.

3.93 In order to gather further evidence on end-user's perceptions on the similarity of services, Ofcom's end-user research asked various questions to determine the services that respondents considered as the closest substitutes to their current service.

3.94 Low bandwidth digital SDH/PDH circuits were among the most common services selected by users of analogue circuits as the service they would switch to in response to a SSNIP in the price of analogue circuits. Almost one quarter of analogue users who said they would switch selected low bandwidth digital SDH/PDH. Among the respondents that said they would switch, twice as many named digital SDH/PDH as named the next most popular service. This result therefore supports the inclusion of digital SDH/PDH in the same market as analogue.

3.95 However, it is less clear from the results of the end-user research for low bandwidth digital SDH/PDH users that analogue circuits were always selected as the next closest substitute. The analysis of those users willing to switch showed that more users would potentially move to Ethernet and SDSL circuits. A number of users did however indicate that they would also be willing to switch to analogue.

3.96 However, what might be significant for this question is that the SSNIP question was asked of respondents with digital SDH/PDH circuits up to 2Mbit/s in the low bandwidth digital SDH/PDH services. As discussed earlier, the digital SDH/PDH users that Ofcom identified as likely to switch to analogue are likely to be at speeds of 64Kbit/s or below. Given that the above switching rates are grouped together with a number of other higher bandwidth digital SDH/PDH users this may obscure the results for 64Kbit/s users[25]. It is therefore not possible to determine from the end-user research the closest substitute services for very low bandwidth users.

3.97 Overall, the end-user research suggests that an appropriate market definition is wider than either analogue or digital low bandwidth SDH/PDH services alone. The end-user research is indicative of digital SDH/PDH circuits constraining the price of analogue circuits. It is not possible however to determine from the above results whether the digital SDH/PDH users (i.e. 64Kbit/s users) would be likely to switch to analogue.

Switching costs

3.98 Where an end-user faces additional costs of switching this may act as a barrier to switching.[26] Ofcom considers whether existing customers of analogue or digital SDH/PDH circuits would face any switching costs and their likely materiality.

[25] This reflects the way the questionnaire was constructed. It was necessary to group together different bandwidth increments into ranges. This was intended to overcome sampling size issues as it would not have been possible (given the overall business population questioned) to undertake the SSNIP questions on each possible bandwidth increment and provide statistically robust results.

[26] This excludes any connection fees the communications provider would be likely to levy. For example, if an end user wanted to migrate its analogue leased lines to digital leased lines, a supplier would need to carry out engineering work (the most expensive part of the migration) and to install new network terminating equipment (NTE). However, these equipment costs should already be reflected in the relative price comparisons (for

3.99 Ofcom has identified two potential switching costs for analogue and digital SDH/PDH services:

- Risks of additional internal costs arising from switching between analogue and SDH/PDH services; or
- Contract termination costs to the user.

3.100 In respect of internal costs, the key issue that might arise is the risk associated with costly disruption, such as a potential break in an end-user's leased line service. This could impact directly on the end-user's ability to communicate between its sites. The likelihood of such risks is likely to multiply where there are complex processes or additional support applications required to switch between services. However, for analogue and digital SDH/PDH circuits, the engineering and processes to switch between these services should be relatively straightforward[27]. It appears unlikely that switching between the two services would pose significant disruption or business risks.

3.101 Where a user's migration to a digital leased line includes changing supplier they may also face penalties for early termination of analogue leased line contract. Ofcom's end-user research asked respondents what the typical duration of their contracts was. In most cases, the typical contract was no longer than 3 years (and in quite a few cases shorter). Although, "up to 3 years" could potentially be a significant time period, when asked end-users did not, in general, consider that contract duration was among the most important barriers to switching.

3.102 Overall, there may be some barriers to switching from analogue to digital (and vice versa) for existing end users which are not faced by purchasers of new circuits. Ofcom considers that these would not be material enough to prevent existing users switching following a SSNIP.

Supply-side substitution

3.103 Supply-side substitution analysis identifies the extent to which existing suppliers of other products and services are likely to start producing the relevant products or services following a price increase and whether the associated constraint would be sufficient to make the price increase unprofitable. As explained earlier in this Section, only entry within a relatively short period of time (and without incurring significant costs) is relevant for supply-side substitution considerations.

3.104 For digital SDH/PDH circuits, supply-side substitution is likely to be less relevant as providers of analogue circuits are also likely to be present in the supply of digital circuits and will therefore already have been factored into the demand-side assessment above. In the case of analogue circuits, as the vast majority of these are sold by BT, supply-side substitution might be more relevant for suppliers currently providing digital SDH/PDH circuits entering the analogue market.

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example as annualised connection fees) set out previously under this discussion. On this basis, these costs are not viewed as additional switching costs.

[27] As discussed under the cost comparisons, many elements of low bandwidth SDH/PDH and analogue circuits would be common to both services (i.e. local access elements). The main change would be with respect to changing Network Terminating Equipment.

3.105 We consider it unlikely that an existing supplier of digital leased lines would start supplying analogue connections to new premises in response to a 5 to 10% increase in the price of analogue leased lines, or vice versa. It is unlikely that operators would incur the sunk costs of local access (especially digging and ducting) to a new site as these are significant in relation to the revenues available from low-bandwidth circuits. This means that operators are unlikely to be prepared to extend their existing network beyond a very short distance in order to supply a low-bandwidth digital or analogue circuit to a new premises. In the case of analogue circuits, which are largely a legacy product, the prospect of declining demand in future further reduces the likelihood that operators would incur the sunk costs necessary to supply them.

3.106 As a consequence Ofcom's assessment is that there is unlikely to be sufficient constraint from supply-side substitution between analogue and digital leased lines in response to a SSNIP.

Proposed market definition

3.107 Ofcom proposes to include analogue and digital SDH/PDH in the same market predominantly based on the following factors:

- The similar functionality of the two services;
- The broadly similar level of prices expected in a competitive market (based on similarities in underlying costs of provision)
- End-user research which suggests that customers would be likely to switch between them in response to a SSNIP.

3.108 In the terminology used in the 2003/04 Review, analogue and digital SDH/PDH services are referred to as traditional interface (TI) services. Therefore, based on the above assessment, we propose that the retail TI market (at least) consists of analogue and digital SDH/PDH services. We consider whether this market definition might be widened to include any other services, or narrowed, particularly according to bandwidth, in subsequent sections.

Issue 2: Traditional interface versus alternative interface

3.109 As referred to in earlier part of this Section, another class of retail leased lines identified in the 2003/04 Review were alternative interface services. As part of the market definition exercise Ofcom has therefore considered whether there continue to be two distinct retail markets for alternative interface (AI) leased lines and TI leased lines or whether these services might fall within the same market. Ofcom has based its analysis on currently available AI and for TI based on digital SDH/PDH circuits at the different bandwidths.

Technical definitions

3.110 As described in Section 1, the term alternative interface was developed in the last market review to refer to a broad category of products that provide a point-to-point fibre connection (including those products referred to as local area network extension services (LES)) supplied, generally, by means of Ethernet over fibre.

3.111 As Ethernet is currently the most widely used form of alternative interface, these services have been referred to as Ethernet-based services for large parts of this document, though it should be noted that Ethernet is not the only form of alternative interface (as discussed in Section 1 above). These circuits have some similarities with SDH/PDH-based (traditional interface) leased lines in that they offer symmetric dedicated transmission capacity between two points, providing guaranteed bandwidth that is available 24/7, and are uncontended (i.e. they are not shared with other users). However, alternative interface circuits are primarily based on packet or frame-oriented technologies which means that they usually are non-deterministic in operation. This manifests itself as variable and unpredictable latency. Whilst allowing cost savings through optimising utilisation of the available bandwidth this does give rise to some limitations for particular applications which require predictable and repeatable latency performance. Ofcom has identified a number of limitations to the degree of substitutability between Ethernet and SDH/PDH circuits, which are considered in the market definition assessment below.

3.112 Alternative interface circuits are also used as both wholesale infrastructure products, e.g. as an input into downstream retail broadband markets, and also as retail products in their own right. Bandwidth splits follow a similar pattern to traditional interface circuits with higher bandwidth products primarily sold as wholesale products.

Megastream Ethernet services

3.113 Megastream Ethernet circuits are provided using dedicated virtual paths over an ATM-core network. This overcomes distance and resilience issues associated with point to point Ethernet links.

3.114 As stated in the LLMR 2003/4, retail products such as MegaStream Ethernet may be regarded as "hybrids" made up of a number of wholesale elements each of which may be based on a different technology. For example, the Access segment of a MegaStream Ethernet circuit would be Ethernet over fibre whereas the "core" segment is provisioned using BT's ATM network. In 2003/04 Review, it was concluded that "the wholesale elements will fall into individual wholesale markets [the implication being that these had already been defined, for example in that review] and will be regulated on the basis of the market into which they fall", that is, if that market was one in which BT had SMP then any remedies imposed would also apply to use of the wholesale element to provide Megastream Ethernet. Ofcom believes that this general approach remains appropriate.

3.115 Following this approach to wholesale definition, it would only be necessary to consider retail market definition for Megastream Ethernet in order to identify markets for the purposes of assessing possible SMP at the retail level. However, the only retail product market that is regulated (and requires assessment) in this review is the low bandwidth traditional interface retail leased line market, which covers circuits with bandwidths of 8Mbit/s or less. Therefore, as the lowest speed Megastream Ethernet services is an AI product it is not necessary to undertake separate retail assessment of this market.

2003/04 Review

3.116 In the 2003/04 Review, Ofcom concluded that retail traditional interface leased lines and retail alternative interface leased lines were in separate markets. Technological and price differences between the two meant that a significant number of traditional

interface leased lines users would be unwilling to switch to alternative interface leased lines, and vice versa. In particular, the 2003/04 Review stated that:

- Ethernet based services could not readily be used to convey certain types of traffic, particularly conventional voice services, but also ISDN, Centrex or national VPNs
- Ethernet based services could not support the conveyance of data traffic based on protocols other than Ethernet
- SDH/PDH services were generally considered not suitable for use in certain data applications such as Storage Area Networks (SAN).

3.117 In was considered that the availability of alternative interface leased lines would not constrain the pricing behaviour of a hypothetical monopolist provider of traditional interface leased lines, and vice versa, with the result that alternative interface and traditional interface leased lines were in separate markets.

Market definition assessment

3.118 Our consideration of Ethernet against digital SDH/PDH leased lines is based on three broad areas:

1. a qualitative assessment, which starts with comparison of the functionality of the two interface types;

2. demand-side substitution analysis based on relative prices and SSNIP analysis for digital SDH/PDH and Ethernet circuits; switching results from Ofcom's end-user research; and an assessment of possible switching costs.

3. Supply-side substitution.

Qualitative assessment

3.119 As stated earlier, the 2003/04 Review, noted a number of differences in the functionalities of digital SDH/PDH and AI leased lines that were considered sufficiently significant to inform a break in the market. Ofcom has considered below whether these differences continue to be apparent and any potential changes (both current and pending), which may act to reduce or remove the key differences in the functionality of AI and digital SDH/PDH services.

3.120 The table below summarises the features of Ethernet and digital SDH/PDH based on our key characteristics.

Table 3: Key features of Ethernet and digital SDH/PDH based on main characteristics

	Ethernet	Digital SDH/PDH
Contention	Dedicated	Dedicated
Latency/jitter	High but becoming less of an issue as applications become more tolerant and ethernet derivatives with guaranteed latency performance become available	Low
Resilience	Medium but high resiliency options are becoming available	High
Symmetry	Symmetrical	Symmetrical
Distance	25 km (35km extended reach services) but distance restrictions being eliminated by new products	Not limited

Source: Ofcom 2007

3.121 The above comparison of Ethernet and digital SDH/PDH highlights the main differences based on the way in which these services are currently delivered. These differences are discussed in more detail below. Ofcom also highlights likely changes to the way Ethernet is delivered and how this may affect its functionality.

3.122 The reliability and predictability of performance and the resilience of digital SDH/PDH leased Lines have traditionally allowed CPs to offer higher Service Level Agreements (SLAs)/Guarantees (SLGs) to end users. With enterprises deploying more technology, the risk associated with failure increases, and for some sectors that traditionally have been intensive users of leased lines (financial, utilities) the risk of failure carries important operational and financial implications.

Latency and jitter

3.123 Digital SDH/PDH leased lines are used for their ability to deliver Time Division Multiplexed (TDM) services that offer characteristics such as synchronisation and low and predictable latency and jitter. These factors were believed to be a very important differentiator between TI and Ethernet leased lines in the last review.

3.124 For example, electricity utilities need low delay and low differential delay to support protection applications within their own electricity distribution networks. These utilities use the characteristics of traditional interface leased lines to perform such functions. Mobile operators require synchronisation, particularly for 3G which has much tighter requirements for base station synchronisation than 2G, this synchronisation of base stations with each other is critical for handover between cells. Although, these synchronisation functions can be delivered in other ways,

such as by using GPS, this does imply a dependence on a synchronisation source outside of the operator's direct control.

3.125 Unlike digital SDH/PDH leased lines, Ethernet services were found in the last review not to be able to carry certain types of traffic such as conventional voice, ISDN, Centrex or national VPNs.

3.126 Since the last market review, technological barriers to improving the predictability of the performance of AI leased lines have gradually eroded to some extent. Enterprise applications have also becoming more agnostic to such characteristics, and are more tolerant of variable delay performance and missing packets or frames.

3.127 As enterprise traffic moves to the IP protocol, technologies such as Voice over IP and IP Centrex mean that Ethernet can support voice and other forms of traffic where the end-user is content to migrate from conventional voice to VOIP. However, this move requires migration of all or part of the end user equipment. This is costly, especially for smaller enterprises. IP phones, for example, are already found in many enterprises in the UK, but cost of switch-over and possible lingering customer resistance to IP telephony might act as barriers to their wider deployment.

3.128 Hence, the economic barrier is still significant, and in order for an end-user to overcome latency and jitter issues it would require a large scale migration of end user equipment and applications in order to deliver similar operational performance to the business.

3.129 Notwithstanding the potential for some latency and jitter issues to be eroded, there are economic barriers to users being able to do so over a relatively short timescale. There are also some residual end users who are likely to have a continuing requirement for very high performance services within the timeframe of this review.

Resilience

3.130 Ethernet services are only currently available as point to point fibre although resilience options (that is, which provide a back-up service) are available and other higher resilience products are due to be launched by BT and others.

Distance limitations

3.131 Ethernet leased lines have traditionally being restricted to short haul LAN services, with SDH/PDH being the technology of choice for long haul WAN solutions. Ofcom has undertaken analysis of the relative volumes of SDH/PDH and Ethernet circuits over different distances, which tends to confirm this picture of the market. In other words, the majority of Ethernet circuits are limited to distances of 5km and below.

Forward looking assessment

3.132 As part of this qualitative assessment, Ofcom has considered market trends and forthcoming developments, for example those being rolled-out on BT's network, that might impact upon any qualitative differences that are currently viewed as persisting between digital SDH/PDH and Ethernet, namely: SLA and SLG issues, availability and distance constraints.

SLAs/SLGs

3.133 One important development in this area is the development and standardisation of "Carrier-class" Ethernet. Carrier-class Ethernet will allow carriers to support higher SLAs/SLGs. This development, alongside the work that is being done around the standardisation of Ethernet SLAs/SLGs, is likely in the next few years to create the conditions for carriers to offer Ethernet services which support SDH/PDH-grade SLAs/SLGs.

3.134 The key issue with respect to SLAs/SLGs however is how quickly it could be expected that CPs could deploy Carrier-class Ethernet. For example, BT has indicated its intention to deploy Carrier-class Ethernet on its 21CN and signed deals with manufacturers.[28] There remain however some finalisation of standards and manufacturers are bringing early versions of their products to the market. This suggests that the capability to support SLAs/SLGs to PDH/SDH standard is yet to be realised. Within a timeframe of 3 years the issues are likely to have been overcome. However, this does not necessarily imply that Carrier-class Ethernet will have been rolled-out to a sufficient degree to impose a sufficient constraint on existing SDH/PDH services. For example, BT has stated that it will roll-out carrier class ethernet as part of its 21CN programme but has not thus far provided details of product availability.

3.135 Economic barriers will be affected by the length of the investment cycle in technologies for both enterprises and Carriers to be able to roll-out these services. This might take anywhere between 2 to 5 years for market-wide adoption of Carrier-class Ethernet. On this basis, it is reasonable to expect some CPs on the current generation of Ethernet to migrate. However, the level of adoption within the timeframe of the review is unlikely to see a complete switch to Carrier-class Ethernet within the time horizon considered by this review. Hence, this service is unlikely to be sufficiently widely deployed to erode fully SLA/SLG issues within the timeframe of the review.

Resilience

3.136 Although the availability of Ethernet services is slightly lower than SDH/PDH services, Ethernet services have resilience options that increase the availability of services that are options for end-users if resilience is an important characteristic for the end-user.

Distance limitations

3.137 The current distance limitations are only prevalent on single point to point services and are not a strong limiting factor on substitutability of Ethernet for SDH/PDH services. However, as enhanced backhaul networks are rolled out, distance limitations will be removed on end to end Ethernet services.

Conclusion on qualitative assessments

3.138 Although Ethernet has a number of functionalities valued by users, Ofcom's assessment of its functionality relative to digital SDH/PDH circuits suggests:

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28 http://www.btwholesale.com/content/binaries/21_Century_Network_Community/c21_MG_011_issue1_200307.pdf

- Differences in the performance of digital SDH/PDH versus Ethernet still persist. However, we can expect that most remaining technological barriers will be removed over the timeframe of the review – although this does not imply that take-up will necessarily be immediate as technological barriers are not the only hurdle to greater switching

- A key driver for improving the relative performance of AI lines compared to TI lines will be the deployment of Carrier-class Ethernet by carriers: this is a superior Ethernet standard developed to overcome the traditional limitations of the current Ethernet standard with respect to various issues such as the ability to support carrier-class SLAs/SLGs, or the ability to provide more scalable solutions for enterprise networks;

- However, deployment of Carrier-class Ethernet by carriers is still some 2 to 5 years away, meaning that in the timeframe of the review some migration might begin to occur with some users moving away from SDH/PDH. Based on investment and economic barriers that are likely to persist, it is considered that this migration would not be significantly large.

3.139 On this basis, although some issues may be overcome from a technical standpoint, there are barriers both to the roll-out by CPs and in terms of migration within the time-frame of this review. This suggests that even if qualitative differences are removed, it will take some time for products to be introduced and for migration to begin to occur to an appreciable extent.

Demand side substitution

3.140 The above comparison suggests that functional differences are likely to remain for the majority of the timeframe of this review. However, quality differences alone do not necessarily mean that these services are in separate markets, as users may be willing to compromise or upgrade to higher quality services in response to a SSNIP.

3.141 To establish whether or not AI and digital SDH/PDH leased lines are in the same market, Ofcom considers below a comparison of relative prices; evidence from Ofcom's end-user research on possible switching; and any barriers to switching that may exist between AI and digital leased lines.

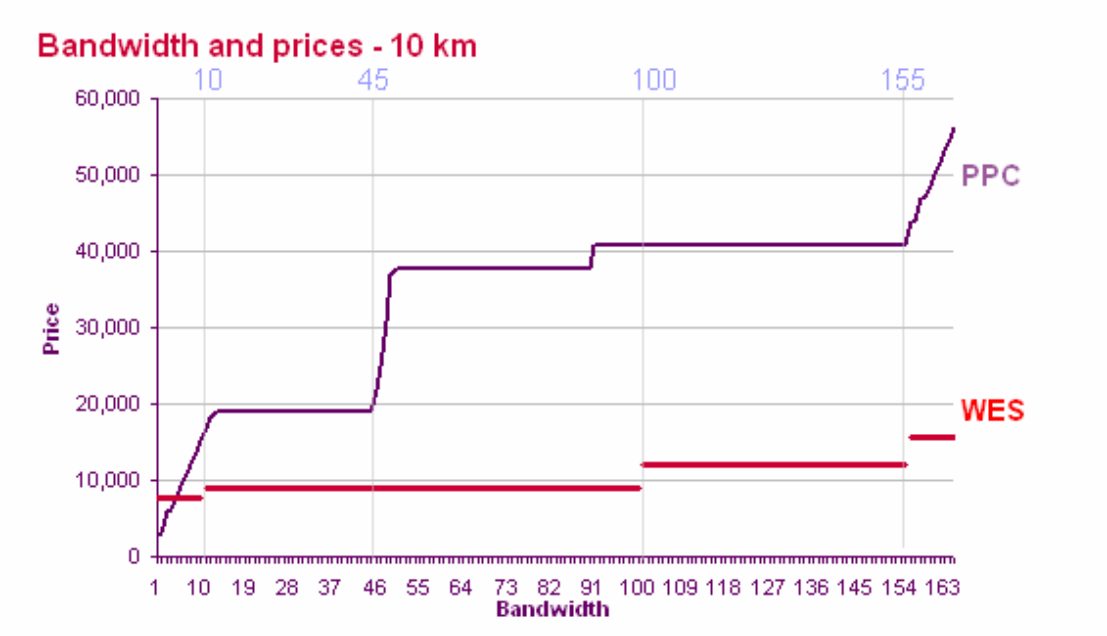
Relative price comparisons

3.142 The Figure below,presents a comparison of AI and digital SDH/PDH prices based on the underlying wholesale input prices, namely BT's WES and PPC prices. This is based on the assumption that these prices should provide a reasonable proxy for the relative differences in competitive retail price levels between services. Ofcom also considers the possibility that actual retail prices differ markedly from cost, and that this may have affected patterns of usage, in subsequent paragraphs. In addition, the implications that actual costs may differ from the levels assumed in Figure 3 (for example, because of different methods of allocating common costs), are also considered below).

3.143 The Figure shows the theoretically cheapest way with which to deliver a particular bandwidth requirement using the available AI or SDH/PDH circuits for one local-end. This is based on a consideration of the different circuit combinations that could be used to deliver a particular bandwidth requirement. This analysis is based

circuits of 10km and outside of the Central London Zone (CLZ)[29] although, as discussed later, this general picture tends to hold for circuits across the distances of most relevance to these markets particularly at higher bandwidths.

Figure 11: PPC/WES price comparison by bandwidth



Source: Ofcom 2007

High bandwidth comparisons

3.144 For bandwidths above 10Mbit/s, SDH/PDH circuits are markedly more expensive than Ethernet circuits. In these circumstances, it is unlikely that existing users of Ethernet circuits would switch to TI in response to a SSNIP. In addition, users considering between Ethernet and SDH/PDH services for a new connection (i.e. otherwise indifferent between Ethernet and SDH/PDH circuits) would not switch to SDH/PDH in response to a SSNIP on an Ethernet circuits. This suggests at higher bandwidths that SDH/PDH circuits would not constrain the price of Ethernet circuits. The question is whether this result holds in the other direction at higher bandwidths (i.e. would Ethernet constrain the price of SDH/PDH circuits)?

3.145 If the prices of Ethernet circuits were significantly below their SDH/PDH-based equivalents, an increase in the price of SDH/PDH might be expected to lead to customers switching away from SDH/PDH-based circuits. However, Ofcom's view is that such substitution is unlikely to be widespread. This is because it is highly unlikely that a significant number of existing SDH/PDH-based customers would currently be using (or considering using) SDH/PDH-based solutions if their needs were met equally well by an Ethernet-based solution. Given such large price differentials apparent at higher bandwidths and clear savings already available to users of Ethernet circuits should evidently be sufficient to prompt switching. However, Ofcom's trend analysis suggests that this has not been observed to an appreciable extent.

[29] CLZ refers to an area of London served by the 0207 dialling code. For the CLZ, BT applies different tariffs for some, but not all, of its leased lines services.

3.146 The market trend data shows that switching from SDH/PDH-based to Ethernet circuits has not been observed to an appreciable extent. For example, from 2004 to 2006 the market for AI circuits at higher bandwidths (above 10Mbit/s) has grown strongly. Over the same period, high bandwidth TI circuits (>2Mbit/s) have also grown for speeds >2Mbit/s and remained broadly stable (at very high speeds). Drawing inferences from the market trend data may however be subject to certain caveats, in particular, the possibility that consumers may have been deterred from switching to AI. This might be the case if observed retail prices were much higher than the competitive level suggested by the above price comparisons (which are based on wholesale input prices).

3.147 It is not possible from Ofcom's profitability analysis[30] to assess the relative difference in the price of Ethernet and digital SDH/PDH retail services. This is because the available retail data has not been broken down by bandwidth for AI and TI services. However, based on the profitability of wholesale input prices, at higher bandwidths, BT has higher profitability on AI services than TI services (>2Mbit/s). In some cases the profitability margins are very high.

3.148 Even if we were to adjust the wholesale prices to take account of the differences in profitability there would still be a significant difference in the price of Ethernet and digital SDH/PDH circuits. And in direction terms, any adjustments, would if anything increases these differences. The crucial issue however is that given the observed retail price differences remain significant whereas there remains relatively limited level of switching. This suggests that other factors might be important. For example, the functional differences and switching costs might be relevant to higher bandwidth Ethernet and digital SDH/PDH markets.

3.149 Overall the price and observed trend data does not support placing Ethernet and SDH/PDH circuits in the same market at higher bandwidths. Given such large price differentials apparent at higher bandwidths and clear savings already enjoyed by users of Ethernet circuits this should evidently be sufficient to prompt SDH/PDH users to switch. It appears that other factors such as switching costs or the differences in functionality may act as a barrier to switching.

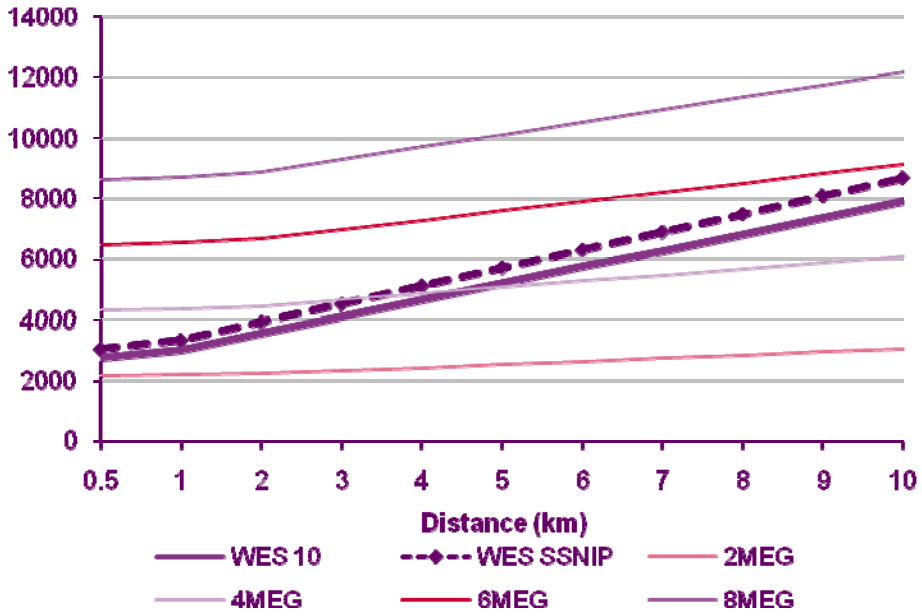
Low bandwidth comparisons

3.150 Although there appears to be clear price differences for circuits greater than 10 Mbit/s, a closer analysis is required for Ethernet and SDH/PDH circuits at lower bandwidths, where price differences are less marked. For the purpose of comparing digital SDH/PDH and Ethernet circuits at low bandwidths, the relevant comparison is based on 10Mbit/s Ethernet (which is the relevant bearer circuit used to deliver lower bandwidth retail AI services) and multiple 2Mbit/s SDH/PDH circuits[31]. In addition, Ofcom has restricted the distances over which circuits are compared as the majority of Ethernet circuits are provided over shorter distances e.g. 97% of BT's wholesale Ethernet circuits are less than 10km. We therefore compare below the prices of 10Mbit/s Ethernet and multiple 2Mbit/s digital SDH/PDH circuits at 10km and below.

[30] See Annex 11.

[31] As shown in figure [11] above, the price of higher bandwidth SDH/PDH circuits considerably exceed the price of an AI circuit and are therefore not considered in the comparison with 10Mbit/s Ethernet services.

Figure 12: PPC/WES price comparison, low bandwidth circuits



Source: Ofcom 2007

3.151 Based on the above price analysis, if an AI-user buying a 10 Mbit/s Ethernet service required nearly all of this capacity (i.e. it faced a peak capacity requirement of between 80 to 100%) then it is unlikely that an Ethernet user would instead switch to multiple 2Mbit/s circuits. It would clearly be more economic for higher bandwidth users requiring 6Mbit/s or more to use a 10Mbit/s Ethernet circuit.

3.152 Similarly, a TI-user only requiring a 2 Mbit/s of bandwidth (i.e. a TI user with only one circuit) would be unlikely to purchase a 10Mbit/s AI circuit in response to a SSNIP. For example a SSNIP on a 2Mbit/s circuit would amount to a price rise of £200-£250 for a 2Mbit/s circuit costing up to £2,500 per annum compared to an average price of £5,000 for a WES service across the distances considered above).

3.153 There may be users with bandwidth requirements between 2Mbit/s and 6Mbit/s who might be willing (based on the price) to substitute between either an AI or multiple TI services. As this does not apply at all distances, we have analysed of AI versus TI over these specific bandwidth ranges. The broad conclusion is that the finding of separte AI and TI markets holds.

3.154 An important caveat in relation to the above distributional analysis (and price comparisons more generally) is that there remains a degree of uncertainty regarding the precise costs. However, Ofcom has undertaken sensitivity analysis, and the magnitude of the price differences shown above is such that it seems unlikely that the conclusions arising from this comparison would be changed materially by different cost assumptions at higher bandwidths. Although different allocations of costs would be more likely to affect the results of the price comparisons at lower bandwidths, Ofcom believes that overall, the above price comparisons are likely to be robust to different cost allocation methodologies and tend to support separate market definition for AI and digital leased lines.

End-user research

3.155 Ofcom conducted end-user research, which asked users including those users with Ethernet and digital SDH/PDH connections what their reaction would be to a SSNIP

on their current connection type. Ofcom's end-user research also considered respondents views on specific leased line service characteristics, which might be relevant to this review. The full results of the end-user research are set out in Annex 9.

SSNIP questions

3.156 Table 4 shows respondents' stated willingness to switch in response to a SSNIP and their stated likelihood of doing so.

Table 4: Respondents' stated willingness to switch in response to a SSNIP

Service type		% consider switching	% likely to switch in reality
Digital SDH/PDH	Up to & incl 2	64%	42%
	>2 to 34 Mbit/s	56%	54%
	155 Mbit/s*	55%	22%
	>155 Mbit/s*	67%	53%
Ethernet	10Mbit/s	56%	36%
	100Mbit/s	59%	46%
	1Gbit/s & above*	25%	25%

*Very low samples

Source: Ofcom 2007

3.157 In general, the above results (based on the column entitled % consider switching) indicate that a very large proportion of respondents would consider switching as shown in column three. Only in the case of 1Gbit/s Ethernet users are the potential switching rates below 55%. It should be noted however that the results for higher bandwidths AI and TI services are based on very low sample sizes such that these results can only be viewed as indicative.

3.158 The discussion of the results in the above table was based on responses to the first stage SSNIP question only asked whether respondents would consider switching. Given the risk that respondents might potentially overstate their willingness to switch, respondents were asked a further question as to how likely they would be to switch in reality. The fourth column in the above table therefore shows adjusted switching rates based only on those respondents that were likely to switch in reality. In many cases the switching rates are lower when only those likely to switch are included but overall the switching rates still remain relatively high (around the 40 to 50 percent mark). These switching rates are well above the upper bound of the critical loss range[32]. This would therefore tend to indicate that a SSNIP on either service would be unprofitable.

3.159 Therefore, the end-user research suggests that a hypothetical monopolist of either Ethernet or digital TI leased lines would face a constraint from users switching to other services sufficient to render a SSNIP unprofitable. This in turn suggests that the market is wider than "markets" for SDH/PDH or Ethernet services alone.

Candidate substitutes

[32] As explained in Annex 9, Ofcom has assumed the same critical loss range applies across all the relevant services.

3.160 In order to gather further evidence on end-user's perceptions of services users would be likely to switch to, Ofcom's end-user research sought to determine the services that respondents considered as the closest substitutes to their current service. Due to the very low sample sizes for higher bandwidth services they have not been presented in the table below.

3.161 As raised in the discussion under "Issue 1" Ofcom indicated a potential bias arising from end-users basing their switching decisions on the retail prices they face (which may differ from the competitive level of prices). Ofcom has therefore sought to take this potential bias into account in relation to the responses to candidate substitutes.

Table 5: Respondents' stated services they would switch to

Start Basket	Speed (Mbit/s)	Most popular end-basket	Speed
Digital SDH/PDH	Up to 2	Ethernet	Low
	2 to 34	Ethernet	Low
Ethernet	10	Digital leased lines (SDH/PDH)	Med
	100	Contended ATM/Frame Relay	Med

Source: Ofcom 2007

3.162 In relation to 10Mbit/s Ethernet circuits, of the respondents that stated that they would consider switching, digital leased lines (SDH/PDH) circuits was among the most common services selected as the service respondents would switch to. However, at 100Mbit/s ATM/Frame relay services were selected and digital SDH/PDH services did not feature strongly in respondents' choices.

3.163 For the majority of respondents with digital leased lines who stated they would consider switching, Ethernet would be regarded as the closest substitute service. The end-user results would therefore tend to suggest that the market could be widened to include Ethernet circuits as the closest substitutes to a digital SDH/PDH circuit and vice-versa. However, as these results tend to disagree with the functional and price analysis discussed above, Ofcom has considered the weight it should place on the results of the questionnaire in relation to digital SDH/PDH and Ethernet in turn below.

Digital SDH/PDH results

3.164 The results presented in Table 4 suggest that the market should be widened to include services other than digital SDH/PDH. This is consistent with Ofcom's conclusion above that analogue circuits should also be included within the low bandwidth TI market (see Issue 1 in this Section). In subsequent paragraphs, Ofcom concludes that it is also appropriate to include SDSL circuits within the low bandwidth TI market (see Issue 4 in this Section)[33].

[33] For higher bandwidth SDH/PDH circuits, the end-user research included 2Mbit/s services within a 2 to 34Mbit/s category. As 2Mbit/s circuits are by far the dominant bandwidth speed within this range and 2Mbit/s circuits would also be constrained by SDSL, this is consistent with finding a wider market for 2 to 34 Mbit/s SDH circuits (i.e. SDSL is in the same market as low bandwidth digital SDH up to and including 2Mbit/s.

3.165 Ofcom has therefore defined a traditional interface market definition including digital SDH/PDH, SDSL and analogue leased lines consistent with the evidence suggested by the end-user research that there is a wider market for low bandwidth SDH/PDH leased lines.

3.166 However, the evidence in Table 5 suggests that a number of users might also view Ethernet as a potential substitute to other traditional interface services. Therefore, having widened the digital SDH/PDH market to include analogue and SDSL, it is relevant to test whether a SSNIP on this wider set of TI services would be profitable.

3.167 Unfortunately, the end-user research did not allow Ofcom to test this in this instance. This is because it was not practicable to devise a questionnaire that tested a SSNIP on multiple market combinations definitions (i.e. that combined different products) in a simple manner and that would also provide meaningful results and robust sample sizes. Nevertheless, as shown in Table 6 below Ofcom has sought to use the results of the survey to test less directly whether a SSNIP on the TI market (including analogue and SDSL circuits) would be profitable.

Table 6: Interpretation of end-user research to assessing SSNIP on TI market

	Number likely switchers [A]	Base [B]	% likely switchers [C] = [A/B]	Number likely to switch outside of TI market [D]	Adjusted switching rate [E] = [C * D]
Combined low bandwidth TI	86	234	37%	27%	10%

Source: Ofcom 2007

3.168 The above table shows the combined claimed switching results for the Traditional Interface market (i.e.analogue, digital SDH and SDSL users). The combined results show that around 37% of these users said they would switch in response to a SSNIP. However, a significant number of these users said that they would switch to another service within the market (for example, some analogue users said they would switch to digital SDH/PDH). Ofcom has therefore taken account of this by excluding these responses from the above switching rate.[34] This adjustment is shown in column D in Table 6.

3.169 As shown in column [D] of Table 6 only 27% out of the base of 86 TI and analogue users (who said they would switch) stated that they would be willing to switch to a service outside the market for TI and analogue circuits. Therefore, we have adjusted the switching level of 37% to account for the majority of stated switching being to another service within the market. The implied adjusted switching rate is shown in column [E].

3.170 This suggests that a SSNIP on the combined TI/analogue market would result in only 10% of TI users switching to an alternative service. The corresponding switching rate of 10% would be below the critical loss likely to render a SSNIP unprofitable. Therefore, this does not suggest that Ethernet services would provide

[34] This assumes that if a respondent on a TI service (i.e. analogue) chose an alternative TI service (i.e. digital SDH/PDH or SDSL) and a SSNIP was imposed on each of these services (analogue, digital SDH/PDH and analogue) then the user would not choose to switch instead to a service outside of this group of services. On this basis, only those "switchers" that chose a service outside of the basket of TI services (e.g. that stated they would switch to an AI service) would be counted as switching.

a sufficiently strong constraint on TI services to justify including them in the market with TI and analogue circuits.

3.171 This result is subject to caveats, in particular that it was not possible to ask users about their response to a SSNIP on both analogue and digital circuits, and the estimated rate of switching may therefore be a lower bound. However, it is consistent with the results of Ofcom's other analyses which suggest that AI and TI circuits should continue to be regarded as separate markets as in LLMR 03/04. Ofcom considers that it provides a conservative approach to market definition, which in the absence of strong price or trend analysis to the contrary remains appropriate.

Ethernet results

3.172 As stated above, the above analysis suggests a SSNIP on Ethernet users would not be profitable (i.e. sufficient respondents would be willing to switch to other services). Based on the end-user research the closest named substitute service would be digital SDH/PDH.

3.173 In relation to the results for Ethernet users, based on Ofcom's estimated price comparisons presented above, the average price of a WES circuit would be around £4,125 per annum per end compared to a price in excess of £10,000 per annum for multiple low bandwidth circuits. It is unclear that users of low bandwidth Ethernet circuits with high utilisation requirements (i.e. with peak capacity requirements close to 10Mbit/s) would be likely to switch to multiple low bandwidth SDH/PDH circuits. The price differences at higher bandwidths (i.e. above 10Mbit/s) are even more marked.

3.174 Given that these differences in price are significant, it is not clear that all end-users had in mind an accurate idea of the price advantages of Ethernet circuits over available alternatives. The questionnaire did not present respondents with indicative prices as these could vary significantly depending on distance and the service options. It appears that these users may have therefore over-stated their willingness to switch in response to a SSNIP on their current service.

3.175 Furthermore, it is unclear that the price of their current service was necessarily reflective of the price differences that might be seen in competitive markets. The price difference of their current Ethernet services relative to digital SDH/PDH services may have been smaller than suggested by the competitive price benchmarks in the price analysis presented above. Therefore, respondents may have had in mind much smaller prices differences than suggested by the price differences between Ethernet and Digital SDH/PDH discussed earlier.

3.176 Unfortunately, due to the very small sample sizes it is not possible to test the responses of Ethernet users on much higher bandwidths (i.e. above 1Gbit/s). As discussed in Section 7, Ofcom currently proposes not to find SMP in those markets. It would have been useful however to have been able to test the responses to the questionnaire for those markets – as this market is more likely to greater competitive conditions.

3.177 It is therefore likely that the above results for Ethernet may well overstate the extent to which those users willing to switch would select a PPC as the next closest substitute to their service relative to a situation where Ethernet prices were set at a more competitive price level. However, this does not require that the end-user research is completely dismissed. The evidence in Annex 9 suggests that the

market is wider than the initial low and medium Ethernet services. As discussed under Issue 5, Ofcom has identified a relatively wide market for Ethernet services (ranging from 10 Mbit/s to 1 Gbit/s). Therefore, the finding of a wider market for Ethernet can be explained by the inclusion of lower bandwidth services with the next highest bandwidth increment, rather than switching to alternative services.

3.178 Overall, the end-user research suggests that respondents may have perceived functional similarity between AI and TI services and were potentially prepared to substitute from AI to TI services, other things being equal. However, in the case of AI and TI, the evidence suggests that "other things" are not equal. There is therefore some inconsistency of these results with other evidence. As with all consumer research, it is not always possible to determine whether respondents' correctly interpreted the SSNIP question. In particular, respondents may have had in mind the retail prices that they face (such that they assumed that the difference of the price of their product was much smaller). This might mean that a SSNIP, in their minds, would be sufficient to prompt switching. Furthermore, they may not have understood that the functionality of Ethernet versus digital SDH/PDH was not precisely the same. In addition, we have identified below switching costs that might potentially reduce the timeframe of any intended migration.

3.179 Our interpretation of the results is that over time that there might be continued migration towards the cheaper AI product. But this does not of itself justify AI and TI in the same market. This is in particular in light of other evidence, which points to switching in response to price differentials not occurring rapidly within this market.

Switching costs

3.180 Some of the technological barriers identified in the last market review between TI and Ethernet leased lines are being removed and those that remain are likely to be removed within the timeframe of the review. However, the economic barriers to end users seem to persist and would be likely to slow the rate of migration from SDH/PDH to Ethernet that would otherwise be expected as functional differences are eroded.

3.181 The market has evolved to some degree to allowing Ethernet to deliver equivalent inter-site communications but there is a change in the end-user equipment needed to achieve this. The key issue is that currently end users wishing to switch from SDH/PDH to Ethernet need to make various investments so that Ethernet networks are capable of supporting the same applications and functions as SDH/PDH applications.

3.182 Moreover, the move from a TI-based enterprise network to one based on Ethernet circuits also requires investing in desktop Customer Premises Equipment, such as IP phones and IP Centrex, to allow convergence of voice and data traffic onto the Ethernet circuit.

3.183 In both cases, the investments required of the end user are likely to constitute a barrier to rapid switching in response to a small price change, which is the relevant consideration for market definition purposes. Overall, the above switching costs are likely to be a deterrent to such switching. For existing users of digital SDH/PDH circuits, to achieve similar performance services over Ethernet requires a wider investment decision (over and above the underlying connectivity). Therefore, although the savings associated with the move from digital SDH/PDH to Ethernet are potentially quite high, there is potential disruption in changing over applications. However, for new investments, such barriers are likely to be less significant. This

suggests that over the timeframe of the review, these barriers are likely to be reduced but not to have been overcome sufficiently to place AI and TI circuits in the same market(s).

Supply side substitution

3.184 Ofcom has considered whether supply side substitutability at the retail level would lead to a widening of the existing market definition to include both SDH/PDH-based and Ethernet-based circuits. Such supply side substitutability would exist if, in the absence of wholesale regulation, the suppliers of Ethernet circuits were able to provide SDH/PDH-based circuits at low cost and within a relatively short period of time (provided that these suppliers would not already providing digital SDH/PDH circuits and their entry would be sufficient to place a constraint on the hypothetical monopolist).

3.185 However, since the majority, if not all, of the suppliers of Ethernet-based circuits already supply SDH/PDH-based circuits (and vice versa), Ethernet suppliers would not place any additional constraints on a hypothetical monopolist supplier of SDH/PDH-based circuits (and vice versa). Ofcom's view is therefore that supply side substitution would not lead to a widening of the traditional interface market definition to include Ethernet-based circuits.

Proposed market definition

3.186 Ofcom proposes a separate market definition for digital SDH/PDH and Ethernet services, based on the following evidence:

- Differences in the functional capabilities of SDH/PDH and Ethernet
- Comparison of relative prices and trends in purchases of these services which suggest that users do not switch rapidly between them to even quite large price differentials;
- survey results which, although subject to significant caveats, are consistent with the observed trends in prices and usage referred to above
- the existence of significant switching costs; and
- Lack of supply-side substitution possibilities.

Issue 3: Leased lines versus virtual private networks

3.187 Virtual Private Networks differ from leased lines that are constructed using point-to-point networks. Leased lines tend to be used exclusively by one client (i.e. are dedicated). On the other hand, there has been technology available for some time which allows multiple users to share network resources. Such technology provides the efficiencies that come from sharing the cost of common network resources, whilst at the same time maintaining a level of security and traffic prioritisation. The resulting networks are known as Virtual Private Networks (VPNs).

3.188 The question is whether these forms of business connectivity services are likely to provide a competitive constraint on any of the dedicated leased lines services (i.e. analogue, digital SDH/PDH and Ethernet) that were discussed above.

Technical definitions

3.189 VPNs can be supported by a range of technologies such as ATM and Frame Relay amongst others, but the majority of corporate data is now moving to Internet Protocol (IP) protocols. Multi-Protocol Label Switching (MPLS) technology is perhaps the leading solution as it offers the ability to configure paths with different service characteristics. For example, MPLS enables high priority traffic such as voice packets to be labelled so that they are routed over low latency routes. As per the LLMR 2004, Ofcom has continued to include ATM and Frame Relay services as VPN variants.

3.190 VPNs can connect to a core using dedicated links. Although the core is shared, it may comprise of a single CP's network, itself made up of high bandwidth leased lines. There is also a range of lower cost alternatives on the market. Virtual connections routed through the Internet can be used in place of leased lines. Here users connect into the VPN using DSL, cable modem, dial-up or wireless.

3.191 A technique known as 'tunnelling' encrypts and encapsulates the private network data and protocol information within the public network protocol data so as to prevent it being accessible to other Internet users. However, the performance of tunnelling is limited by the delay and bandwidth congestion which characterise the Internet and which is not controllable by the VPN user.

3.192 VPNs accessed over the Internet can work together with leased line connections to the same VPNs. VPNs accessed over the Internet can also work alongside a point-to-point network. For example within a large business it will connect its main sites using leased lines and then use ADSL connections for remote users. Smaller businesses may use VPNs entirely accessed over the Internet (or even those larger businesses willing to accept performance associated with sending data over the Internet). End-user survey results, together with anecdotal evidence based on viewing various sample VPN bills, indicate that a significant portion of organisations make use of both types of connection.

3.193 For the purpose of our market definition assessment below, Ofcom has considered VPN services from two perspectives (potentially sitting at the each end of the available range of VPN service qualities): "high-end" VPNs with dedicated leased line links into a contended core where traffic is prioritised ("LL VPNs); and internet-based VPNs using DSL connections with data conveyed across an internet core – with traffic conveyed on a best efforts basis ("Internet-based VPNs).

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3.194 In the last market review, Ofcom noted that other managed data products such as VPNs and Internet access, were generally contended/shared at some point, and thus did not provide guaranteed bandwidth. Further, the end user was viewed as having less flexibility, as there is more third party management. Also, the LLMR noted that these products were not usually provided with a high level of customer care as standard and although it is possible for consumers to purchase enhanced service levels on some products, it normally fell short of leased line service levels.

Market definition assessment

3.195 Our consideration of VPNs against leased lines services is based on three broad areas:

- a qualitative assessment, which starts with comparison of the functionality of the VPNs and leased lines;
- demand-side substitution analysis based on relative prices and SSNIP analysis for VPN and leased line services; switching results from Ofcom's end-user research; evidence on market trends and usage of VPN services; and an assessment of possible switching costs.
- Supply-side substitution.

Qualitative assessment

3.196 Services providing similar end-uses may be in separate markets if the quality of the different services differs substantially. This is particularly the case if end-users (or a substantial number of end users) fall into distinct groups, some with a strong preference for a high quality level and a correspondingly high willingness to pay for it, and others with a much weaker preference and hence lower willingness to pay. It would follow that a SSNIP on the price of one quality level would generate insufficient switching to the other quality level to place them in the same market. On the other hand, where there is a sufficient range of quality (and price) levels, it is possible that there is a chain of substitution linking all products in the chain. This may be the case, even where direct substitution between the highest and lowest quality products in the chain would not occur. Where there is such a chain of substitution, so that there is a common pricing constraint linking all products in the chain, it is appropriate to place such products in the same market. In the light of this, we have made a comparison of leased lines to internet-based VPNs as well as for LL VPNs (where traffic prioritisation is possible), which broadly reflect the range of available service qualities that end-users might experience at the retail level.

Internet-based VPNs

3.197 Point-to-point networks generally provide a better service than VPNs run over the Internet when it comes to reliability, performance and security.

3.198 As noted above a technique known as 'tunnelling' encrypts and encapsulates the private network data and protocol information to prevent it being accessible to other Internet users. The fact that some security-conscious organisations such as banks are willing to use such networks for the purposes of online banking implies that it is possible to balance security risk against cost in respect of certain applications. However, the underlying perception remains that internet-based VPNs are by their nature less secure. Even though the VPN traffic is encrypted, many organisations are not willing to trust a system over which the number and identity of third parties handling their data are unknown. LL VPNs by contrast would use private connections run over Communications Provider's core networks or the (lower speed) PSTN.

3.199 As well as the security limitations described above, VPNs accessed via the Internet cannot guarantee performance. Specifically, there is no ability on the public Internet to separate classes of services, which means that business-critical data is treated in the same way as other applications. Time-sensitive traffic such as voice and video

can therefore be affected by relatively high rates of latency (delay) and latency variation, which makes these VPNs less suited to applications such as voice and video. This feature of the Internet is less likely to affect non-time critical applications such as email.

"Leased line" VPNs

3.200 The problems of reliability, performance and security are much less likely to affect VPNs that make use of leased line connections.

3.201 For certain LL VPNs, customers can choose between service level agreements (SLA) which provide varying levels of guarantee regarding network availability, performance and security. At the top end of the performance range is a 'real-time optimised' class of service, which provides a similar level of service to a point-to-point network by prioritising certain traffic. At the bottom end is a 'general data level' quality which utilises available bandwidth on a best efforts basis. Further, different SLAs can apply to a VPN at different times of the day, meaning that a company need only choose to pay for the more expensive SLAs when required.

3.202 Further, VPNs using dedicated leased line connections are less likely to suffer from the same security issues as those using broadband Internet connections. Users of these VPNs can be reasonably sure that traffic will only transit trusted networks (either the CP's core or the networks of third parties with whom the CP has a robust contractual relationship).

3.203 At least in terms of functionality, VPNs making use of dedicated connections and corresponding traffic prioritisation in the core are likely to be viewed by end-users as providing a service equivalent to an uncontended end-to-end service. Often this type of service is marketed to users as a service capable of delivering dedicated-class services. For example, a Cisco brochure states[35]:

'Multi-Protocol Label Switching (MPLS) is the state-of-the-art in IP Virtual Private Networks that provides the performance, reliability, and security of a leased-line network with the any-to-any scalability and flexibilities of an IP network.'

3.204 Perhaps more importantly the high level SLAs that are often acquired along with this type of VPN mean that the services provided to users will be presented as an uncontended service.

3.205 The comparison above therefore indicates that point-to-point networks and VPNs are broadly used for the same purposes, but that VPNs accessed over the public Internet do not provide the same quality of service or security guarantees as leased lines connections to VPNs. In contrast, LL VPNs can provide a level of service that is much closer to that provided by point-to-point networks. Indeed, there is little difference between a point-to-point network and a LL VPN except for the technology within the VPN that enables more efficient usage of network resources.

Demand side substitution

3.206 To establish whether or not VPNs and dedicated leased lines are in the same market, Ofcom has considered whether these services are potential demand-side substitutes based on:

[35] http://www.cisco.com/warp/public/cc/techno/mplsty/prodlit/mngeg_cs.pdf

- a comparison of relative prices;
- evidence from end-user research (including SSNIP analysis and overall patterns of usage); and
- possible switching costs.

3.207 Ofcom has focused its analysis on substitution opportunities between LL VPNs and dedicated leased lines on the grounds that these are the closest functional substitutes. It should follow that if highest quality VPNs are not in the same market, then internet-based VPNs, which offer lower quality of service are not. However, for completeness, Ofcom has also considered evidence on the substitutability of internet-based VPNs.

Price comparisons

3.208 In the case of internet-based VPNs, it is clear that these services are much cheaper than dedicated leased lines. A number of CPs provide online literature with pricing examples highlighting the large cost savings available[36]. For example, based on broadband rental of £20 per month and connection fees as low as £175 show that the cost per site would be far smaller than a point to point leased line service. By contrast, the wholesale input price of a local-end is around £2,000 per annum, which represents a low-end estimate of the "equivalent" leased line costs. Clearly with these price savings available, if internet-VPNs were able to address the same needs as a leased line service then the majority of users would have switched to such VPN services already.

3.209 There is some difficulty in constructing an equivalent "price" for LL VPN services against a relevant dedicated point-to-point link. The equivalent to a VPN constructed using a point to point network is difficult to model and it depends on the overall VPN requirements (by number of sites, capacity etc). Although VPN retail prices are available from BT this does not easily convert into an equivalent number of point to point links.

3.210 In any case, for price comparison purposes, Ofcom has focused on the fact that LL VPNs themselves often make use of leased lines as an input. Therefore a SSNIP on leased line services would also potentially increase the price of a VPN service, suggesting that LL VPNs could best be characterised as a downstream service rather than as a substitute for leased lines. This is consistent with the fact that many communication providers (CPs) cited System Integrators and networked IT services players as providing much of the competition in the market for VPNs, rather than just CPs.

3.211 However, further examination of the interaction between the impact of a SSNIP on leased lines is necessary. This is a price increase in leased lines would not necessarily result in the price of LL VPN services rising by the same amount as the leased lines themselves. LL VPNs make use of common core, and therefore only one component of the LL VPN – the links into the core – would increase along with the general increase in leased lines.

3.212 The fact that LL VPNs run a significant portion of traffic across a core network means that a LL VPN could constrain a point-to-point network to some degree. It can be seen that VPNs are more likely to constrain a price increase on a point-to-

[36] http://www.vpn-for-business.co.uk/

point network if the costs associated with the provision of core services accounted for a high proportion of total VPN costs. For example, if the core accounted for 75% of VPN costs, then a 10% SSNIP on leased lines would only translate through to a 2.5% increase in VPN costs. Under these assumptions (and given similar functional and price characteristics) it seems reasonable that users would switch to a LL VPN in response to an increase in leased lines and on this basis the two services would likely belong in the same market. If the core accounted for a much smaller proportion of LL VPN costs, it would be less likely that LL VPNs would constrain leased lines (assuming end-users were otherwise neutral between leased lines and LL VPNs)[37].

3.213 Ofcom carried out analysis to determine the proportion of total VPN costs that were accounted for by costs relating to use of the core. This analysis used a BT IP Clear VPN which uses dedicated leased line connections as the basis for the comparison. It can be seen that around 50% of the cost of these services can be accounted for by leased lines, such that a 10% SSNIP on a leased line would result in a VPN increasing in price by 5%.

3.214 It is important to note that BT's core is likely to account for a higher proportion of VPN costs then would be the case with alternative VPN providers. This is because these VPN providers are likely to have less extensive networks, hence smaller cores, and hence would rely on longer distance leased lines than would generally be the case with BT. This means that a 10% SSNIP on the leased lines would often result in the VPN of these service providers increasing by more than 5% - again increasing the likelihood that these VPNs would not constrain a SSNIP on leased lines.

3.215 Overall, our analysis suggests that the price of LL VPNs would increase with the price of leased lines, although by less than the full increase of a leased line network. We consider in the next section whether, taking into account the likely extent of switching implied by a 10% price rise on leased lines, switching to LL VPNs would prevent a hypothetical monopolist of leased lines raising its prices by 10%.

End-user research : SSNIP analysis

3.216 The preceding analysis has focussed on a number of factors to examine whether VPNs and point-to-point networks are likely to be substitutes. Our end-user survey directly sought information from users on their likely response to increase in the price of their service by 10% in order to test whether sufficient users would be likely to switch to a VPN-based service to yield a SSNIP unprofitable. If VPNs are capable of constraining a price increase on leased lines, then these services belong in the same market.

3.217 Respondents from organisations that did not currently have a VPN were asked whether a 10% price rise across all business connectivity services would make them consider switching to a VPN service within a year of the price rise. Respondents from organisations that already used a VPN service were also asked whether a hypothetical price rise of 10% across all VPN component parts would make them consider switching to point-to-point connectivity services within a year of the price rise.

[37] Ofcom notes that this analysis only considers the likely response to a relative change in the price of a leased line service. Therefore, it ignores any absolute differences in the price of leased line services and VPNs.

3.218 It is important to note that the switching question put to respondents was generally broader than that which would normally be used to determine market definition. Specifically, users were asked about their response if the price of "all their business connectivity services" increased (i.e. a rise across all their services used to send voice and data), whereas standard SSNIP tests seek to determine the response if only the price of only one candidate product increases.

3.219 This broader question was asked of VPN users in particular due to the nature of switching from leased line connections to a VPN. This decision is likely to be based on a complete change in the business connectivity services. By definition a VPN is suited to connecting multiple sites of a business's network, and so it would not be expected that an end-user would simply switch from a single point to point leased line to a VPN.

3.220 In response to the SSNIP question, 44% of businesses that were currently without VPN services would consider switching to a VPN to avoid a 10% price rise on all the other business connectivity services that they were using. Against this, 34% of those people using a VPN would consider switching to other services to avoid a SSNIP on a VPN.

3.221 These switching rates are relatively high (and significantly exceed the critical loss factors that are likely to apply in these markets). Hence, this might suggest that the market is broader than the dedicated leased line market. However, there are some factors to take into account regarding the precise question asked:

- As stated in paragraph 3.218 above the question was couched in terms of a SSNIP on all services, testing substitution when the price of all of the user's current lease line services increases has greater potential to result in an excessively broad view of the market relative to a SSNIP imposed on only one of the leased line service used.

- It should be noted that the change associated with moving to VPNs may require a sustained price rise over a longer period of time than one year as a complete transition of all applications and network to VPNs is likely to entail a number of switching issues (these are discussed further in the paragraphs below).

- respondents were asked only if they would consider moving to another service. Clearly behaviour that falls short of actual switching is again likely to overstate the extent of switching which would actually occur.

- The above SSNIP question also only specified VPNs services as the potential service that respondents could switch to.

- The question also did not explain that the price of a VPN might also increase as a result of a SSNIP (e.g. around 5% based on the analysis presented above), which would reduce the likelihood of switching and would directly increase the profitability of the SSNIP in the price of leased lines when used as an input to VPNs.

3.222 Ofcom considers that these results are useful indication that end-users may be willing to switch to VPN services as part of a wider decision to replace all of their connectivity services. However, it is unlikely that such switching behaviour is likely to provide a constraint on hypothetical monopolist of either an AI or TI leased line service over relatively short timeframes.

3.223 In relation to this latter point, it is worth noting that the evidence from the responses to other SSNIP questions (where respondents were asked to name the service they would switch to or were presented with a range of alternative) contrasts to the above result. For the SSNIP questions where respondents had a choice of services, VPNs were not among the most popular services selected for users on dedicated leased lines.

3.224 Therefore the results of the SSNIP questions posed to leased line customers suggests that they would be willing to switch to VPNs as part of a larger scale switching decision. However, the end-user research does not suggest that users would be willing to switch when faced with a SSNIP on an individual service leased line service only.

End-user research: service characteristics

3.225 The results of our end-user survey provide information both on particular characteristics that customers value and also on the features in relation to which they would be willing to compromise in order to avoid a SSNIP. These results help inform the question of whether quality differences are likely to place at least some VPNs and point-to-point networks in separate markets.

3.226 First, respondents were asked to identify service features that were important when making decisions abut their company's business connectivity services and to rate nine service features: resilience, availability, dedicated (uncontended) connection, range, jitter, latency, symmetry, bandwidth- upload speed and bandwidth – download speed.

3.227 End-users were also asked whether they would compromise on some of these features in order to avoid a 10% price increase on their current voice and data services that they were using. Specifically, users were asked whether they would be willing to sacrifice the following features to avoid a SSNIP: bandwidth, contention, symmetry, resilience and latency and/or jitter and were able to select one or more of these service features.

3.228 Although having a symmetric service was the service feature least valued by business and was also the feature in respect of which users were most willing to compromise (indicating that customers might be willing to shift from leased line services to ADSL-based VPNs), the overall results broadly point to customers not viewing lower quality services such as VPNs making use of Internet connections as being close substitutes to higher quality point-to-point services.

3.229 Moreover, it is particularly important to note here that switching to a VPN offered over ADSL links would involve compromising on not just one of the nominated service features but on multiple service features simultaneously. Hence a willingness to compromise on only one service feature in order to avoid a SSNIP does not imply that users would be willing to shift from a point-to-point network to an ADSL-based VPN where numerous compromises would be required.

3.230 In relation to dedication/contention, around 22% of data users were willing to compromise on this service to avoid a SSNIP (which is just above the critical loss factors likely to render a SSNIP unprofitable)[38]. It is not clear however what degree of compromise respondents had in mind when they opted for this change. For

[38] The marginal cost and prices likely to apply in the relevant markets broadly imply that for a 10% SSNIP to be unprofitable, demand needs to fall by around 16-21% or more.

example, users may accept contention if it is not associated with a reduction in their service experience on an end-to-end basis.

3.231 Given that around 95% of users viewed having a dedication connection as either 'business critical' or 'very important' it seems unlikely that users would be willing to compromise a large extent on this service feature to avoid the SSNIP. This is consistent with the fact that under a separate SSNIP test (as discussed in Annex 9) most users of leased lines nominated switching to another type of dedicated leased line to avoid a SSNIP, rather than shifting to a contended service.

3.232 It is also worth examining end-users' views on having services characterised by low levels of jitter and latency, as these are features which cannot be provided over VPNs with Internet connections. While customers did not count this as amongst the most important service characteristic, it was still a feature that between around 65% and 87% of the market viewed as 'business critical' or 'very important'. Moreover, this was one of the features on which users were least willing to compromise in order to avoid a SSNIP. This again implies that Internet-based VPNs are in a separate product market to point-to-point networks.

3.233 Users' responses in regard to dedication, together with the broader consideration that switching to a VPN making use of ADSL connections would involve compromising on additional service features, strongly suggest that most users would be unlikely to switch to VPNs making use of ADSL connections in response to a SSNIP on a point-to-point network. However, while the above responses provide strong evidence to suggest that Internet based VPNs are not likely to be viewed as close substitutes to point-to-point networks, they are less informative on where VPNs that are run over private networks are likely to fit in.

Patterns of usage

3.234 The end-user research provided data on the pattern of usage of VPNs and leased lines. Although not necessarily providing conclusive evidence, this information is likely to provide an indicative view whether these services are potentially substitutes or complements.

3.235 The responses to our end-user research indicate that most customers have both leased lines and VPNs. Specifically, 83% of respondents had leased lines, 68% had VPNs generally and 63% had ADSL/cable modem accessed VPNs.

3.236 These results indicate that many users make use of both point-to-point networks and VPNs accessed via Internet connections. This information, together with the fact that Internet-based VPNs are a significantly cheaper service than leased lines, tends to indicate that these services are not seen as close substitutes. In other words, the fact that Internet-based VPNs are significantly cheaper than point-to-point connections but that many customers used both these services implies that the services were used for different purposes – suggesting that they are not sufficiently close substitutes to be regarded as part of the same market.

3.237 The survey did not differentiate between leased lines used as an input into VPNs and leased lines used to form point-to-point networks. Hence it is not possible to determine whether the majority of leased lines acquired by end-users were used to access VPNs or were instead used as part of a point-to-point network. This means that the observed patterns of usage do not provide a clear indication of whether point-to-point networks and VPNs accessed over leased lines are close substitutes.

3.238 This also makes it hard to assess whether point-to-point networks are still being acquired in significant numbers. If new point-to-point networks were still being acquired in significant numbers when a cheaper leased line VPN option was available, this would tend to indicate that some other factor served to differentiate these products.

3.239 However, Ofcom notes that the result show that some respondents made use of both types of VPNs (indicated by the fact that 68% of users had VPNs and 63% had ADSL-accessed VPNs). This could indicate that the different types of VPNs operate in separate markets (and that some VPNs are in fact complementary services).

3.240 Summing up, what we are able to conclude is that most users use leased lines and also use ADSL-based VPNs. Although not conclusive, this suggests that ADSL-based VPNs and leased lines are in separate markets. Specifically this pattern of usage is consistent with ADSL-based VPNs being used to support remote access and using leased lines to connect their main sites.

3.241 It is not possible from end-user research to form a conclusion about the relationship between leased lines and LL VPNs. Although the evidence suggests some willingness to switch their current leased line connection to a VPN service, the nature of the specific question asked of VPN/leased line customers is likely to have led them to overstate their willingness to switch. Ofcom considers that another reason for this may be associated with the switching costs, which are discussed in the following paragraphs.

Switching costs

3.242 Switching costs are a key factor that are likely to impede users substituting from a point-to-point network to LL VPNs. As these can be significant, this provides further grounds for viewing these products as operating in separate markets.

3.243 A customer wishing to switch from a point-to-point network to a VPN could incur significant switching costs associated with the need to accommodate the wide area VPN into their network. With the point-to-point network the management and configuration of the network are totally within the customer's control but a switch to a VPN will necessitate some ceding of this control to the VPN supplier. It is possible that the VPN is sufficiently flexible that it can be readily accommodated into the customer's network but nevertheless there is always likely to be some level of disruption which will involve capital and operational expenditure.

3.244 In addition, it rarely makes sense to switch to a VPN on a link-by-link basis as the advantage of a VPN is that it is a network rather than a selection of point-to-point links. This implies that migrating to a VPN will be a significant and disruptive undertaking requiring careful and costly management to ensure business continuity and minimise the risk to essential business operations. Risk-averse enterprises will possibly run both networks in parallel for a period. The complexity of the migration means that each migration is likely to be bespoke in nature requiring significant planning from both the VPN supplier and the customer.

3.245 Finally, VPNs are services which tend to be managed by third parties. This is because management is a function which is to a large degree inherent to the VPN, which therefore merges what were previously two separate infrastructure and management functions. Thus the decision to move to a VPN may involve broader decisions about whether an organisation seeks to outsource its IT function.

Outsourcing IT can involve significant changes to staff and equipment including the replacement of existing equipment such as edge routers and firewalls, and the transition of IT support staff to the VPN supplier.

3.246 While there may be some offsetting switching benefits if the change to a VPN is undertaken towards the end of the life cycle of a particular point-to-point network, on the whole switching costs will make it less likely that customers will substitute to a VPN simply in response to a SSNIP on leased line prices.

Supply-side substitution

3.247 Ofcom considers that the possibilities for supply-side substitution at the retail level by suppliers of VPNs who are not currently suppliers of leased lines would not provide a competitive constraint on a provider of leased lines services.

3.248 Ofcom has identified below three scenarios by which, at least theoretically, supply-side substitution could occur. For each scenario, Ofcom has then considered whether such supply-side substitution by suppliers of retail narrowband would prevent a SSNIP in the retail broadband price. The three scenarios for supply-side substitution that Ofcom has considered are:

- the use of their existing "VPN" network to provide wholesale inputs (e.g. ADSL currently used to provision VPNs);
- the building of any necessary access (and backhaul) networks; and
- the use of wholesale leased line inputs.

3.249 In order to supply leased lines services, VPN suppliers would need their own network or would need to purchase the necessary wholesale services. Clearly some supply-side substitution options can be ruled out on technical grounds. For example, wholesale inputs using ADSL cannot be used to provide a retail leased line service. Hence, suppliers providing ADSL services could not switch in this manner.

3.250 On the other hand providers with leased line networks used to provide VPNs could in principal easily switch to providing dedicated leased lines. However, it is likely that suppliers with existing Ethernet or Digital SDH/PDH networks are already currently suppliers of VPN. VPN providers with their own networks are also likely to provide point to point networks and would not constitute an additional constraint.

3.251 An alternative approach could be for an operator to enter the market by building necessary access (and backhaul) networks. However, Ofcom considers this form of supply-side substitution is unlikely in response to a 5 to 10% increase in the price of leased lines. The reason for this is that the costs of providing a wholesale broadband access network (especially digging and ducting) include significant sunk costs and would be likely to include significant time delay in responding to the price increase.

3.252 A further potential means of supply-side substitution could be from current VPN suppliers procuring wholesale leased lines or some other downstream variation in order to supply retail broadband services. However, as noted in the paragraphs above, the definition of the retail product market should be conducted under an assumption of an absence of SMP regulation. It cannot be assumed that in the absence of regulation that a wholesale leased lines product would be provided by a

hypothetical monopolist. Even if current VPN suppliers could obtain leased line wholesale inputs to allow them to supply retail leased line customers this would not provide a constraint on a hypothetical supplier of the leased line wholesale input. This is because, by definition, the hypothetical monopolist would be providing the wholesale inputs.

3.253 In addition to the scenarios identified above, an alternative question is whether other suppliers, for example LLU operators or cable companies (potentially using LLU as an input to its VPN service) could easily supply-side substitute. This question is considered in more detail under the next issue, where symmetric and asymmetric broadband services are discussed. The overall conclusion is that although it is possible to upgrade these services, doing so would take considerable time and cost, such that it would not represent supply-side substitution over a relatively short timeframe.

3.254 Therefore in the absence of wholesale regulation existing suppliers of other symmetric data products/services would not be able to constrain the activities of a hypothetical leased line monopolist to the competitive level through supply side substitution.

Proposed market definition

3.255 VPNs accessed via Internet links are unlikely to be close substitutes for point-to-point leased line networks as they are not able to offer the same service features. Ofcom has also excluded leased-line based VPNs from leased lines markets based on the following evidence:

- Such VPNs appear to be more appropriately regarded as a service downstream of leased line markets as they involve not just the provision of a network but also of a network management function;
- As leased lines are an input to such VPNs services, the ability of a supplier of VPNs to constrain a hypothetical monopolist supplier of leased lines is limited;
- The results of end-user research suggest that users often purchase leased line VPNs along with ADSL based VPNs and/or point to point connections, which is consistent with the view that they are used for different purposes;
- A user switching from a leased line network to a VPN would incur switching costs which reduce the likelihood of doing so in response to a SSNIP; and
- Lack of supply side substitution possibilities.

Issue 4: Broadband markets

3.256 To assess if broadband products and services are in the same market as retail leased lines, Ofcom has examined whether symmetric and/or asymmetric broadband services place a competitive constraint on the pricing of retail leased lines.

3.257 The following section does not consider whether a constraint exists in the opposite direction (i.e. whether retail leased lines offer a competitive constraint on asymmetric broadband services) as this has been considered (at the retail level) in the context of Ofcom's Wholesale Broadband Access Market Review (WBAMR) and is not necessary for the purposes of the LLMR. In any case, the WBAMR

proposals suggest that asymmetric broadband access services are not constrained by symmetric broadband services such as leased lines or SDSL services.

Technical definitions

3.258 Symmetric broadband services are provided using Symmetric Digital Subscriber Line (SDSL) in the access transmission whereas asymmetric broadband services are provided predominantly using either ADSL or cable modem for the access transmission technology.

3.259 SDSL is a Digital Subscriber Line (DSL) variant. It runs over one pair of copper wires, typically with a maximum range of about 3 kilometres. The main difference between ADSL and SDSL is that ADSL has been designed to co-exist with narrowband voice on the same line whilst SDSL has been designed to use the available bandwidth exclusively. SDSL has the same upstream data rate as downstream (symmetrical), whereas ADSL always has smaller upstream bandwidth (asymmetrical).

3.260 SDSL is provided using the copper pairs in the access network and can therefore be provided over an existing dedicated telephone line with appropriate SDSL modems. However, if the end-user wished to use SDSL for data services and maintain their voice service the SDSL service would require a second dedicated telephone line or a switch to VOIP-based telephony (which can be carried over SDSL as packetised voice). This means that the customer would potentially be required to pay two line rentals, one for the SDSL service and the other for the PSTN service, or would need to migrate to IP-telephony.

3.261 SDSL services are generally available at speeds up to 2Mbit/s each way, with contention rates mostly marketed at 10:1 although services are available from 1:1 (i.e. uncontended) to 20:1 (higher levels of contention are technically possible). ADSL connections are available with downstream speeds up to 24Mbit/s, although up to 8Mbit/s remains the most commonly available maximum downstream speed, with an associated upstream speed of up to 1Mbit/s[39]. Contention rates for ADSL connections can be up to 50:1. Technically there is no reason why ADSL cannot be offered on a dedicated basis and some providers have begun to offer 1:1 dedicated connections, although the roll-out out of these services has been very limited[40].

2003/04 Review

3.262 The 2003/04 Review found SDSL services to be in the Traditional Interface Symmetric Broadband Origination (TISBO) market, while ADSL services were in a separate market.

3.263 The inclusion of SDSL services reflected the view that "the functional similarities of SDSL and SDH/PDH-based circuits (the ability to provide symmetric, dedicated origination) are such that the price of the former is likely to constrain that of the latter to a sufficient degree that the two can be viewed as demand side substitutes and as such to be in the same economic market"[41]. It was recognised that SDSL

[39] Some LLU operators have begun deployment of ADSL2+, which allows speeds of up to 24Mbit/s for download where the signal to noise ratio would allow.

[40] For example Fluidata provides "ADSL leased line" service offering dedicated links with Virtual Paths across its core network.

[41] Final statement, para A.322.

services “may not be able to offer the same service levels as other symmetric broadband origination services”, but noted that they were generally cheaper.

Market definition assessment

3.264 Our consideration of SDSL and ADSL services against low bandwidth leased lines is based on three broad areas:

1. a qualitative assessment, which starts with comparison of the functionality of the two interface types;

2. demand-side substitution analysis based on relative prices and SSNIP analysis for digital SDH/PDH and ADSL/SDSL circuits; switching results from Ofcom’s end-user research; and an assessment of possible switching costs.

3. Supply-side substitution.

Qualitative assessment

3.265 In terms of bandwidth ADSL technologies are able to offer much greater speeds, both for uploading and downloading, compared to the period of the previous market review and because of this there is a real trade-off to be made for many end users between price and performance: big price savings with a reduction in performance from DSL versus leased lines. At the time of the previous review this opportunity to switch was not available as the DSL products at that time were more limited in their ability to meet the needs of leased lines customers (512/256kbit/s vs. 2000-8000 kbit/s today).

3.266 Although ADSL connections by definition offer lower upload, an ADSL connection has the capability to offer a degree of symmetry based on its upload speed. Therefore, a user with a 1Mbit/s leased line might compare this to BT’s maximum speed service ADSLmax running (dependent on line) with a download speed up to 8Mbit/s and an upload speed of up to 832 kbit/s and consider this as broadly “equivalent” in bandwidth terms to its current leased line service.

3.267 For most users however it is not “symmetry” per se that is required simply the necessary upload and download speeds to meet its needs. However, the nature of inter-site traffic for a business is such that the same capacity requirement is often needed in both directions.

3.268 In addition, with associated high contention rates of ADSL connections, typically the bandwidth is not guaranteed and is also associated with poorer service quality in terms of latency and jitter, and overall throughput. For some users with very limited quality requirements such service guarantees may not matter so much, for example if the business connectivity services are for low bandwidth/delay tolerant applications.

3.269 In comparison to ADSL, SDSL connections offer the ability to support dedicated, i.e. uncontended, symmetric bandwidth at speeds comparable to low speed digital leased lines, i.e. up to 2Mbit/s. However, SDSL connections are still essentially a packetised service with unpredictable latency and are not suitable for those applications where the requirement is for predictable latency or where a channelised 2Mbit/s, i.e. E1, is required. Such applications are primarily voice telephony applications, in particular PBX connectivity. Nevertheless, SDSL is a much more viable alternative to leased lines for those applications where the

principal requirement is data transmission and such applications represent a growing proportion of the installed base of leased lines.

Table 7: Key features of SDSL/ADSL and digital SDH/PDH based on main characteristics

	ADSL	SDSL	Digital SDH/PDH
Bandwidth	up to 8Mbit/s downstream and up to 1Mbit/s upstream	Up to 2Mbit/s	64kbit/s up to 2.5 Gbit/s
Contention	20:1 typically (up to 50:1 for residential services)	Varies from 1:1 to 10:1	Dedicated
Latency/jitter	High	High	Low
Resilience	Low	Low	High
Symmetry	Asymmetric	Symmetric	Symmetric
Distance [Note: for xDSL the distance limits refer only to the loop length and not the end-to-end circuit length.]	available speed varies with length of local loop (practical limit of the order of 5km)	available speed varies with length of local loop (practical limit of the order of 3km)	Not limited

Source: Ofcom 2007

Demand-side substitution

3.270 In the 2003/04 Review, ADSL services were considered to be in a different market to leased lines because they were (i) contended and (ii) asymmetric. As a result of these differences in functionality, it was regarded as unlikely that a sufficient number of leased line customers would respond to a SSNIP by switching to ADSL services, to render the SSNIP unprofitable[42].

3.271 Some of the altnets Ofcom has interviewed suggested that some substitution had started to occur, as ADSL upload speeds had improved. It was suggested that some business users who required symmetric connections at speeds of up to 1Mbit/s could meet their needs more cheaply by switching to ADSL, although the contention levels involved meant that this would only be possible for certain applications.

3.272 It is important to note for market definition purposes, that the fact that some customers previously consuming low bandwidth leased lines are now purchasing ADSL services does not necessarily mean that the two services should be placed in the same market, since it does not imply that sufficient switching would occur in response to a SSNIP to render it unprofitable.

[42] Op cit, para A.47

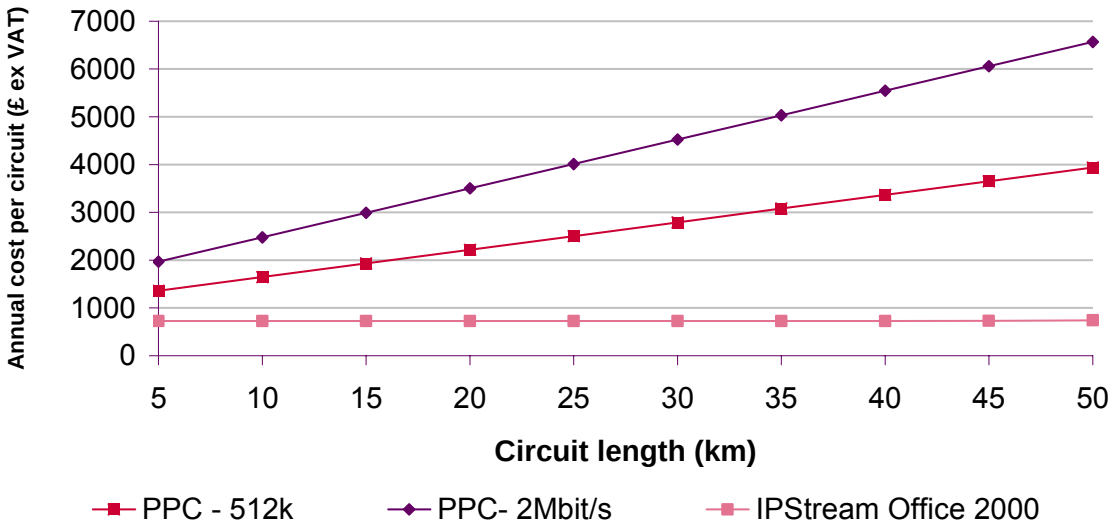
3.273 It is correct to observe that the functionality of ADSL, such as available bandwidths, has increased since the LLMR 2003/04. This enhanced functionality means that a class of customers that previously potentially only had the choice to use low bandwidth leased lines can now use cheaper ADSL services. However, if there are sufficient numbers of customers still remaining on low bandwidth leased lines services it could still be profitable for a hypothetical monopolist to increase prices.

3.274 The observed switching may in fact represent a growth in the DSL market at the expense of TI, but this does not necessarily imply that TI is sufficiently constrained by DSL (as those remaining still value the characteristics of TI services). Observed migration of some users of leased lines to ADSL does not therefore necessarily imply that that those users remaining on leased line service would be likely to switch to ADSL services in response to a SSNIP, this will depend on the price responsiveness and proportions of likely switchers for the remaining leased lines users. To consider this demand-side substitution further, Ofcom presents below relative price comparisons of ADSL, SDSL and leased lines services and evidence from end-user research.

Price comparisons

3.275 Figure 5 shows comparative price information based on BT's IPstream 2000, and Digital SDH/PDH (PPCs) at 2 Mbit/s and 512 Kbit/s. IPStream is the BT wholesale input that can be used to deliver a 2Mbit/s Business ADSL broadband service.

Figure 13: ADSL Price Comparisons



Source: Ofcom 2007

3.276 The above figure compares ADSL circuits both to a 512 Kbit/s PPC and a 2 Mbit/s service. The comparison with 512 Kbit/s is shown as this would provide an equivalent upload speed to a 2Mbit/s ADSL service (albeit there would be much better bandwidth guarantees with the PPC compared to a contended ADSL service). A user switching from a 2Mbit/s PPC to an ADSL 2000 would experience an associated compromise in their upload speed.

3.277 The above analysis shows that ADSL would be cheaper than digital SDH/PDH circuits. As the price of Ethernet circuits discussed under Issue 2 in this Section, would be more expensive than digital SDH/PDH (with an Ethernet circuit just over

£4,000 per annum at 5-10km), Ofcom has not presented this in the above chart as the same results hold for Ethernet circuits (i.e. ADSL would be significantly cheaper).

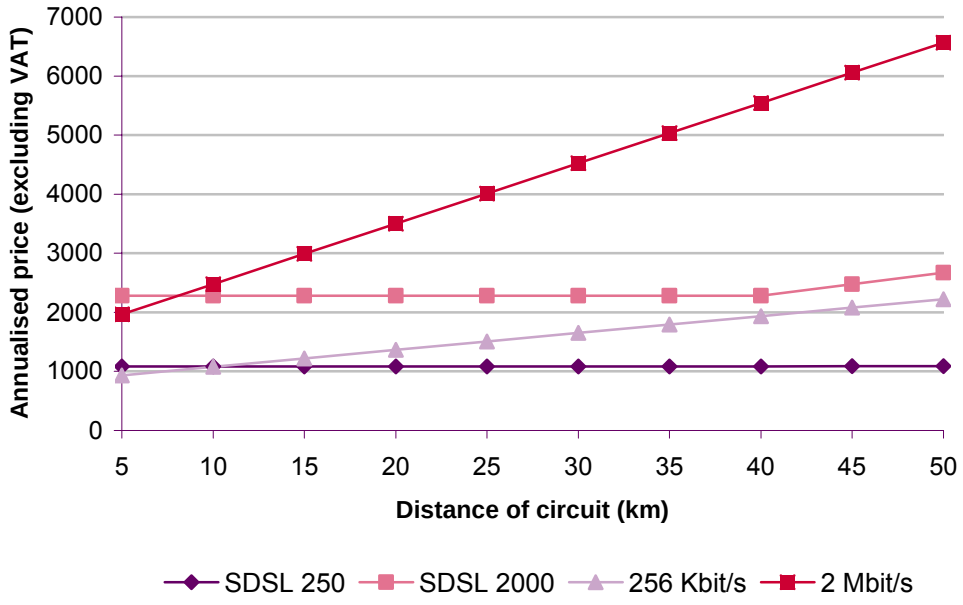
3.278 The above price comparisons show that savings are available in switching to ADSL, but this appears to be insufficient to suggest that ADSL acts as a constraint on pricing of low bandwidth circuits, either at 512kbit/s or 2Mbit/s. ADSL pricing might be expected to be closer to the price of low bandwidth circuits if there were a sufficient constraint between low bandwidth leased lines and these services.

3.279 It should be noted in undertaking a comparison of likely prices of ADSL and leased lines that ADSL services also address the wider retail markets in particular residential and business broadband access, which may tend to dominate the pricing of ADSL used for wider business connectivity and act to prevent prices from increasing upwards. If ADSL imposed a sufficient constraint on low bandwidth leased lines, then it might be the case that the price of a leased line would move closer to ADSL, but there is limited evidence that prices for low bandwidth leased lines have moved significantly closer to ADSL services. This suggests that the migration that has occurred from leased lines to ADSL has been insufficient to impose a price constraint (i.e. low bandwidth leased lines still command a significant premium relative to ADSL services). On balance, the evidence suggests that ADSL services and leased lines continue to fall into separate markets.

SDSL services

3.280 Figure 6 shows price comparisons for BT's charges for wholesale digital SDH/PDH circuits and SDSL services at speeds of 256 Kbit/s and 2Mbit/s.

Figure 14: SDSL/PPC price comparison



Source: Ofcom 2007

3.281 The comparison of lower bandwidth SDSL and digital SDH/PDH circuits (at 256 Kbit/s) shows that they are priced very closely particularly at shorter distances

(below 25km) where the majority of digital SDH/PDH circuits are purchased. Post SSNIP, SDSL would be cheaper at any distance.

3.282 At higher bandwidths of 2Mbit/s, there is greater divergence in the pricing. With 2Mbit/s SDSL services charged at a flat rate over distances up to 40km and the PPC gradient being much steeper, SDSL remains cheaper over most distances.

3.283 In a similar way to our comparison of analogue services and digital SDH/PDH, it may be the case that SDSL services tend to be used by customers with relatively low bandwidth requirements. If so, SDSL services would be likely to provide a direct constraint on a SSNIP on lower speed digital SDH/PDH services. It is then possible that SDSL could impose a constraint on higher bandwidth (up to 2Mbit/s) SDH/PDH services within the market through the chain of substitution described earlier, when defining the market for low bandwidth TI circuits.

3.284 As for SDSL imposing a direct price constraint on digital SDH/PDH at 2Mbit/s, it can be seen that SDSL is cheaper for circuits at 10km and above given the flat charging gradient. Putting aside functional issues of SDSL services to a low bandwidth SDH/PDH, the price savings on offer should have been sufficient to prompt switching to these services. Ofcom considers below what the trend analysis suggests with respect to SDSL services providing a constraint on digital SDH/PDH. Following the trend analysis, it considers the impact of a SSNIP would be given the above price comparisons.

3.285 Annex 5 provides details of trend data for digital SDH/PDH and SDSL. Overall, usage of low bandwidth digital SDH/PDH circuits has remained broadly stable, whereas the sub-2Mbit/s part of the market is in decline. The overall volumes of SDSL are very low by comparison, but starting from a very low base there has been strong growth.

3.286 There are two factors which may have reduced the scope of switching between digital SDH/PDH and SDSL services:

- The limited availability of SDSL; and
- Pricing of SDSL relative to digital SDH/PDH.

3.287 In terms of the availability of SDSL, the number of SDSL enabled exchanges has been rather limited, which would limit the scope of areas where wholesale SDSL inputs are available. Approximately 809 out of BT's national total of 5592 exchanges are SDSL enabled, which represents nearly 15% of exchanges. It is likely to be the case however that overall population coverage is higher. This is because the SDSL enabled exchanges are likely to be in areas of higher population and business densities. Furthermore, SDSL coverage could extend beyond those where BT provides wholesale SDSL services. For example, operators may have built out their own networks to other exchange areas and/or SDSL could be provisioned by operators at LLU enabled exchanges (although this would require full unbundling of the MPF).

3.288 To consider the coverage of the SDSL enabled exchanges, Ofcom has referred to external data[43], which suggests that around 7.2 million premises are within 1.6km of

[43] http://www.samknows.com/broadband/dsloperator.php?provider=btadsl

an SDSL enabled exchange[44]. This data is likely to refer to households rather than businesses. But, in coverage terms, 2Mbit/s SDSL services are currently capable of addressing approximately 20% of those premises (based on total number of premises included within this external data). If this is also representative of the distribution of businesses, then it potentially explains why there has been limited take-up of SDSL despite it being a potential substitute for digital SDH/PDH services.

3.289 However, SDSL does entail some potential compromises in quality and therefore if this service is in competition with digital SDH/PDH, then leased line users would expect some reduction in price to compensate for this. In Ofcom's discussions with stakeholders, a number of CPs expressed concerns regarding the pricing of wholesale SDSL services currently available. This might suggest that currently available SDSL pricing does not provide an appropriate competitive price benchmark and this may have undermined the take-up of this service by end-users. However, it may still be the case that, at competitive price levels it could provide a sufficient constraint on the pricing of digital SDH/PDH. This is considered below.

Impact of a SSNIP

3.290 Putting aside the above concerns raised by CPs, Ofcom has conducted SSNIP analysis based on the relative prices. This adopts a similar approach to that presented under Issue 2 in relation to alternative versus traditional interface circuits. In the analysis, we considered the number of potential users that would potentially switch between services following a SSNIP.

3.291 This analysis used the current distribution of circuits by distance and assumed that users would always switch to the lowest priced service. And in the context of the SDSL and digital SDH/PDH, the distance comparison is particularly relevant as it is at shorter distances (where SDSL is potentially more expensive) that a SSNIP on 2 Mbit/s PPC might prompt switching to an SDSL service.

3.292 Based on the distribution of circuits, Ofcom's analysis suggests that a significant number of users (77%) would already currently find an SDSL product cheaper. Post-SSNIP this number would rise to 100%. Therefore, even if SDSL is currently priced uncompetitively, it could still potentially impose a competitive constraint on a hypothetical monopolist.

3.293 The above analysis does not however indicate whether a SSNIP would be unprofitable or not. But it does suggest that a significant number of users of digital SDH/PDH would find a SDSL service cheaper at current prices. For those users with shorter distance requirements, where digital SDH/PDH remains the cheapest option, a SSNIP on digital SDH/PDH would also result in SDSL being cheaper. This represents a potentially significant number of digital SDH/PDH users (23%) that might potentially switch.

3.294 The results of this distributional analysis differ from the comparison we made of AI versus digital SDH/PDH. In that comparison, either the majority of AI users already found their service cheaper than the relevant TI. At low bandwidths, there were instances where a smaller number of AI users found a TI service more economic but the proportion that were likely to switch in response to a SSNIP was very small. This suggests that the likelihood of a SSNIP affecting the choice between AI and TI

[44] BT currently estimates that 1.6km is the practical limit for provision of 2Mbit/s SDSL IPStream services (see SIN405 available from http://www.sinet.bt.com/).

is significantly smaller than that of a SSNIP affecting the decision to use SDSL in preference to an SDH/PDH circuit.

End-user research

SSNIP results

3.295 As discussed under Issue 3 above in relation to VPNs, the SSNIP results from consumer research point to contended services not being in the same market as dedicated services (i.e. that a SSNIP on all dedicated services would be profitable). On this basis this would point to contended ADSL and leased lines being in separate markets.

3.296 In the case of both ADSL and SDSL, dedicated (i.e. uncontended) variants of these services are possible. But, in relation to the above SSNIP question, most respondents may have a perception that ADSL services are invariably associated with high levels of contention. This might therefore deter users from switching to those services if the bandwidth the service can guarantee is at a very low level.

3.297 This latter point is important as in general ADSL upload speeds already tend to be much lower than the available download speed. Indeed, as the download speed increases the differences become much more marked (i.e. the difference in upload and download speed for a 512Kbit/s ADSL connection would be far smaller than in the case of 8Mbit/s connection). This may suggest that only for services addressing the lowest bandwidth requirements ADSL might impose a competitive constraint. Additionally, achievable speed is a function of loop length and so for some users their distance from the local exchange might effectively eliminate ADSL as a viable alternative to a low bandwidth digital leased line.

3.298 The functional similarities of SDSL and SDH/PDH-based circuits allow symmetric, dedicated capacity to be provided using either technology. A question arises over whether the same can be said of ADSL services, in particular whether the asymmetric nature of the service is sufficient to place it in a separate market. To inform the answer to this question, the end-user research provides additional evidence on the service characteristics that end-users value.

Service characteristics

3.299 In general terms, symmetry was rated lowest in importance of service features with only 13% rated it business critical / 39% very important. However, overall upload speeds were rated as relatively important (78% rated it business critical / 27% very important) this suggests that a minimum level was still valued (even if the overall requirement for download speed to match upload speed was less important).

3.300 Going forward respondents did not think that symmetry and upload speeds were becoming significantly more important. Indeed, of the service characteristics respondents were most likely to compromise on, symmetry was the characteristic that the largest number named (31-38% of respondents that would switch would compromise in this area).

3.301 For those respondents that named a service that they were likely to switch to in response to a SSNIP, ADSL and Cable services did feature among some of the main services that respondents named. However, when presented with a range of

business connectivity services to choose from, far fewer respondents opted for ADSL/Cable services suggesting less willingness to compromise on symmetry.

3.302 Indeed, a significant result from the responses of SDSL users is that the vast majority of users named symmetric services in preference to an ADSL service. Given that SDSL is likely to be the closest substitute to ADSL services it follows that if these users are unwilling to compromise on symmetry of their service other symmetric users would be even less willing to switch to ADSL.

3.303 The fact that SDSL users expressed a preference for other symmetric services is also consistent with the ability of communication providers to differentiate the prices of SDSL services relative to ADSL based on the greater willingness to pay for symmetric services.

Switching costs

3.304 Ofcom does not consider that switching costs would be material. In the case of ADSL and SDSL switching costs are generally likely to be low as these services can be delivered over existing phone lines or new copper connections with relatively inexpensive customer premises equipment (relative to leased line services). There would be limited internal switching costs to the company involved.

Supply side substitution

3.305 On the supply side, existing suppliers of asymmetric broadband services could constrain the suppliers of symmetric leased lines services if they are not already present in the latter market and could start supplying retail leased lines quickly and at low cost in response to a price increase. To carry out the supply-side substitution analysis, existing suppliers of asymmetric broadband services are put in two categories: those using LLU and those who do not use LLU.

3.306 Suppliers of asymmetric broadband services using LLU may be able to supply-side substitute into low-bandwidth retail leased lines by using SDSL in combination with LLU.

3.307 There are some LLU operators which do not provide retail leased lines (as these operators are focussing on residential and business asymmetric broadband products). The key question will be the extent to which these providers could easily supply-side substitute from asymmetric to symmetric in a short enough timeframe. In a number of cases those suppliers with the highest LLU coverage are already present in the leased lines market. Remaining LLU players either have smaller footprints or appear to be focussed on asymmetric broadband access markets and Ofcom's assessment is that they are unlikely to be able to easily enter the LL market within the timeframe of this review.

3.308 In any case, these operators would require relevant upstream inputs to backhaul traffic from their LLU exchanges. In the absence of regulation it would be unlikely that they could access additional relevant wholesale inputs (i.e. symmetric backhaul products) needed to begin supplying leased lines customers to impose an additional constraint.

3.309 Suppliers of asymmetric broadband services that do not use LLU might be ready to supply retail leased lines if they could have access to the wholesale symmetric inputs. However in absence of wholesale regulation, the requisite inputs would not be available and this type of substitution would not be possible.

3.310 Ofcom considers that supply-side substitution does not arise in the absence of wholesale remedies.

Proposed market definition

3.311 The above demand-side and supply-side substitution analysis leads Ofcom to consider that asymmetric broadband services would not put a competitive constraint on the pricing of retail leased lines in the absence of regulation of wholesale leased line markets. Therefore retail leased lines and asymmetric broadband services are in separate markets. On the other hand, Ofcom considers that symmetric broadband services are closer substitutes to digital SDH/PDH services, such that they should be included in the traditional interface market.

Issue 5: Bandwidth breaks (for specific services)

3.312 Ofcom has considered the extent to which retail leased lines at different bandwidths are substitutes from an economic perspective.

3.313 Given Ofcom's proposal that separate retail markets for traditional and alternative interface circuits remain, it is necessary to assess the bandwidth distinctions for both these services. For the purposes of analysing potential bandwidth breaks for different service, Ofcom has focused on demand-side analysis, based on likely competitive prices of different bandwidths.

Technical definitions

3.314 Traditional interface retail leased lines are currently available at a number of bandwidths, based on bearer capacity these are primarily:

- 64kbit/s and multiples thereof up to 31 x 64Kbit/s;
- 2Mbit/s;
- 34 and 45 Mbit/s; and
- 140 and 155Mbit/s
- 622 Mbit/s

3.315 Alternative interface retail leased lines are currently available at the following bandwidths:

- 10 Mbit/s
- 100 Mbit/s
- 1 Gbit/s
- 2.5 Gbit/s
- 10 Gbit/s

3.316 This section therefore considers the potential bandwidth breaks that might exist in this review.

2003/04 Review

3.317 In the 2004 market review, bandwidth breaks were specified on the basis of an analysis of competitive, cost-related prices. For the UK excluding Kingston upon Hull, Ofcom found there to be separate markets for low, high and very high capacity retail traditional interface leased lines and a single market for retail alternative interface leased lines. Ofcom identified two breaks in the chain of substitution between traditional interface retail leased lines of different bandwidths, namely above 8Mbit/s and above 155Mbit/s.

Comparison of functionality

3.318 Products which are substitutable from a functional perspective are at least potentially close demand-side substitutes. Ofcom's view is that, in terms of pure functionality, multiples of low bandwidth circuits are in the majority of cases substitutes for circuits of higher bandwidth and vice versa[45].

Demand-side substitution

3.319 Substitutability in terms of functionality is not sufficient, to demonstrate that two products are sufficiently close demand-side substitutes to be defined as being in the same market. That would require that a hypothetical monopolist was constrained not to set prices significantly above the competitive level by switching between them.

3.320 So, for example, the use of multiples of lower bandwidth traditional interface circuits must be economic for retail customers, in order for it to constrain the hypothetical monopolist of higher bandwidth circuits.

3.321 Ofcom has examined the likelihood of substitution of traditional interface leased lines of lower capacity by traditional interface leased lines of higher capacity and vice versa. For this exercise, cost oriented wholesale (service based PPC charges (based on the annualised cost of providing for one local end) have been assumed to be a reasonable proxy for the relative differences in retail prices at their competitive level. The reason for this is that competition at the retail level is expected over time to drive retail leased line prices in close relationship to their wholesale input prices.

3.322 For AI, service-based WES prices have been used. However, Ofcom has considered further the underlying costs of Ethernet circuits, as available evidence from BT's financial statements suggest that there are a number of costs common to Ethernet circuits at different bandwidths such that differences in wholesale input prices might reflect decisions over the allocation of those common costs rather than differences in the incremental costs of provisioning those services. On this basis, Ofcom has also undertaken a comparison of Ethernet services based on BT's underlying costs of provisioning those services.

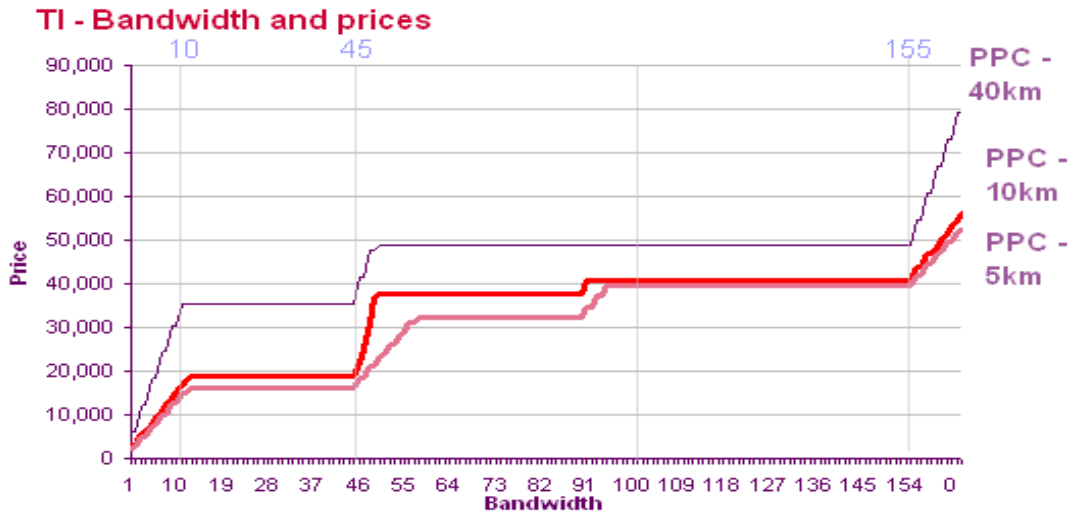
Price comparison – traditional interface

3.323 Figure 7 below provides comparative price information on different bandwidths of traditional interface services based on BT's wholesale PPCs for the UK outside of

[45] However there may be some costs associated from moving from a single circuit to multiple bonded circuits which are likely to require the use of more complex and expensive CPE to implement the bonding.

the London area BT refers to as the Central London Zone ("CLZ"), where it applies differentiated charges for some leased line services.

Figure 15: Competitive price estimates for digital SDH/PDH (non-CLZ)



Source: Ofcom 2007

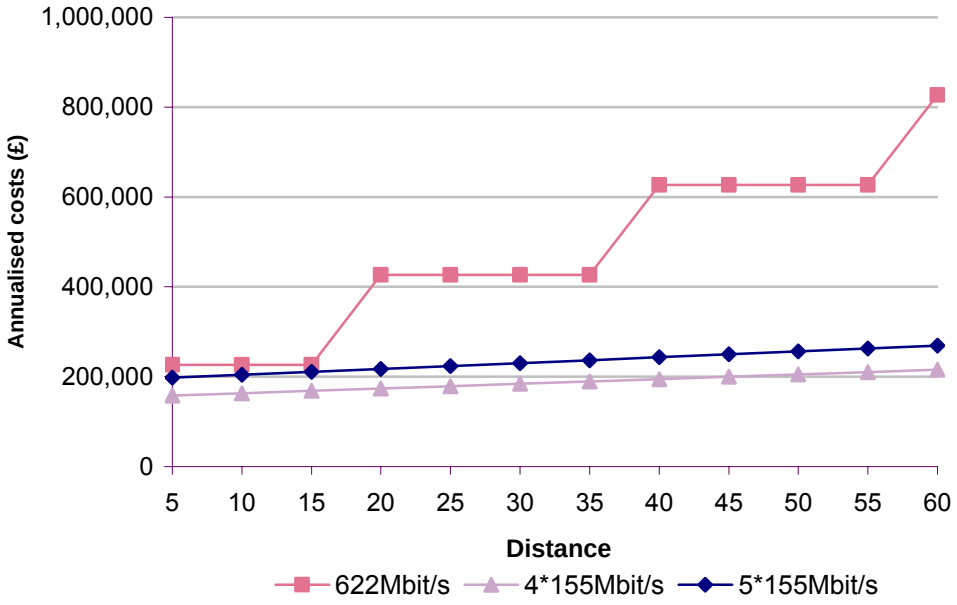
3.324 The results are shown in Figure 7 present in summary form the theoretical combination of circuits that would provide the cheapest way of delivering a particular bandwidth requirement at different distances. For example, a user requiring 100Mbit/s would be likely to purchase a 155Mbit/s circuit. At low bandwidths up to around 10Mbit/s, a user could use multiples of 2Mbit/s circuits to deliver their bandwidth requirements (rather than using the next bandwidth increment of 34 Mbit/s).

3.325 Ofcom's interpretation of price analysis set out in the Annex is that bandwidth breaks exist at around 8Mbit/s, 34/45Mbit/s and 155Mbit/s as shown by the "steps" in the above chart. The smoother the increase in the (total) price as total bandwidth increases, the more likely it is that circuits of different bandwidths fall in the same market. Whereas in the above analysis there appears to be clear steps. The analysis points to the existence of three distinct markets:

- Low bandwidth: up to and including 8Mbit/s
- High bandwidth: above 8Mbit/s, up to & incl. 45Mbit/s
- Very high bandwidth: above 45Mbit/s

3.326 Figure 8 below also shows a comparison of 155 Mbit/s versus 622 Mbit/s circuits and shows that multiple 155 circuits could in theory constrain the price of 622 circuits (indeed 5*155 circuit would nominally offer more than 750Mbit/s of capacity and at a lower price than 622Mbit/s circuit).

Figure 16: 155 versus 622 Mbit/s circuits



Source: Ofcom 2007

3.327 There appear to be large differences between the price of a 622Mbit/s circuit and that of multiple 155Mbit/s circuits at longer distances. However, the majority of circuits purchased are over shorter distances, where prices are more clearly consistent with the existence of a common pricing constraint. Given that Ofcom is not required to review high bandwidth retail markets, and the fact that for the 622Mbit/s market the volumes are extremely small (for example BT recorded only one circuit sale in 2006 at the wholesale level), it would not be practicable in any case for the purposes of SMP assessment to identify a separate market for 155 and 622Mbit/s services.

Sensitivity analysis

3.328 The above price comparisons are reliant on a number of assumptions regarding the construction of a PPC service. This includes the relative length of trunk and terminating elements charged for; assumptions about utilisation; and distances used. Ofcom has undertaken sensitivity analysis, which generally tends to confirm that the above bandwidth breaks are robust to changing assumptions, given that the retail demand at these distances tends not to be very high. In summary, changing assumptions have the following impacts (in terms of magnitude and directionality):

- **Trunk and terminating assumptions**: the above analysis is based on assumptions regarding the average length of the terminating segments of 2km outside of the CLZ. Hence, the analysis assumed that for longer distances, the trunk network will be used to an extent depending on the relevant distance of the overall circuit. The impact of increasing the length of terminating segments, holding the end to end distance constant, would be to reduce the price of a PPC as the distance related charge on trunk is higher. However, only under extreme assumptions would it be likely to vary the position of the bandwidth breaks.

- **Utilisation assumptions**: if the current purchaser of a leased line has a peak capacity requirement less than 100% of its capacity, it might be cheaper for them

to use multiple lower bandwidth circuits. Ofcom's sensitivity analysis considered whether different utilisation rate assumptions would impact on the above market definition. The results show that for 2Mbit/s to constrain a 34Mbit/s circuit would require utilisation levels of 35% (i.e. a maximum capacity requirement of 12Mbit/s or below).

- For 34/45Mbit/s versus 155Mbit/s, if users only required utilisation of 60% of the latter over very short distances (i.e. if users of a 155Mbit/s bandwidth circuit require peak capacity of less than 100Mbit/s of bandwidth) there might be substitution opportunities (i.e. users could instead switch to multiple 34/45 circuits). At longer distances, this would require that users had peak utilisation rates of 40% of capacity, which appears unrealistic. Therefore, a small proportion of 155Mbit/s users might find 34/45Mbit/s cheaper following a SSNIP, however the proportions involved are unlikely to impose a sufficient constraint on a SSNIP imposed across 155Mbit/s circuits at all distances.

- **Distance**: leased line pricing generally contains fixed connection and rental elements and distance related rental fees. Depending on the relative balance of these charges, the incentive to substitute from higher to lower bandwidths could therefore (in principle) vary, depending on the distances used. Ofcom's overall assessment is that across all distances the bandwidth split results are generally robust. It is generally only for very short or very long distance circuits that the balance of charges has the potential to affect the switching decision. Given the low level of retail demand for very short and very long distance circuits this factor is not likely to be material to Ofcom's conclusions.

3.329 Therefore the above analysis is therefore generally robust across a plausible range of assumptions.

Price comparison – alternative interface

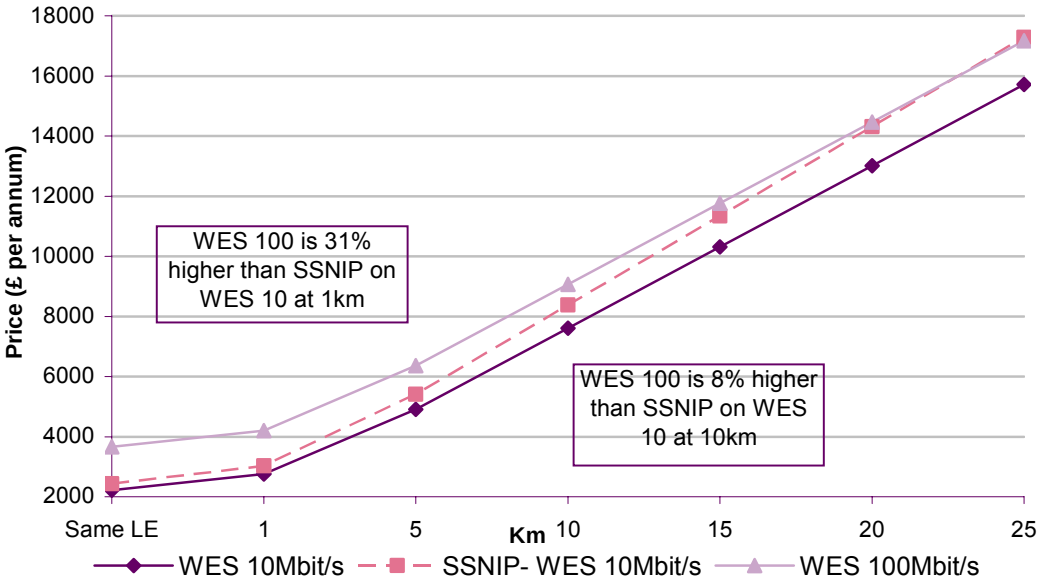
3.330 Ofcom has considered whether relative prices suggest that different bandwidth Ethernet products are in the same market. It has made pricing comparisons using BT/ Openreach's standard published prices for wholesale AI (WES) product and on the basis of the underlying costs of provision supplied to us in May 2007 which may be more likely to reflect the competitive level of prices. The comparisons based on published prices are presented first. There is no distinction between WES pricing for CLZ and non CLZ and so the graphs set out below would apply to a comparison of pricing throughout the UK.

3.331 The analysis below has been carried out on WES costs structured as follows: each circuit consists of one local end and a main link. The price for one local end includes a connection fee which has been amortised over three years[46], as well as an annual rental cost. In addition, there is a main link annual rental charge per metre, calculated on the radial distance between the local serving exchanges. As WES circuits have a maximum distance of 25km, with the exception of WES Extended Reach (ER) which has a maximum distance of 35km, the comparison has been made over these distances.

[46] The analysis was also carried out with connection costs amortised over 1,2 and 5 years but this does not make any difference to the results discussed below. There is no trunk/terminating distinction on WES products, therefore no trunk/terminating ratio assumptions or sensitivity analysis were needed in relation to the WES price analysis.

3.332 The Figure below presents information on the relative price of BT's Ethernet 10 and 100 Mbit/s leased lines and also plots the SSNIP-adjusted price of the 10 Mbit/s product alongside this data.

Figure 17: Comparison of Ethernet 10 and 100Mbit/s circuit prices



Source: Ofcom 2007

3.333 Based on the pricing of WES circuits the above figure suggests a break in the market for WES 10 and 100 Mbit/s circuits. Only at longer distances (where Ethernet has very limited reach) would it be likely that a SSNIP might prompt switching to a 100 Mbit/s Ethernet circuit from a 10 Mbit/s circuit. Indeed, as the majority of circuits are purchased at distances of up to 10 km there would appear to be a fairly clear break between 10 and 100 Mbit/s circuits suggesting that 100Mbit/s circuit would not constrain the price of a 10Mbit/s service. For a user with demand for capacity between 10Mbit/s and 100Mbit/s, it seems clear that a 100Mbit/s circuit will be cheaper than multiple 10Mbit/s circuits at almost any distance and that this would not be affected by a SSNIP. Ofcom undertook a similar comparison of WES pricing between 100 and 1 Gbit/s circuits which suggests a similar result (i.e. separate markets for 100 and 1 Gbit/s circuits).

Costs associated with wholesale inputs

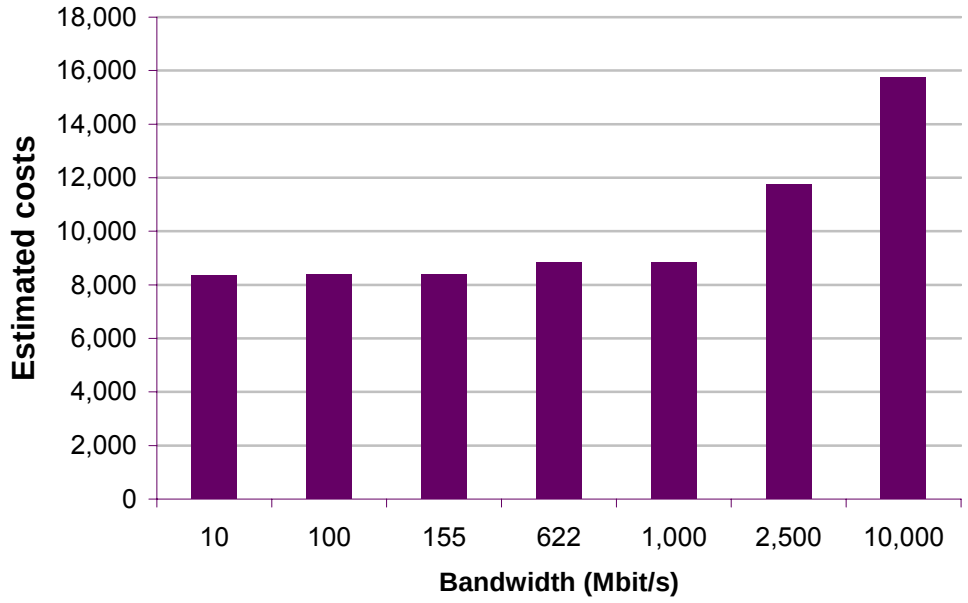
3.334 The above pricing comparisons using BT's WES prices would suggest separate markets at every bandwidth increment. This would be a change from the conclusions of the last market review. However, Ofcom has undertaken a further assessment of likely wholesale input pricing. This is because, unlike with TI leased line products, the ongoing cost of Ethernet circuits does not appear to vary as significantly with bandwidth.[47] Further the one-off costs associated with installing an AI line do not vary significantly depending on whether a high or low bandwidth AI line has been installed. A consequence of this is that even 2 WES 10 circuits would be more expensive than a WES 100 over 1km. This is because AI circuits are

[47] This is because the costs of duct and fibre, which are generally invariant with higher bandwidth, form a very high proportion of the total cost of provision of Ethernet services provided over fibre pairs even at very high bandwidths.

currently supplied on the basis of one fibre (or pair of fibres) per circuit with no opportunity for infrastructure sharing (other than duct) at any point over the length of the circuit. This is in contrast to TI circuits which employ multiplexers to allow different segments of the circuit to share fibre and electronics with other circuits in an optimal fashion.

3.335 This suggests that the above WES pricing for different bandwidths may be primarily the result of commercial pricing decisions, reflecting consumer willingness-to-pay, rather than a reflection of cost differences between the different bandwidth services. Ofcom has used fully attiributed cost data supplied by BT Openreach in May 2007 to derive estimates of the cost of providing wholesale Ethernet circuits[48] across different bandwidths. The fully allocated cost estimates are set out in Figure 18 below.

Figure 18: Comparison of estimated WES costs across different bandwidths



Source: Ofcom 2007

3.336 The results show that, up to and including 1Gbit/s, the variations in cost per circuit are not significant, on the other hand there appears to be a step change in the costs of provisioning 2.5 and 10Gbit/s. In the case of bandwidths up to 1Gbit/s the common costs such as digging and ducting and fibre tend to dominate and the differences in equipment costs are fairly limited[49]. In the case of bandwidths of 2.5Gbit/s and 10Gbit/s the above cost differences appear to reflect differences in costs of providing these services relative to other bandwidths, principally due to differing equipment costs.

3.337 On this basis, this cost data is suggestive of a break between 2.5Gbit/s and 1Gbit/s as the differences between equipment costs are sufficiently significant that a competitive provider would be expected to price to reflect these differences. A

[48] We assumed that the circuit comprises of two connections, two local end rentals as well as 3.9 kilometres of main link. We have annualised costs over 5 years with no allowance for the time value of money.

[49] Reference to common costs refer only to costs that do not vary by bandwidth, that is the cost of digging and duct etc which can be used to support circuits of all bandwidths and are common to all the circuits contained in the duct. This is in contrast to other general overheads which would be common to a wider range of services.

SSNIP would be unlikely to prompt switching from 1Gbit/s to a higher bandwidth service. It would also not be economic to use multiple 1Gbit/s circuits if a SSNIP were imposed on the higher bandwidth service.

3.338 On the other hand the above cost analysis does not suggest further breaks in the market at 1Gbit/s and below. Indeed in the presence of a large common cost component with costs generally invariant to bandwidth (e.g. the cost of duct which is shared by circuits of different bandwidths) there is a more general question about the relevant benchmark for the competitive prices.

Market up to & including 1 Gbit/s

3.339 In a competitive market with such a cost structure (i.e. large amounts of Ethernet costs invariant by bandwidth) it would be expected that competing providers would be likely to provision the full portfolio of bandwidths as it is likely to be efficient for an operator to provide circuits of all bandwidths rather than concentrating on a subset of bandwidths. The most efficient way of recovering common costs is likely to be by means of prices which reflect demand conditions as well as incremental costs of provision. This could mean that, in a competitive market in which all operators supplied AISBO circuits of various bandwidths, price differentials between circuits of different bandwidths might be greater than suggested by incremental cost differences, as they may depend on differences in willingness to pay.

3.340 In the case of identifying possible breaks in bandwidth markets, the question is whether it would be possible to monopolise a particular bandwidth range (i.e. low bandwidths) such that a break might be found to exist in that market. However, if the basis for considering market definition is a “competitive price” benchmark derived on the basis of cost allocation decisions which are in turn based on an assessment of competitive conditions in that market then this becomes a rather circular process. It may in fact be preferable (where common costs tend to dominate) to instead move directly to a consideration of homogeneity of competitive conditions across bandwidths.

3.341 Assessing variations in competitive conditions is a departure from the methodology used in relation to TI circuits, but Ofcom considers that this is explicable as price differences for TI circuits are likely to reflect cost differences underlying the provision of different bandwidths. As discussed at the beginning of this Section, market definition is not an end in itself. The definition of the scope of the relevant economic market is carried out in order to identify the products and the geographic area over which an assessment can be made of operators’ ability to act to an appreciable extent independently of competitors, customers and consumers i.e. whether there are any operators that hold a position of SMP within a particular market.

Variations in competitive conditions

3.342 The reasons for variations in competitive conditions between low bandwidth alternative interface and high bandwidth services are likely to arise from significant sunk costs and economies of scale which are likely to act as a barrier to competitive entry. In the absence of regulation, it is likely that retail competitors to BT would be reliant on self-supply or interconnection with OCPs in order to compete. Given that a significant proportion of the costs of entry would need to be sunk the question is whether these barriers are more or less likely to be overcome at different bandwidths such that variations in competitive conditions might be observed.

3.343 In the case of higher bandwidth AISBO services the much higher revenues likely to be associated with 2.5Gbit/s services suggests that CPs would be able to offset associated investment risks associated with high sunk costs. In the case of high value retail services the CP would face relatively higher certainty that any investments sunk in the provision of a single retail contract could be recovered over the duration of the contract. At lower bandwidths, due to the dominance of common costs, operators need to be present across a wider set of bandwidths to take advantage of possible economies of scope and scale. Therefore in order to compete effectively the CP would need to ensure a larger volume of sales over a particular timeframe, which may limit the scope of competition as it makes the prospect of entry riskier (i.e. the CP would need to secure multiple contracts in order to compete).

3.344 The above discussion therefore suggests that CP's may be able to compete more intensively for higher bandwidth services. Indeed, this potential basis for variations in competitive conditions is also supported by BT's retail market shares. BT's retail national market share for low bandwidth AI services is 72% compared to 13% for high bandwidth AI services.

3.345 The above analysis suggests that, for the purpose of assessing SMP, two separate AI markets might be considered, one for circuits up to and including 1Gbit/s and the other for circuits over 1Gbit/s. This has been informed primarily by the cost comparisons but is also supported by the likely variations in competitive conditions. For the purpose of assessing SMP, Ofcom considers that it is not appropriate to identify a further break in the market at low bandwidths for Alternative Interface markets as there is no compelling evidence of significant variations in competitive conditions at these bandwidths.

3.346 It should be noted that the above comparisons that inform a break at 1Gbit/s are based on BT's current network costs. As discussed in relation to "Issue 2" above within the timeframe of this review BT is likely to roll-out an Ethernet infrastructure, which may fundamentally change the cost structures that inform the above bandwidth comparisons. Ofcom has therefore included a forward looking assessment below.

Forward-looking assessment

3.347 Within the timeframe of this review BT plans to roll-out a DWDM-based backhaul network ("Project Orchid"), which may fundamentally change the cost structures. It is likely that BT's provisioning of Ethernet and other backhaul services will move from dedicated point to point circuits to network-based provisioning of that capacity with capacity reserved across a number of backhaul networks based on high capacity DWDM backhaul rings in a manner similar to that in which TI circuits are provisioned now. On this basis, it is likely that BT will have a large amount of fixed common costs to allocate between different services. The incremental costs of providing additional bandwidth will not vary significantly and the competitive pricing of bandwidth would tend to reflect the opportunity costs of providing other bandwidths over the same capacity.

3.348 Ofcom has not sought to determine the precise costs associated with this network roll-out as these costs would require detailed forecasting. It is likely however that the provisioning costs over this network would generally continue to be broadly invariant to bandwidth. Nevertheless, it is unclear that even if Ethernet is increasingly based on a networked topology that this will fundamentally change the incremental costs of provisioning very high bandwidths. This would rely on BT or

other CPs prospectively sinking large costs into very large capacities. Whereas it appears likely (at least in terms of BT's roll-out plans) that there will still be sufficiently large differences in the incremental costs of provisioning higher bandwidth services.

3.349 Therefore, Ofcom considers that at least for the duration of this market review that the break between low bandwidth and high bandwidth AI services is appropriate.

3.350 The analysis of prices and underlying costs set out above suggests that it is appropriate to define a number of distinct markets for circuits of different bandwidths, as follows:

- For TI circuits: the analysis indicates that the boundary between the markets for high and for very high bandwidth TI circuits should now be set at 45Mbit/s, rather than 155Mbit/s as in 2004. In other words, very high bandwidth circuits should be defined as those with bandwidths above 45Mbit/s, rather than above 155Mbit/s as previously.

- For AI circuits: the analysis indicates that there is a clear distinction between AI circuits at bandwidths above 1 Gbit/s and those at 1 Gbit/s and below. These differences appear unlikely to be eroded on a forward looking basis. On this basis, Ofcom proposes to define a market for low bandwidth AI services up to and including 1Gbit/s and a market for high bandwidth AI services above 1Gbit/s for the purposes of assessing SMP.

End-user research

3.351 In general terms, bandwidth was rated among the most important service features (33% rated it business critical / 55% very important). Going forward, end-users ranked upload/download speeds as the most important characteristics. In other words, bandwidth was regarded as of high and increasing importance.

3.352 Responses to the SSNIP question suggested that between 19-22% switchers were prepared to compromise on bandwidth, a higher proportion than some other characteristics. Therefore, although bandwidth is among the most important service features there appears to be some willingness to compromise on this service characteristic in response to relative price changes.

3.353 However, it also appears that this willingness may have been limited to relatively small sacrifices in bandwidth. When presented with switching options respondents tended not to compromise on bandwidth which might indicate as their first preference that they would prefer to remain on similar speed services. This is reinforced by the higher overall importance that respondents placed on bandwidth now and going forward.

3.354 Although only indicative, the results of the survey suggest that respondents rarely compromised on bandwidth (although they sometimes would select higher bandwidth services when compromising or switching to other services). It is therefore likely to be appropriate to define a number of separate markets, differentiated by bandwidth, as Ofcom proposes. The survey results do not, by themselves, allow more precise conclusions to be drawn.

Switching costs

3.355 Ofcom does not consider that switching costs would be a material issue as changes to bandwidth would not entail any additional costs other than relevant changes to Customer Premises Equipment associated with any upgrades. This should already be factored into our assessment of service-based charges/costs used in the demand-side comparisons above. Therefore, there are no further one-off costs associated with switching between different bandwidths.

Supply side substitution

3.356 Ofcom notes that suppliers of leased lines generally supply circuits at a variety of bandwidths. Hence, if the current suppliers of low bandwidth traditional interface circuits were treated as a "hypothetical monopolist" this would include all significant suppliers currently also providing higher bandwidth traditional interface circuits, and vice versa.

3.357 Switching on the supply side from one bandwidth to another would not therefore constitute new entry or an additional competitive constraint. Therefore, such suppliers are not relevant to supply-side substitution since they supply services already identified as demand-side substitutes.

3.358 Ofcom has therefore concluded that there is no supply-side substitution between the higher and lower bandwidth traditional interface leased line markets.

Proposed market definition

3.359 Ofcom proposes the to define the following markets:

TI circuits:

- A market for low bandwidth TI circuits up to and including 8Mbit/s
- A market for high bandwidth TI circuits above 8 Mbit/s and up to and including 34/45 Mbit/s
- A market for very high bandwidth TI circuits above 34/45 Mbit/s

AI circuits:

- A market for low bandwidth AI circuits up to and including 1Gbit/s
- A market for high bandwidth AI circuits above 1 Gbit/s.

Ofcom bases this conclusion on:

- The analysis of prices and underlying costs which suggests significant differences in the competitive price of circuits on either side of the above bandwidth break points
- The survey evidence which suggests that there is some, but only limited, willingness to compromise on bandwidth in response to a SSNIP
- the lack of supply-side substitution possibilities.

Issue 6: Wave Division Multiplexing services

3.360 Wave Division Multiplexing (WDM) is a technology that can be deployed to provide transmission of multiple wavelengths of light over short or long distances using wave division multiplexers. It increases the data carrying capacity of optical fibre by simultaneously operating multiple wavelengths over a single optical fibre.

3.361 The last market review found WDM services, including BT's Wavestream, to be upstream of the wholesale leased lines market and therefore outside the scope of the review. However, Ofcom considers it is relevant to understand developments in the retail market for these services which may impact on the market definition.

Technical definitions

3.362 Wave Division Multiplexing (WDM) increases the data carrying capacity of optical fibre by simultaneously operating multiple wavelengths over a single optical fibre pair[50]. WDM services can be used to provide transmission of multiple wavelengths of light over short or long distances using wave division multiplexers. There are three broad types of wave division multiplexers available:

- Coarse Wave Division Multiplexer (CWDM): CWDM uses lower frequency lasers and a wide spread of frequencies to enable transmission of up to 18 wavelengths over distances up to 60km;
- Dense Wave Division Multiplexer (DWDM): DWDM uses higher frequency lasers and a lower range of frequencies in order to enable transmission of up to 32 to 128 wavelengths nation-wide;
- Ultra Dense Wave Division Multiplexer (UDWDM): UDWDM, meanwhile, uses high frequency lasers and a very narrow spread of frequencies to carry a greater number of wavelengths.

3.363 CWDM is therefore the relatively cheaper and more cost effective for certain applications where fewer wavelengths and/or smaller transmission distance is needed. The distinguishing characteristics of the WDM technology are:

- WDM based access circuits are mainly used for very high bandwidth requirements such as data warehousing, and Storage Area Networking (SAN) applications;
- WDM (currently) uniquely, supports multiple delivery of different interfaces;
- Each wavelength can be used to supply SDH/PDH, Ethernet, or other protocols such as Fibre Channel, Fibre Connection (FICON) or Enterprise Systems Connection (ESCON) providing flexibility;
- WDM based access can provide a combination of Metropolitan area ring and longer haul city-to-city connectivity to meet resilience requirements between sites such as data centers and head offices; and
- Once installed the ability to add additional wavelengths can be achieved very quickly by service providers and the actual incremental costs due to additional service cards whilst not insignificant are compensated by the rapid and flexible provisioning.

[50] This is likely to be single fibre pair although single fibre working might be possible

The 2003/04 Review

3.364 The last market review acknowledged that a market for WDM was starting to emerge, but was still in its infancy, especially for retail services where WDM was deployed over a point to point fibre architecture to deliver high bandwidth services directly to end users.

3.365 In any case, the last market review found WDM services to be upstream of the wholesale leased lines market and therefore outside the scope of the review. The decision was based on the following findings:

- WDM can be used to deliver both AI and TI services; and when employed to support the delivery of those services, it is characterised more as a technological input into a service, rather than a service in itself;
- WDM was characterised as an input in the same way as copper or fibre, therefore upstream of all wholesale markets; however, because of its early stages of development, regulation was not necessarily warranted.

Market definition assessment

3.366 At the time of last market review, WDM based retail services were beginning to be offered by BT, under the product name Wavestream. Since then, BT's Wavestream services have grown and also other providers have started to offer WDM-based services to end users.

3.367 The analysis of the current distribution of WDM services shows that at the end of 2006, there were 688 WDM-based retail circuits in the market. While in absolute volume terms the number of services in the market is not sizeable, it is in terms of bandwidth and revenue.

3.368 On the basis of the above developments it is necessary to consider WDM services against AI and TI leased lines based on three broad areas:

- a qualitative assessment, which starts with comparison of the functionality of the WDM and AI and TI leased lines;
- demand-side substitution analysis based on relative prices and SSNIP analysis for WDM and leased line services; evidence on market trends and usage of WDM services; and an assessment of possible switching costs.
- Supply-side substitution.

3.369 These issues are considered in turn below.

Comparison of functionality

3.370 There are some characteristics that are unique to WDM-based services and that SDH/PDH and Ethernet circuits cannot match:

- WDM-based retail services provide the ability to quickly and economically add a variety of high bandwidth circuits. The time frame required to change the configuration of the service is a function of the commissioning and installation of cards in the equipment at each end (and would be in the order of a few days) as the existing fibre circuit will be used. For both SDH/PDH and Ethernet circuits,

new fibre circuits must be added, where existing capacity is fully utilised, which is costly and will have a far longer lead time;

- WDM-based retail services allow for the delivery of Fibre Channel, FICON and ESCON interfaces which are not available as AI or TI circuits; and

- WDM-based services allow for the delivery of long range AI services: with BT's *Wavestream*, for example, it is possible to order national gigabit Ethernet, which is not possible with the distance limited WES services.

3.371 The analysis of the characteristics and functionality of WDM-based retail services suggest that very high bandwidth TI and AI leased lines can replicate some, but not all of the functionality of WDM services.

3.372 More importantly, given the distribution of the current demand, AI and TI high bandwidth leased lines are not able to provide the right combination of range, bandwidth and characteristics that most end users are demanding for this segment of the market. For example, the analysis of current circuit volumes shows the following distributions for WDM services:

- Bandwidth: over 80% of total circuits are 2.5G and above (in excess of 90% are 2.5G circuits)

- Range: 69% of circuits are above 25 Kms; 31% are up to 25 Kms (10% up to 10 Kms).

3.373 Assuming that the distribution of the circuits sold is representative of the actual demand under competitive conditions, it is clear that for most of the current end users of WDM-based services the WDM market is addressing a particular segment of the market in terms of the combination of bandwidth and range. For high bandwidth AI and TI leased lines these services cannot provide the same combination of range and bandwidth. AI is constrained on distance and TI on bandwidth.

3.374 One other key differentiator is the ability to economically and quickly add extra high bandwidth connectivity once the end user has purchased an initial service. Hence, an end-user with a high and very quickly growing demand for bandwidth will value services that can add bandwidth quickly at a relatively low cost per additional circuit.

3.375 This flexibility or scalability is potentially a key differentiator between WDM services and other services. The following demand-side substitution analysis considers price differences between AI and TI services and Wavestream over various bandwidths in order to determine whether scalability and other functional differences might be sufficiently significant.

Demand-side substitution

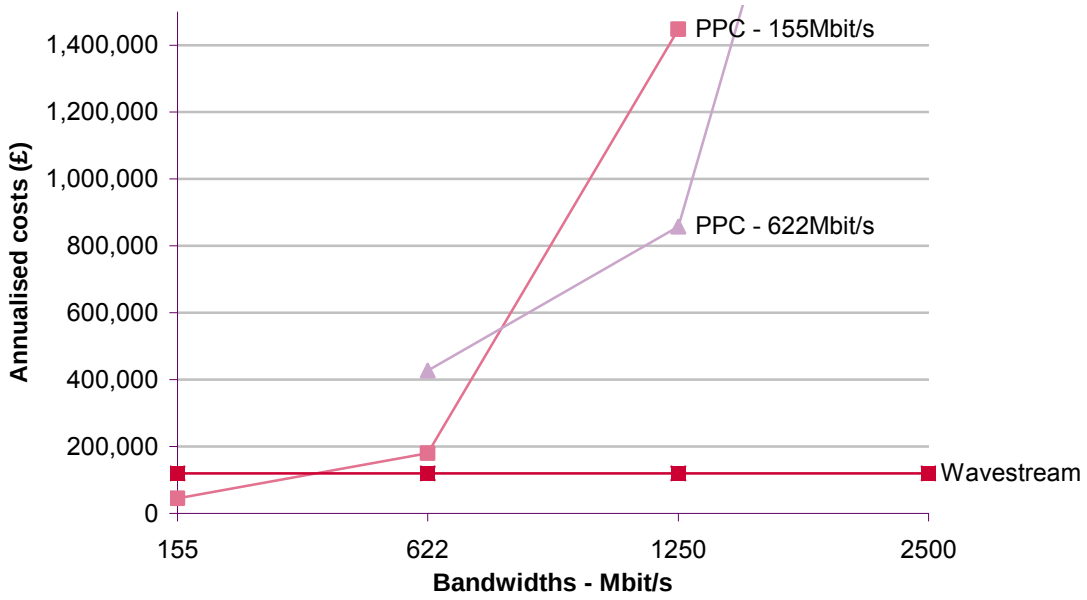
3.376 The following assessment considers whether at very high bandwidths users would consider AI and TI high bandwidth circuits to provide an economic substitute for WDM-based retail services or vice versa.

Price comparisons

3.377 Ofcom has compared the price of BT's Wavestream services with the AI and TI equivalents: WEESs and Megastream services respectively.

3.378 The analysis compares the price of Wavestream Connect with high bandwidth TI Megastream circuits from BT. The analysis compares 155Mbit/s and 622Mbit/s (based on available prices) against Wavestream services. Since most of the market for Wavestream is above 30 Kms, the reference product is for 25 Kms circuits[51]. The comparison is also made on the basis of multiple circuit requirements. In particular, given that flexibility of adding extra wavelengths at a low cost is a key requirement, Ofcom considers how much the price of Wavestream moves as you add wavelengths incrementally as compared to delivering via the addition of 155Mbit/s and 622Mbit/s SDH/PDH services.

Figure 19: Comparison of WES cost based on BT cost allocations



Source: Ofcom 2007

3.379 The results for 155 SDH/PDH circuits show that as wavelengths are added to deliver extra circuits, Wavestream becomes more economical. Hence at bandwidths at 622Mbit/s and above it can be seen that Wavestream represents the most economical solution. It is evident that if an end-user only required lower bandwidth (in the range of 155Mbit/s) then it would not be economic to utilise a wavestream service.

3.380 For 622 circuits, it would clearly be uneconomic to utilise a 622 circuit at any bandwidth. On this basis Wavestream is always cheaper, so a SSNIP on Wavestream would clearly not prompt switching to 622 SDH/PDH circuits. It is interesting to note in the context of the price comparison of 622Mbit/s that BT is selling relatively few 622 Mbit/s circuits at the retail level and there was extremely low take-up when these services were offered. Therefore, it may be the case that Wavestream services now address the demands of customers who might previously have used a very high bandwidth TI circuit.

3.381 The above price comparison of Wavestream against 155 Mbit/s SDH/PDH circuits supports there being a separate market for Wavestream – where Wavestream

[51] For higher distances, the price of Megastream grows proportionally more than the price of Wavestream

services are addressing the very high bandwidth market (this is even without considering the ability of Wavestream services to offer the ability to add incremental capacity cheaply).

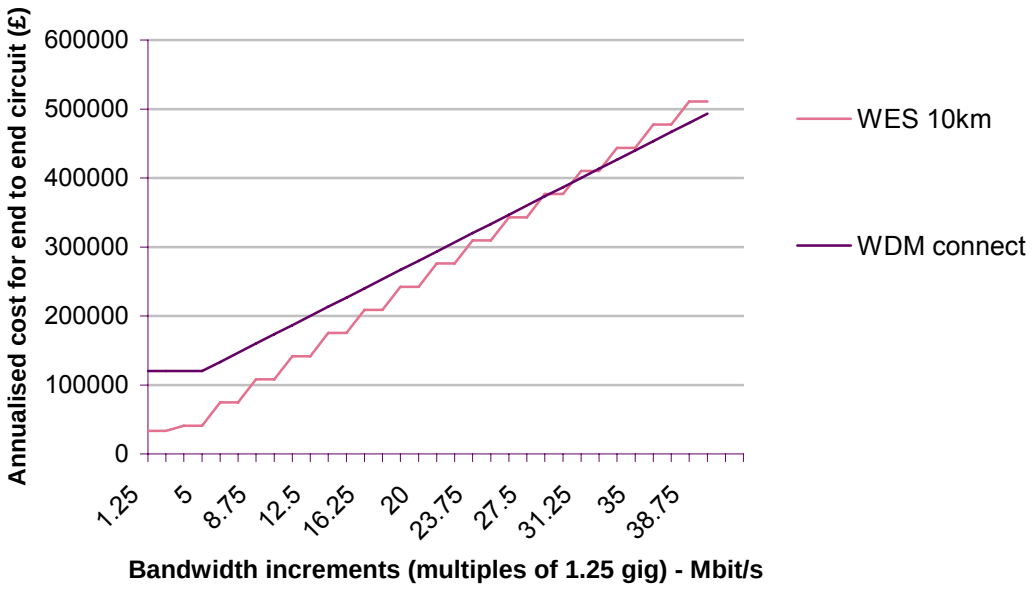
3.382 From the above chart, there could be a point where if sufficient numbers of users were grouped around a requirement for bandwidth at (2*155) that this could place these services in the same market. (i.e. users would have a choice between using multiple 155Mbit/s circuits or Wavestream services). However, as over 80% of total circuits are 2.5G and above (in excess of 90% are 2.5G circuits) it is suggestive that the majority of users are unlikely to have capacity requirements as low as 2*155Mbit/s.

Does the price of AI high bandwidth leased lines constrain the demand for WDM-based retail services?

3.383 Figure 20 below compares the cost of adding connectivity using multiple Ethernet Gigabit circuits versus the cost of adding incremental bandwidth to a Wavestream Connect service. This analysis is based on the price of a WEES (i.e. an end-to-end WES service) used as a proxy for the competitive price of a retail end-to-end Ethernet gigabit circuit.

3.384 The analysis below shows the costs of adding different bandwidth increments in 1.25 Gbit/s increments. An illustrative circuit length of 10 Kms has been used for the comparison given that that the majority of Ethernet circuits are purchased at those distances (or below). The results are not likely to be sensitive to the distance assumed.

Figure 20: Comparison of WES cost based on BT cost allocations



Source: Ofcom 2007

3.385 The above results show that Wavestream prices are at a premium compared to Ethernet circuits. Hence, a SSNIP on Ethernet lines would be insufficient to prompt end users to switch to Wavestream service.

3.386 The market trend data in Annex 5 shows that a relatively large number of high bandwidth users are on Wavestream services. The question is therefore why would users on Wavestream services wish to pay such a large premium over Ethernet services? The price gap can be explained in part by the cost of the WDM equipment and the premium the end user is willing to pay for the added functionalities it needs. The above price comparisons could reflect in particular the ability to add bandwidth quickly.

3.387 Ofcom notes however that the price gradient associated with Wavestream services is much steeper than might be suggested by the costs of provisioning incremental bandwidths. As discussed above, the addition of new wavelengths entails the installation of new cards compared to entirely new circuits in the case of Ethernet. Indeed the price gradient for BT's previous Wavestream pricing was much flatter, potentially better reflecting the relatively low incremental costs of provisioning additional bandwidth.

3.388 Ofcom has not presented this price analysis based on previous pricing here, but this analysis tended to show that from bandwidth requirements of 10Gbit/s and above Wavestream would attract relatively lower additional costs such that starting at a lower bandwidth requirement and adding flexibility cannot be matched by providing services using Ethernet circuits. Ofcom considers that this would provide a better benchmark for the relative costs of Wavestream and Ethernet services and would tend to support a separate retail market for Wavestream.

End-user research

3.389 Due to very low sample sizes for very high bandwidth users and the fact that only two users had Wavestream services; Ofcom has not considered evidence from the end-user research in relation to the assessment of WDM services.

Switching costs

3.390 Ofcom does not consider that switching costs would be a material issue as changes to WDM would not entail any additional costs other than relevant changes to Customer Premises Equipment associated with any upgrades, i.e. the addition of new service cards. This will already be factored into our assessment of service-based charges/costs used in the demand-side comparisons above. Therefore, there are no further one-off costs associated with switching between different services.

Supply side substitution

3.391 It is likely that providers of WDM services already present in the market for SDH/PDH and AI services as WDM can be used as an input into those markets. On this basis, switching on the supply side from the provision of SDH/PDH or AI services to WDM would not constitute new entry or an additional competitive constraint. Therefore, such suppliers are not relevant to supply-side substitution since they supply services already identified as demand-side substitutes. On the other hand there are a number of providers of AI and TI services that do not currently supply WDM services.

3.392 However, in the absence of wholesale regulation, Ofcom considers that supply-side substitution at the retail level is unlikely, because the costs of local access to a new site that would be incurred by a new entrant are significant and include sunk costs, such as digging and ducting. WDM services require a transparent end-to-end

optical path unlike TI/AI leased lines where individual TI/AI circuits can be used as wholesale inputs. As the WDM requires such optical paths (generally) over longer distances this suggests only those with a large network would be able to provide it without having to incur significant sunk costs.

3.393 Ofcom has therefore concluded that there is no supply-side substitution between these markets.

Proposed market definition

3.394 Based on the results of our analysis, we conclude that WDM-based retail services are not part of either the very high bandwidth AI or TI markets, and are therefore not included in the leased line markets which are the subject of this market review. This proposed conclusion is based on the following evidence:

- TI and AI circuits cannot provide all the functionality of a WDM circuit, in particular it is possible to increase the capacity of an existing WDM circuit quickly and at low incremental cost;
- WDM circuits are likely to be priced at a premium under competitive conditions; suggesting that they will be used largely by customers who need the enhanced functionality described above;
- The lack of supply-side substitution possibilities

Retail market definition conclusions (in the absence of wholesale regulation)

3.395 Ofcom has concluded from the above analysis that the following relevant product markets exist in the UK (in the absence of wholesale regulation) for retail leased lines:

- low bandwidth traditional interface retail leased lines (including analogue circuits and digital circuits at bandwidths up to and including 8Mbit/s);
- high bandwidth traditional interface retail leased lines (at bandwidths above 8Mbit/s up to and including 45 Mbit/s);
- very high bandwidth traditional interface retail leased lines (at bandwidths above 45 Mbit/s);
- low bandwidth alternative interface retail leased lines (at bandwidths up to and including 1Gbit/s); and
- High bandwidth alternative interface retail leased lines (at bandwidths above 1Gbit/s).

Retail market definition (in the presence of upstream wholesale SMP regulation)

3.396 The purpose of this section is to assess whether the retail market definitions derived above change if wholesale remedies based on a finding of SMP in those wholesale markets are taken into account. This is necessary only for the retail markets where Ofcom has reviewed to assess whether any additional regulatory remedies are required for this retail market (i.e. retail low bandwidth traditional interface markets).

3.397 For the purpose of this section it is assumed that cost oriented PPCs are available on regulated terms and conditions for markets. These wholesale remedies do not affect the conclusions above about demand-side substitution. The possible impact on supply-side substitution is discussed below.

Issue 1: Retail leased lines: analogue and digital SDH/PDH distinction

3.398 The presence of wholesale regulation by means of PPCs is not expected to modify the conclusion of the analysis carried out in the absence of any regulation, given that it was already concluded that analogue and low bandwidth digital leased lines are in the same relevant market, based on demand side considerations. This relatively broad market could not be narrowed any further by the presence of PPC regulation at the wholesale level.

Issue 2: traditional interface retail leased lines vs alternative interface retail leased lines

3.399 Ofcom's view is that the presence of wholesale regulation by means of PPCs (or indeed cost oriented trunk segments or AISBO) does not modify the conclusion of the analysis carried out in the absence of any regulation.

3.400 As described previously, the demand side analysis is unaffected since the availability of cost based wholesale inputs would not affect consumer preferences.

3.401 On the supply side, the presence of wholesale regulation could make it easier for suppliers of one symmetric data service (SDH or Ethernet-based) to enter the supply of the other. This is because existing suppliers of one product (e.g. Ethernet-based alternative interface retail leased lines) might use wholesale inputs (such as PPCs), in order to offer the other product (e.g. traditional interface retail leased lines). However, all the major suppliers of alternative interface products are also suppliers of traditional interface retail leased lines and cannot therefore be considered a new and additional competitive constraint on the hypothetical monopolist.

3.402 The market defined in the absence of regulation is therefore not broadened by considering the impact of upstream regulation.

Issue 3: Leased lines and VPNs

3.403 The presence of wholesale regulation could make it easier for suppliers of other symmetric data services to enter the supply of retail leased lines. This is because existing suppliers of other symmetric data products might then purchase leased line wholesale products, such as PPCs, in order to offer retail leased line products. However, almost all existing suppliers of other symmetric data products are also suppliers of retail leased lines and cannot therefore be considered a new and additional competitive constraint on the hypothetical monopolist.

3.404 Ofcom is therefore of the view that the other existing suppliers of other symmetric data products, if any, are not in a position to impose a competitive constraint on the hypothetical monopolist. This is why Ofcom considers that in the presence of the proposed wholesale remedies, supply-side substitution between retail leased lines and other symmetric data products is not present.

3.405 The above considerations show that in the presence of the proposed wholesale remedies, retail leased line services and other symmetric data services are in separate markets.

Issue 4 : Leased lines versus broadband services

3.406 The introduction of wholesale remedies is not expected to modify the conclusion of the demand side substitution analysis. This is because the demand-side substitution analysis is not influenced by the presence or absence of PPC regulation at the wholesale level.

3.407 The presence of wholesale regulation could make it easier for suppliers of asymmetric broadband services to enter the supply of symmetric broadband services and of leased lines in particular. This is because existing suppliers of asymmetric broadband services might then purchase leased line wholesale inputs, such as PPCs, in order to offer leased lines.

3.408 In the case of broadband service providers, Ofcom's market review of Wholesale Broadband Access identified a number of "Principal Operators" that were the main LLU operators in the provision of broadband access. In general all of these providers are present or have related undertakings present in leased lines markets. Therefore, there is, in general, a limited number of broadband providers not already present in leased lines markets. Any supply side substitution from broadband would be on a limited scale such that it is unlikely to impose a sufficient additional constraint.

3.409 This is particularly likely to be the case as Ofcom has identified factors that are likely to limit the speed at which these asymmetric broadband services suppliers can enter the supply of leased lines and win customers from the existing suppliers. Such factors reduce the strength of the competitive constraint these potential entrants would impose on the hypothetical monopolist in case of a SSNIP, so that they do not satisfy the criteria for supply-side substitution. These factors are of two types: factors affecting the time needed to acquire and organise PPCs in a network capable of delivering retail leased lines, and factors influencing the time needed to attract a sufficiently large number of customers. The latter relates to the various barriers to switching (e.g. contract lengths, customers averse to forgoing volume discounts, customer inertia) and barriers to expansion identified as part of the market power assessment in Section 7. The former type of factor refers to the lead times needed to acquire PPCs and Point of Connection (POC) equipment, that can last up to 110 working days if there has been appropriate forecasting or 165 working days in the absence of forecasting, i.e. more than 7 months. In addition, for a new entrant there would be the time needed to organise these wholesale inputs in a functioning network and to start offering commercial services.

3.410 For a class of new entrants to constitute supply side substitutes, it is necessary that they would be able to enter sufficiently quickly and at sufficiently low cost to make a SSNIP by the hypothetical monopolist in leased lines unprofitable. The above considerations show that this requirement is not fulfilled by potential entrants into leased lines from asymmetric broadband services. The possibility of entry into retail leased lines by such suppliers is, however, included as part of the assessment of market power (under criteria such as potential competition and entry barriers).

3.411 Ofcom concludes, therefore, that in the presence of the wholesale remedies, retail leased lines and asymmetric broadband services are in separate markets.

Issue 5: Retail leased lines bandwidth distinctions

3.412 As noted above, consideration of demand-side substitution has identified two break points in the chain of substitution from the lowest (including analogue) to highest bandwidth traditional interface retail leased lines.

3.413 In the light of Ofcom's proposed wholesale regulation for trunk and traditional interface symmetric broadband origination segments, it is appropriate to investigate whether or not the availability of traditional interface symmetric broadband origination at cost oriented prices is likely to alter the previous conclusion on market definition. The focus of this analysis is on supply-side substitution, since the (non-) existence of wholesale regulation does not influence demand-side issues in this case.

3.414 A hypothetical monopolist supplier of low bandwidth traditional interface leased lines is not constrained by supply-side substitution from a higher bandwidth supplier because there is no supplier that only sells high bandwidth leased lines. In other words, all high bandwidth suppliers are also likely to be low bandwidth suppliers and vice versa. Supply-side substitution is therefore not relevant.

Issue 6: Retail WDM services

3.415 Ofcom's view is that the presence of wholesale regulation by means of PPCs (or indeed cost oriented trunk segments) for low bandwidth digital SDH/PDH leased lines would not affect our conclusion in relation to retail WDM services.

Retail product market conclusions (in the presence of regulation)

3.416 Ofcom has concluded from the above analysis that the following product markets exist in the UK (in the presence of wholesale regulation) for retail leased lines:

- low bandwidth traditional interface retail leased lines (including analogue circuits and digital circuits at bandwidths up to and including 8Mbit/s);
- high bandwidth traditional interface retail leased lines (at bandwidths above 8Mbit/s up to and including 45 Mbit/s);
- very high bandwidth traditional interface retail leased lines (at bandwidths above 45 Mbit/s);
- low bandwidth alternative interface retail leased lines (at bandwidths up to and including 1Gbit/s); and
- High bandwidth alternative interface retail leased lines (at bandwidths above 1Gbit/s).

Question 1: Do stakeholders agree with our proposed retail market definition? In particular, do you agree that separate markets continue to exist for traditional interface and alternative interface retail leased lines?

Question 2: Do stakeholders believe that there is evidence that might support an alternative view?

Section 4

Retail geographic market definition

Introduction

4.1 Section 3 set out our approach to market definition and defined the various retail product markets relevant to this market review. This Section now defines the geographic scope of the relevant retail markets. It begins by setting out our general approach to geographic market definition and then develops an analytical framework, building on the approach adopted in our Disaggregated Markets discussion document, published in March 2006. We then go on to define the relevant retail geographic markets for each of the retail product markets defined in Section 3.

Disaggregated markets discussion document

4.2 In March 2006 we published a discussion document on the extent to which there was evidence of geographic variations in competitive conditions in the various leased lines product markets in the UK. In the discussion document we set out an analytical framework for making the assessment. In defining the scope of the relevant geographic markets in this market review we have built on the analytical framework set out in the Disaggregated Markets discussion document and have taken into account the responses which we received to that discussion document.

Geographic market definition

4.3 The principles of demand-side and supply-side substitution also apply to the definition of the geographic scope of the relevant economic market. However, rather than considering alternative products, the analysis assesses the effect on demand of the relevant product in the geographic area being considered if there is a relative price change in a narrow geographic area. If the products in the relevant product market in other areas are sufficient substitutes, such as to render the price rise unprofitable then the geographic scope of the relevant market is widened to include these additional areas. Similar principles apply in relation to supply-side substitution. It can also be appropriate to consider whether there exist geographic variations in competitive conditions, common pricing constraints and chains of substitution. As explained below, we consider that in the context of geograohic market definition of the various retail markets defined in Section 3, geographic variations in competitive conditions and common pricing constraints are most relevant.

Geographic demand-side substitution

4.4 The question being asked in this assessment is whether the purchaser of retail leased lines services would purchase the service from another geographic area if faced with a local SSNIP by a hypothetical monopolist, to the extent that it would render the SSNIP unprofitable. If the SSNIP would be unprofitable then this other geographic area should be grouped with the original area being considered for the purpose of defining the relevant market.

4.5 However, retail leased lines, in keeping with communications networks more generally, have a fixed and pre-defined geographic presence. This means that a retail consumer would only be able to switch its demand to an alternative area if it is

willing to move to that alternative area. Thus, the relevant question is whether a sufficient number of retail customers would move location (business premise) in response to a SSNIP, such as to make the SSNIP unprofitable.

4.6 Given that the cost associated with moving location is likely to be significantly higher than the cost of a retail leased line SSNIP, it is reasonable to conclude that geographic demand-side substitution is either a very weak or non-existent constraint. This approach would therefore lead to the definition of very narrow markets from the demand-side, which is unlikely to be practical to analyse or be representative of competitive constraints that exist. We therefore conclude that in this case demand-side substitution is not relevant to assessing the geographic market definition.

Geographic supply-side substitution

4.7 The question being asked in this assessment is whether a supplier of retail leased lines who is operating in one geographic area would start supplying in another geographic area if this other area was exposed to a SSNIP by a hypothetical monopolist, to the extent that it would render the SSNIP unprofitable. If the SSNIP would be unprofitable then these geographic areas should be grouped together for the purpose of defining the relevant market.

4.8 In communications markets geographic supply-side substitution is generally considered to be a weak or non-existent constraint due to the high cost and long lead times associated with deploying new network infrastructure[52]. Therefore, similar to geographic demand-side substitution, we conclude that supply-side substitution is not relevant to assessing the geographic market definition[53].

Variations in competitive conditions

4.9 Also relevant is paragraph 56 of the European Commission's Guidelines on market analysis and the assessment of market power, which states that in cases where there is a sufficient degree of variety in competitive conditions between areas (what a sufficient level might be is not specified), distinct local markets should be defined:

> *"According to established case-law, the relevant geographic market comprises an area in which the undertakings concerned are involved in the supply and demand of the relevant products or services, in which area the conditions of competition are similar or sufficiently homogeneous and which can be distinguished from neighbouring areas in which the prevailing conditions of competition are appreciably different. The definition of the geographic market does not require the conditions of competition between traders or providers of services to be perfectly homogeneous. It is sufficient that they are similar or sufficiently homogeneous, and accordingly, only those areas in which the conditions of competition are 'heterogeneous' may not be considered to constitute a uniform market."*

[52] Note that the market definition is being conducted on the assumption that there is an absence of wholesale regulation, thus we cannot assume that there exist wholesale products which would allow a retailer to supply-side substitute at the retail level.

[53] In considering competitive conditions below we have taken account of the distance by which an operator would be prepared to build out its network in order to reach a particular premise.

4.10 Therefore, different geographic areas are found to be in the same relevant geographic markets to the extent that:

- competitive conditions in different areas are sufficiently homogeneous; and
- the area can be distinguished form neighbouring areas where the competitive conditions are appreciably different.

4.11 In light of the unsuitability of using demand-side and supply-side substitution to defining the geographic scope of the relevant markets, we have analysed the extent to which there exist geographic variations in competitive conditions to inform our market boundary assessment. As noted above, this is consistent with the approach set out by the European Commission in its SMP Guidelines, in particular at paragraph 56.

4.12 When assessing the geographic scope of a market on the basis of the homogeneity of competitive conditions it is normal practice to start with a narrow definition (small area) and then to see how this can be augmented. This raises the question of what geographic unit should be used for the geographic market assessment. That is, what is the smallest unit of area to be considered and how should it be defined?

4.13 In some cases there will be an interaction between these two questions. However, in the first instance, the question relating to what constitutes an appropriate geographic unit will be considered in isolation. Following this the factors that should be used to identify similar conditions of competition will be considered.

Common pricing constraint

4.14 A factor that is sometimes an additional consideration when defining the scope of product and geographic markets, in addition to demand-side and supply-side substitution, is whether there exist common pricing constraints across customers, services or areas such that they should be included within the same relevant market even if demand-side and supply-side substitution are not present. For example, it might be the case that a common pricing constraint exists where an operator or operators sets a uniform national price which results in the competitive pressure in one area being transmitted to other areas.

Chains of substitution

4.15 Both the product market and the geographic market can be affected by chains of substitution[54] which have the effect of broadening the relevant economic market. Because of the limitations associated with the use of demand-side and supply-side substitution when applied to leased lines markets (discussed below), chains of substitution are likely to be of limited relevance.

[54] A chain of substitution may exist for example where a customer would not travel from location A to location C to purchase a product and avoid a SSNIP, but would travel to location B. This may suggest that locations A and B are in the same geographic market but location A is in a separate geographic market from location C. However, if there are customers in location B who would travel to location to C to purchase a product to avoid a SSNIP in location B, then this may suggest that locations B and C are in the same market. Because of a chain of substitution between locations A and B and locations B and C, locations A and C would be defined in the same geographic market.

Overview of demand and supply for leased lines services

4.16 Demand for wholesale leased lines services is largely derived from demand for retail business connectivity services, therefore before considering demand and supply at the wholesale level (which we do in Section 6), it is necessary to consider it at the retail level. Retail business connectivity services are purchased by multi-site business customers to provide telecommunications capacity between the different business sites. These can take a number of different forms, supported by different technologies but have the common characteristic that they have multiple ends, the geographic location of which will be different (for example different floors in a building, different areas of a city, different cities in a country or different countries).

4.17 This geographic dimension to business connectivity services means that within the product definition there is also an inherent geographic element in that the retail product links at least two geographically distinct locations. In the simple case of a single retail leased line, this would be two geographic areas; one at each end.

4.18 On the supply-side, a retail service provider would be able to provide a service in those geographic locations where it has network, or where it is able to secure provision of wholesale inputs from a third-party supplier (as long as the retail service provider was able to interconnect with the wholesaler)

Retail Geographic market definition

4.19 In Section 3 we defined five separate retail products (in the absence of wholesale regulation) which are relevant for this market review. These were:

- low bandwidth traditional interface retail leased lines (including analogue circuits and digital circuits at bandwidths up to and including 8Mbit/s);
- high bandwidth traditional interface retail leased lines (at bandwidths above 8Mbit/s up to and including 45 Mbit/s);
- very high bandwidth traditional interface retail leased lines (at bandwidths above 45 Mbit/s);
- low bandwidth alternative interface retail leased lines (at bandwidths up to and including 1Gbit/s); and
- High bandwidth alternative interface retail leased lines (at bandwidths above 1Gbit/s).

4.20 This part of this Section now considers what the appropriate retail geographic market definition is for these retail product markets. These retail definitions will then be used to inform the definition of the relevant wholesale markets for this review.

Analytical framework

4.21 As set out in Section 3 there are a number of analytical tools which can be deployed when defining the geographic scope of the market. As with the definition of the product market it is usual to start by considering demand-side and supply-side substitution. However, as noted above we conclude in this case that demand-side and supply-side substitution is not relevant to defining the scope of the relevant geographic market. We also consider that chains of substitution are not relevant to our analysis of leased lines markets.

4.22 One tool which we consider could be useful is the presence of common pricing constraints. In the context of geographic market definition, common pricing constraints can lead to pricing pressures which exist in one geographic area being transmitted to other areas. As such it could be appropriate to define the boundary of the geographic market as the areas in which the common pricing constraint exists. In the Hull area, KCOM is the incumbent operator and where it is required to publish its prices it sets a common price for all of its leased line/ business connectivity services. Further consideration is given to this approach for each of the markets below.

4.23 Finally, identifying those areas where there are sufficiently homogeneous conditions of competition is also an appropriate method for identifying the boundary of leased lines markets. This will help to ensure that we are able to define the market in such a way that we can tailor appropriate regulatory solutions where they are required. This is consistent with the approach of the Commission and Ofcom of market definition being a means to an end and not an end in itself, where the end is to identify whether ex-ante regulation is required or not.

4.24 In the 2003/04 LLMR Ofcom concluded that the Hull area was a distinct geographic market from the rest of the UK partly on the basis that KCOM was by some distance the biggest communications provider, with a much wider network reach than other providers throughout the Hull area. This remains the case and as such Ofcom continues to consider that the Hull area constitutes a separate geographic market from the rest of the UK in each of the retail product markets defined in Section 3. The precise definition of the Hull area is provided in the Notification in Annex 15 below.

What geographic unit should be used when assessing variations in competitive conditions?

4.25 As explained in the Disaggregated Markets discussion document, there is a variety of geographic units available to Ofcom for conducting its geographic analysis. At one extreme, and in keeping with the view that retail customers are unlikely to move business premises in response to a SSNIP, it could be concluded that the geographic unit should be individual premises, i.e. each business premise would be considered separately. We have estimated, based on the Experian Business Database that in the UK there are about 154,000 individual business premises which would be interested in using leased lines products and therefore such an extreme position may be impractical. We therefore need to consider a more practical building block. Table 8 below sets out some options for possible geographic units and identifies the approximate number of units needed to cover the entire UK.

4.26 When selecting an appropriate geographic unit it is likely that there will need to be a trade-off between granularity and practicality. Using individual business premises would certainly allow a very granular assessment to be conducted, but obtaining accurate data, conducting the analysis and specifying/implementing the findings is likely to be impractical. On the other hand, the geographical unit selected needs to be capable of mapping the local competitive constraints that exist in the market and in effect this means that the unit should not be so large as to arbitrarily mix together areas that have heterogeneous competitive conditions. For example, using the nations and regions areas may seem to be attractive from a presentational point of view, but such large areas are likely to comprise very diverse competitive conditions within each area and as such their use would fail to capture the local competitive

conditions that are being assessed. Each of the options identified in Table XXX are discussed in more detail below.

Table 8: Geographic unit options

Option	Geographic unit	Number of units
1	Full postcode	c.1.8m
2	Premises	c.154k
3	Postal sector	c.10k
4	BT local exchanges	c.5.6k
5	BT Tier 1 node areas	67
6	Counties/metropolitan districts	c.70
7	Nations and Regions	12

Option 1 – Full postcode

4.27 Full postcodes represent an aggregation of a small group of premises that are geographically close to one another. The grouping of premises into postcodes is independent of any Communications Provider and technology and this may be considered desirable from a neutrality point of view. However, because of this independence it is possible that the competitive conditions will vary within a postcode. This is because network rollout will not necessarily follow postcode boundaries and thus there may be some premises within a postcode that have access to a certain service and others that do not. This type of misalignment is an inherent consequence of aggregating premises. However, from a practicality point of view, some level of aggregation will be necessary. Therefore, when selecting the geographic unit, Ofcom is mindful of this issue and aims to minimise any adverse affects. There is thus a trade-off between granularity/ precision and practicality.

4.28 With c.1.8 million postcodes in the UK this option is biased towards granularity in the trade-off between granularity and practicality, as the practical implications of handling c.1.8 million units are formidable.

Option 2 - Premises

4.29 The use of individual business premises would support very granular assessments and if implemented accurately would avoid the inadvertent mixing of consumers that face different competitive conditions. However, with what we esitimate to be approximately 154,000 individual business premises in the UK which may be expected to use retail leased lines services, obtaining accurate data, conducting the analysis and specifying/ implementing the findings is likely to be impractical and thus would not allow the identification of areas in which competition is sufficiently homogenous such that they may be considered distinct geographic markets.

Option 3 – Postal sector

4.30 Postal sectors represent an aggregation of a group of postcodes that are geographically close to one another, thus reducing the total number of geographic units needed to cover the UK. Compared with premises and postcodes their use would therefore be a move towards practicality in the trade-off between granularity and practicality.

4.31 As with postcodes, postal sectors also provide a technology neutral approach to aggregation. Greater aggregation means that there is a greater likelihood that competitive conditions will vary within any given geographic unit and/or that any variation will be larger. However, some variation has to be accepted as a natural consequence of trading-off granularity and practicality. With approximately 10,000 unique postal sectors in the UK use of postal sectors may represent a reasonable trade-off.

Option 4 – BT local exchanges

4.32 With approximately 5,600 individual exchanges, the use of BT's local exchange footprints offers about twice as much aggregation as postal sectors, but still offers a reasonable level of granularity. It therefore probably strikes a reasonable balance in the trade-off between granularity and practicality. However, this approach is not technology neutral as it has as its basis the network topology of BT. In addition, as with postcodes and postal sectors there is a likelihood that competitive conditions will vary within any particular BT exchange area as network rollout will not necessarily follow BT exchange area boundaries and thus there may be some premises within a BT exchange area that have access to a certain service and others that do not[55].

Option 5 – BT's Tier 1 node areas[56]

4.33 It could be appropriate to use BT Tier 1 node areas. This would give a greater degree of aggregation compared to groups of exchanges. However, similar to using BT exchange areas, this geographic unit would not be technology neutral as it is based on BT's network and there is a likelihood that competitive conditions will vary within any particular BT exchange area as network rollout will not necessarily follow BT Tier 1 node area boundaries i.e. it would not give a sufficient degree of granularity for a market assessment.

Option 6 – Counties/metropolitan districts

4.34 Counties and metropolitan districts represent an aggregation of a group of individual premises within that county/ district and as such offer a further level of aggregation. As with postcodes, individual premises and postal sectors (options 1, 2 and 3) it would provide a technology neutral approach to aggregation. Although there would be the benefit in terms of practicality as there would only need to be around 70 areas considered, there would be a larger issue with the lack of granularity. With greater aggregation there is a greater likelihood that the competitive conditions will vary within any given geographic unit and/or that any variation will be larger.

Option 7 – Nations and regions

4.35 This option would be similar to option 6 in that it would provide a technology neutral solution but would face the same problems associated with the level of aggregation and would not provide an effective means to test differences in competitive conditions.

[55] Note that in contrast to Ofcom's recent notification on the wholelsale broadband access markets where we found that competition is to a large extent based on operators providing competiting services using BT's local loops (that is, based on LLU) and so tends to be homogeneous within local exchange areas, competition in leased lines in the absence of remedies is based on investment in competing local access infrastructure. As such local exchange areas are not relevant to the geographic reach of leased lines competition.

[56] A BT Tier 1 node area is the geographic area in which leased lines are parented to a particular BT Tier 1 node.

Conclusion on geographic unit

4.36 In light of this discussion we consider that the most appropriate geographic unit for assessing the retail leased lines geographic market definition is postal sectors (Option 3). This is because this option provides a suitable trade-off between granularity and practicality. In particular this option provides a manageable number of units from which to conduct the analysis and the data is in most cases readily available from service providers.

Assessing geographic variations in competitive conditions

4.37 In conducting this analysis we have sought to build on the analytical framework developed in the Disaggregated Markets discussion document. In doing so we have used information from a variety of sources. This information can be summarised as follows:

- Data from service providers on the services which they provide at the retail level, including the geographic locations of the ends of these retail services;
- Consumer research; and
- Information on BT's pricing policies and how these may or may not vary by geography.

Retail service provision data

4.38 We requested that operators provide us with information on each of the retail circuits which they provide. For the purposes of retail market definition, this includes information on the postcode location of each end, the bandwidth of the circuit , whether the circuit is analogue or digital and the interface of the circuit (traditional interface or alternative interface).

4.39 With this information we have been able to identify the retail provider of each circuit and assign it to the relevant product market as defined above. From the geographic information we are then able to construct a picture of how geographic service shares vary on a geographic basis. In doing this we have followed the same methodology used in the Disaggregated Markets discussion document. This uses the postal sector as the basic geographic unit (or building block) for conducting the analysis.

Consumer survey evidence

4.40 The main purpose of the geographic element of the consumer research was to ascertain the extent to which consumers source their retail leased lines services from multiple suppliers. Because of the inherent geographic element of leased lines, in the absence of regulation requiring the provision of wholesale products, if there exist barriers to consumers purchasing leased lines from multiple suppliers this would limit the ability of operators to compete and restrict them to offering services only in areas where they are able to provide services on their own network.

4.41 The results of the consumer research conducted for this market review is generic across all of the relevant retail markets considered as the research did not ask whether the likelihood of a business using multiple suppliers is linked to the bandwidth purchased. In summary, the consumer research conducted has found that around half of businesses use more than one supplier to provide business

connectivity services, with the propensity to do so positively correlated with business size. Where a business uses multiple leased lines suppliers, the majority were found to use BT as one of the suppliers. Where a business uses only a single supplier just over half used BT.

4.42 We have also taken into account the consumer research we conducted for the Disaggregated Markets discussion document to inform our conclusions in this market review. In that consumer research we were able to include bandwidth specific questions.

BT pricing policies

4.43 The third element of the retail geographic analysis information is the pricing policies adopted by BT in each of the relevant retail product markets. It would be preferable to have the pricing policies of all operators in order to conduct a comprehensive analysis of geographic variations in competitive conditions. However, because retail leased lines are only one of a number of products sold by service providers to businesses and the fact that these tend to be priced on a bespoke basis, it is only possible to observe the retail prices of BT where it has obligations to publish these.

4.44 This information is relevant to our analysis as it can inform the extent to which there exists a common pricing constraint across geographic areas (see above). In circumstances where BT sets a national price within a particular product market (and it is not required to do so by existing SMP obligations) then this may indicate that there exists a national market.

4.45 In the same light, to the extent that BT sets prices which vary on a geographic basis then this may indicate that there are geographic variations in competitive conditions which BT is responding to by setting lower prices in some areas compared to others.

4.46 Annex 7 provide a detailed explanation of the analysis we have conducted to inform our geographic market definitions. The rest of this section now summarises that analysis and defines the scope of the retail geographic market for each of the retail product markets defined above.

Question 3: Do stakeholders agree with our proposed approach to geographic market definition?

Low bandwidth traditional interface retail leased lines (including analogue circuits and digital circuits at bandwidths up to and including 8Mbit/s)

4.47 As was noted in the Disaggregated Markets discussion document, the 2003/04 Review concluded that the retail low bandwidth traditional interface leased lines market was national (excluding the Hull area) and that this was based on national buying patterns where retail customers would buy these retail leased lines as a bundle, across geographic areas, such that buyers are concerned with the price of the bundle as a whole rather than being concerned with prices in different geographic areas. However, the 2003/04 Review also recognised that BT applied a distinct pricing scheme to the CLZ and that this pricing behaviour meant that it was unlikely that BT faced a national pricing constraint at the retail level.

Service share analysis

4.48 This analysis uses the data provided by operators on the retail leased lines services that they provide and involves estimating operators' shares of service provision in each of the postal sectors in the UK. The following two maps show the share of BT on a postal sector basis in this retail market. Figure 21 shows the UK as a whole and Figure 22 shows the London area. The outer black boundary line identifies the Central London Zone (CLZ) which is the area of London served by the 0207 dialling code. The inner black boundary line identifies the City of London administrative boundary.

Figure 21: Low bandwidth traditional interface retail leased lines service shares: UK

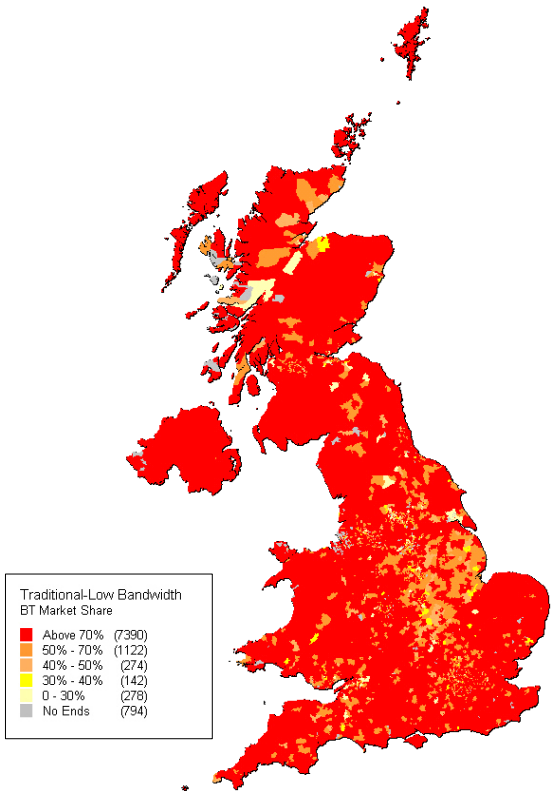
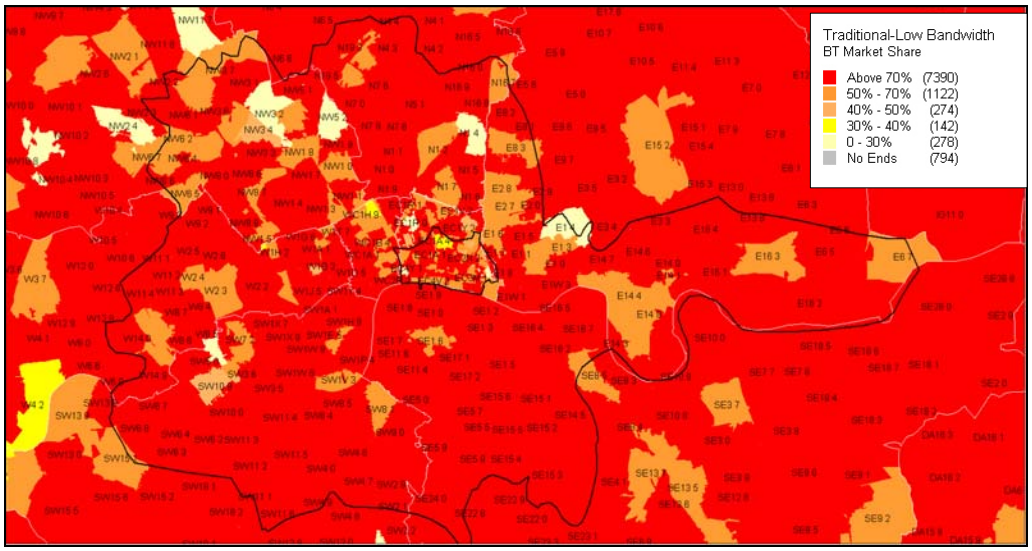


Figure 22: Low bandwidth traditional interface retail leased lines service shares: CLZ



4.49 These Figures show that BT's service share in this product market are reasonably uniform (in the vast majority of cases above 50%) throughout the UK, including and throughout London. This is indicative that competitive conditions are geographically relatively homogeneous in this retail product market.

Consumer survey evidence

4.50 The consumer research conducted for the Disaggregated Markets discussion document found that there was limited use of multiple suppliers by large businesses. Of the businesses that did use multiple suppliers, the research found that those buying low bandwidth leased lines were significantly less likely to use more than one supplier than those businesses buying high and very high bandwidth leased lines[57]. Where a business used multiple leased lines suppliers, just under half used BT as one of the suppliers. Where a business used only a single supplier over half used BT, with the next highest single provider being used by around 5% of businesses.

4.51 The consumer research conducted for this market review is summarised above.

4.52 The consumer survey evidence both from this market review and the Disaggregated Markets discussion document could suggest that, except for the largest of the large businesses, buying patterns suggest that it is important for businesses to be able to source low bandwidth retail leased lines from a single supplier. This could support a conclusion that suppliers of leased lines face competitive conditions on a national, or at least a very broad, geographic basis at the retail level.

BT pricing policies

4.53 BT currently prices some of its retail low bandwidth traditional interface leased lines circuits at a discount in the CLZ. To the extent that there are any variations in competitive conditions within the CLZ area then any benefits to end users (in terms of reduced prices from BT in response to increased competitive pressures) will be spread across the whole of the CLZ area and be of benefit to all end users within that geographic area. This could suggest that there is a break in the geographic scope of the market such that the market is not UK-wide and there could be a separate local market in the London area, which maybe could be defined by the CLZ boundary. However, BT is currently subject to retail regulation in this market which requires it to publish its prices. It is not clear that absent such regulation that BT would continue to price in the way it has historically. It may be expected that BT would price on a more bespoke basis, which is common practice amongst its competitors in this market and by BT itself in other retail leased lines markets where it is not under such regulatory obligations.

Conclusion on geographic market definition in the low bandwidth traditional interface retail leased lines market

4.54 The analysis of retail service shares and the consumer survey evidence suggests that the geographic scope of the low bandwidth traditional interface retail leased lines product market is national (excluding the Hull area). While there does exist differential pricing at the retail level with lower prices available in the CLZ which

[57] That is to say that large business buying high bandwidth and very high bandwidth leased lines were more likely to use multiple suppliers.

might suggest that there are different competitive conditions in the London area, we do not consider that this by itself is sufficient evidence to show that there exist sufficiently different geographic competitive conditions such that local markets should be defined.

High bandwidth traditional interface retail leased lines (at bandwidths above 8Mbit/s up to and including 45 Mbit/s)

4.55 The approach to the geographic analysis of the remaining retail product markets is similar to that explained above for the low bandwidth traditional interface retail market. Again, the 2003/04 Review concluded that this market was national in scope[58]. The main reasons for this were the same as those for the low bandwidth traditional interface retail market and as such we do not repeat them here. However, unlike in the low bandwidth market, as BT is under no obligation to publish its prices in the high bandwidth traditional interface retail leased lines market it is not possible to say whether it offers geographically differentiated prices.

Service share analysis

4.56 As with the low bandwidth market the following maps show the share of BT on a postal sector basis in the high bandwidth traditional interface retail market. Figure 23 shows the UK as a whole and Figure 24 shows the London area. Again, the outer black boundary line identifies the Central London Zone (CLZ) which is the area of London served by the 020 7 dialling code. The administrative boundary of City of London is shown in Figure 25.

[58] Although noting that there is a difference in the scope of the product definition in this market review. The LLMR included bandwidths of 155 MBit/s in the high bandwidth traditional interface retail market, whereas this market review finds those bandwidth circuits to be included in the very high bandwidth traditional interface retail market.

Figure 23: High bandwidth traditional interface retail leased lines service shares: UK

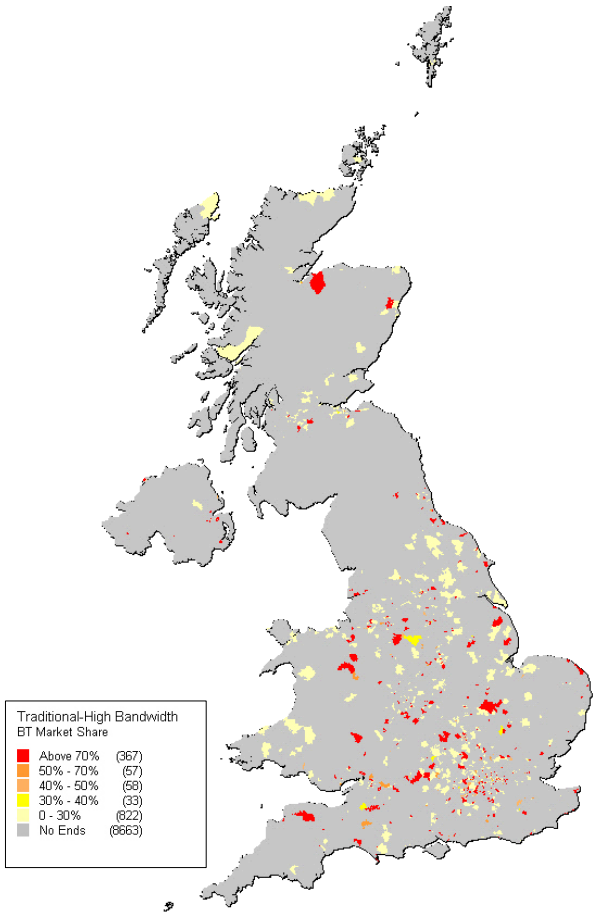


Figure 24: High bandwidth traditional interface retail leased lines service shares: CLZ

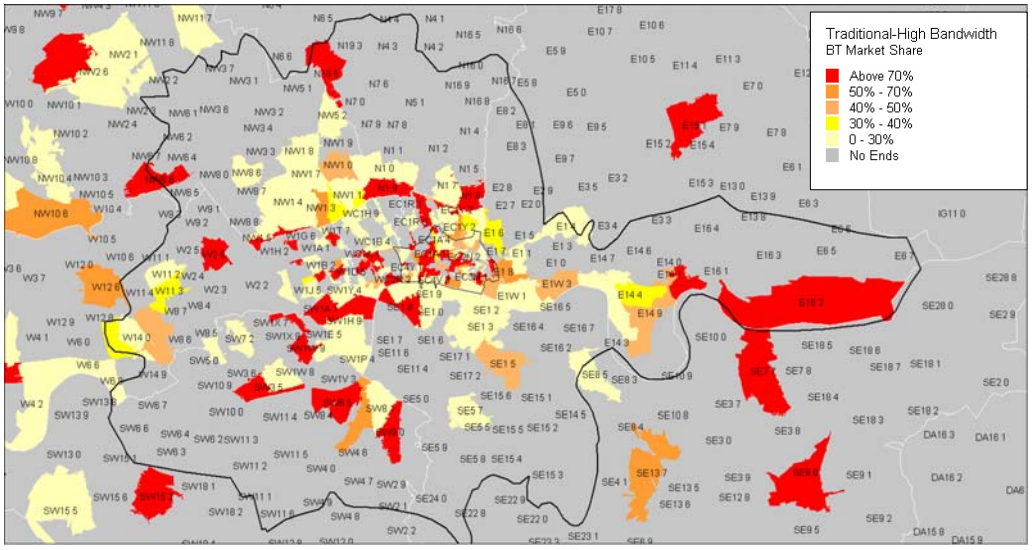
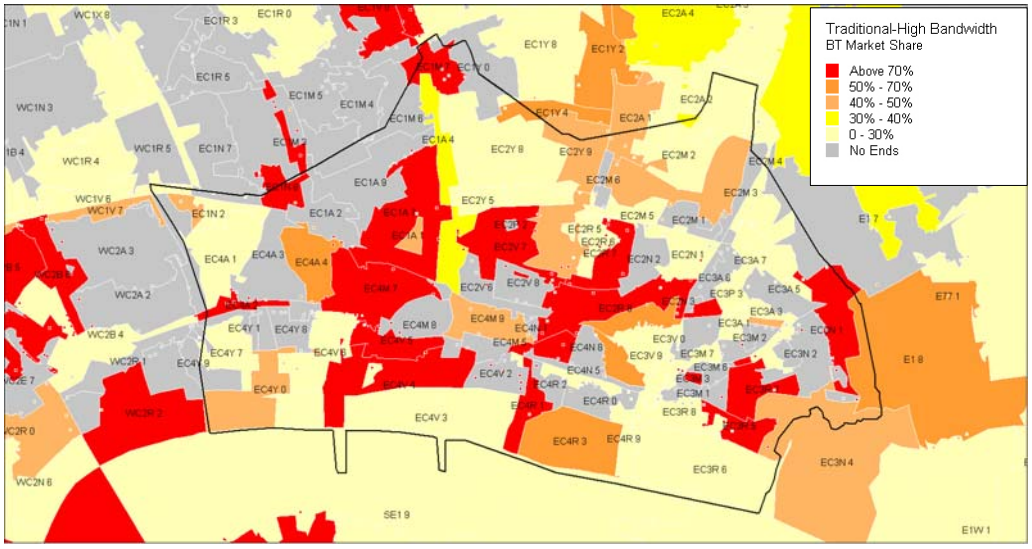


Figure 25: High bandwidth traditional interface retail leased lines service shares: City of London



4.57 These figures show that in those postal sectors where there is demand for high bandwidth traditional interface retail leased lines services there is significant variation in BT's service share. However, it must be borne in mind that we have calculated these service shares on the basis of retail market information which reflects the provision of regulated wholesale inputs. As such the picture may be different absent such upstream regulation. However, in the context of high bandwidth traditional interface circuits, this market review is concerned with the wholesale level. Therefore it is not necessary to come to a definitive view of the precise scope of the retail geographic market.

Consumer survey evidence

4.58 As noted above, the consumer research conducted for the Disaggregated Markets discussion document found that large businesses buying high bandwidth leased lines were more likely to use multiple suppliers than those buying low bandwidth leased lines.

4.59 The consumer research conducted for this market review is summarised above .

4.60 The consumer survey evidence both from this market review and the Disaggregated Markets discussion document could suggest that it is less important for businesses to be able to source high bandwidth retail leased lines from a single supplier. If this is the case this could reduce the strength of argument for finding that the scope of the retail geographic market is national in scope.

BT pricing policies

4.61 As noted above, BT is under no obligation to publish its prices in the high bandwidth traditional interface leased lines market it is not possible to say whether it offers geographically differentiated prices.

Conclusion on geographic market definition in the high bandwidth traditional interface retail leased lines market

4.62 The analysis of retail service shares and the consumer survey evidence is inconclusive on whether the geographic scope of the high bandwidth traditional interface retail leased lines product market is national (excluding the Hull area) or local in scope. However, as this market review, for the purposes of high bandwidth traditional interface services, is concerned with assessing the relevant wholesale markets, it is not necessary to come to a conclusion on this question. We analyse the appropriate wholesale market definitions in greater depth in Section 6 below.

Very high bandwidth traditional interface retail leased lines (at bandwidths above 45 Mbit/s);

4.63 The LLMR concluded that this market was national in scope[59]. The main reasons for this were the same as those for the low bandwidth traditional interface retail market and as such we do not repeat them here. However, as in the high bandwidth market, BT is under no obligation to publish its prices in the very high bandwidth traditional interface retail leased lines market so it is not possible to say whether it offers geographically differentiated prices.

Service share analysis

4.64 The following maps show the share of BT on a postal sector basis in the very high bandwidth traditional interface retail market. Figure 26 shows the UK as a whole and Figure 27 shows the London area. Again, the outer black boundary line identifies the Central London Zone (CLZ) which is the area of London served by the 020 7 dialling code. The administrative boundary of City of London is shown in Figure 28.

[59] Again noting that there is a difference in the scope of the product definition in this market review. The LLMR included bandwidths of 155 MBit/s in the high bandwidth traditional interface retail market, whereas this market review finds those bandwidth circuits to be included in the very high bandwidth traditional interface retail market.

Figure 26: Very high bandwidth traditional interface retail leased lines service shares: UK

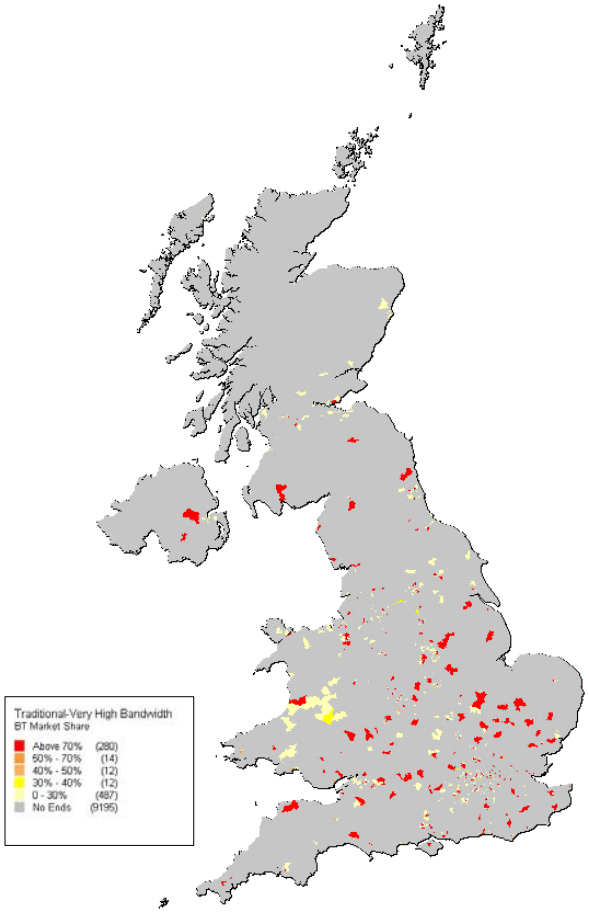


Figure 27: Very high bandwidth traditional interface retail leased lines service shares: CLZ

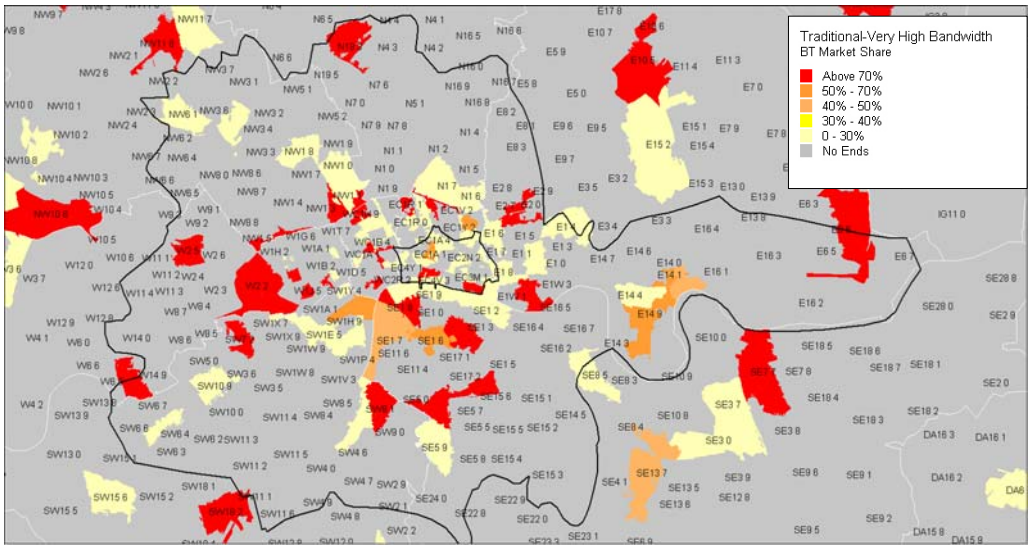
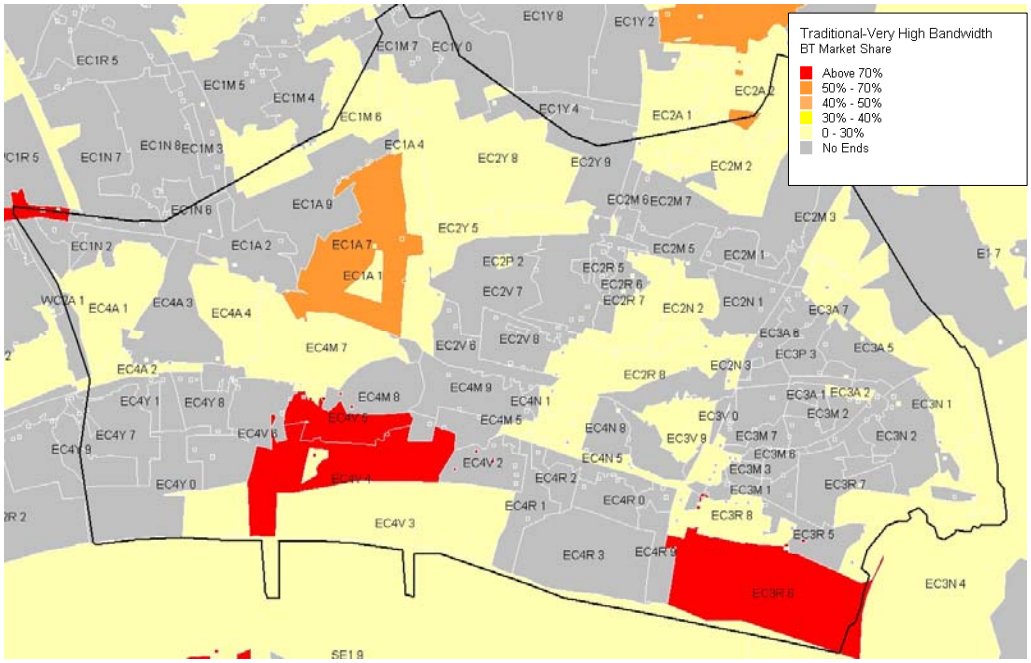


Figure 28: Very high bandwidth traditional interface retail leased lines service shares: City of London



4.65 These figures show that in those postal sectors where there is demand for very high bandwidth traditional interface retail leased lines services there is variation in BT's service share. However, as noted above, we have calculated these service shares on the basis of retail market information which reflects the provision of regulated wholesale inputs. As such the picture may be different absent such upstream regulation. However, in the context of very high bandwidth traditional interface circuits, this market review is concerned with the wholesale level. Therefore it is not necessary to come to a definitive view of the precise scope of the retail geographic market.

Consumer survey evidence

4.66 The consideration of the consumer survey evidence here is similar to that for the high bandwidth traditional interface retail market. As noted above, the consumer research conducted for the Disaggregated markets discussion document found that large businesses buying very high bandwidth leased lines, like those buying high bandwidth leased lines, were more likely to use multiple suppliers than those buying low bandwidth leased lines.

4.67 The consumer research conducted for this market review is summarised above.

4.68 The consumer survey evidence both from this market review and the Disaggregated Markets discussion document could suggest that, it is less important for businesses to be able to source very high bandwidth retail leased lines from a single supplier. If this is the case this could reduce the strength of argument for finding that the scope of the retail geographic market is national in scope.

BT pricing policies

4.69 As noted above, BT is under no obligation to publish its prices in the very high bandwidth traditional interface leased lines market it is not possible to say whether it offers geographically differentiated prices.

Conclusion on geographic market definition in the very high bandwidth traditional interface retail leased lines market

4.70 As was the case with the high bandwidth market, the analysis of retail service shares and the consumer survey evidence is inconclusive on whether the geographic scope of the very high bandwidth traditional interface retail leased lines product market is national (excluding the Hull area) or local in scope. However, as this market review, for the purposes of very high bandwidth traditional interface services, is concerned with assessing the relevant wholesale markets, it is not necessary to come to a conclusion on this question.

Low bandwidth alternative interface retail leased lines (at bandwidths up to and including 1Gbit/s); and

4.71 As noted in the discussion of the product market definition, the LLMR concluded that there was a single alternative interface retail leased lines market which included all available bandwidths. Therefore, there is no comparable previous geographic market definition for the low bandwidth alternative interface leased lines market. That said, the LLMR defined the alternative interface market as national in scope. Again BT does not have any obligation to publish its retail prices in this market so it is not possible to say whether it offers geographically differentiated prices.

Service share analysis

4.72 The following maps show the share of BT on a postal sector basis in the low bandwidth alternative interface retail market. Figure 29 shows the UK as a whole and Figure 30 shows the London area. Again, the outer black boundary line identifies the Central London Zone (CLZ) which is the area of London served by the 0207 dialling code. The administrative boundary of City of London is shown in Figure 31.

Figure 29: Low bandwidth alternative interface retail leased lines service shares: UK

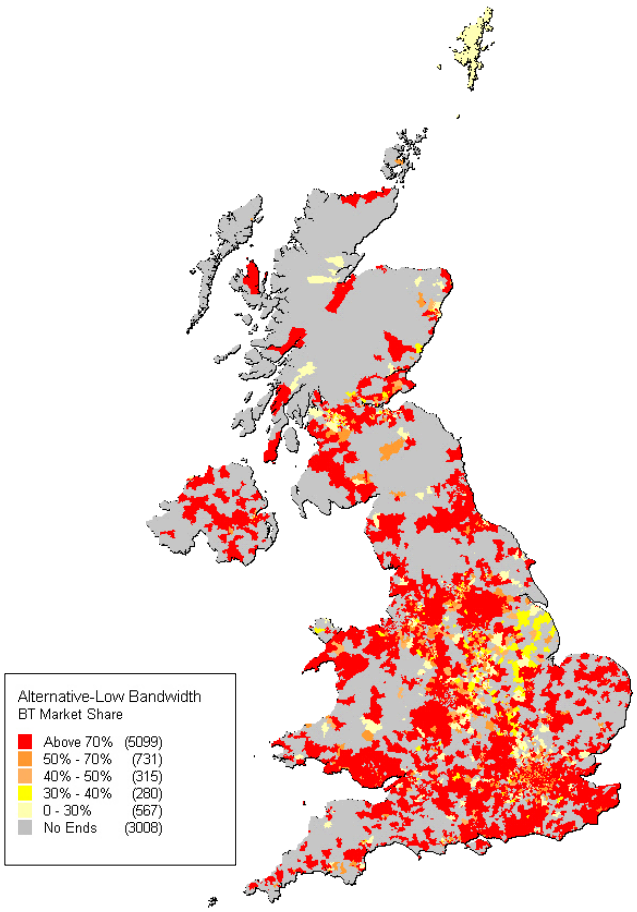


Figure 30: Low bandwidth alternative interface retail leased lines service shares: CLZ

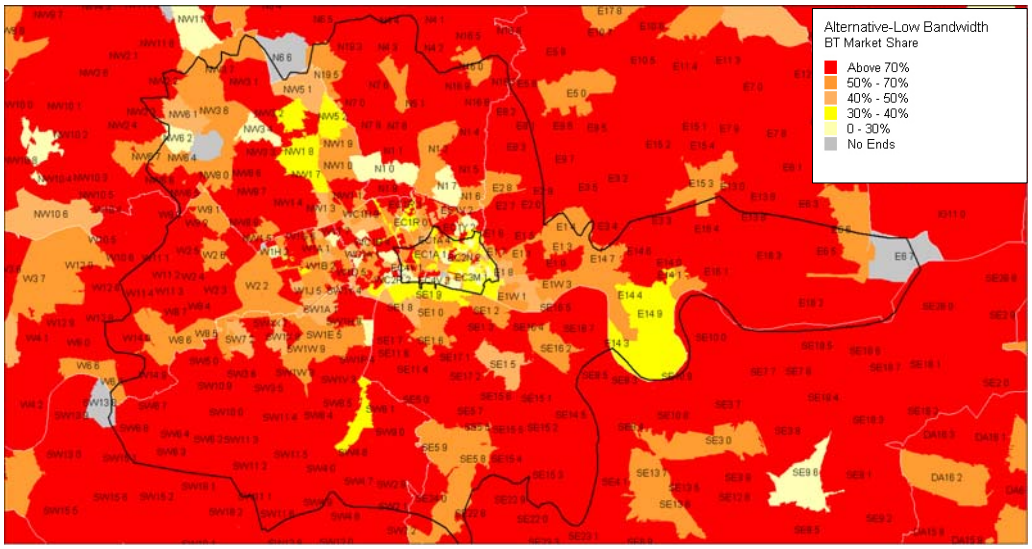
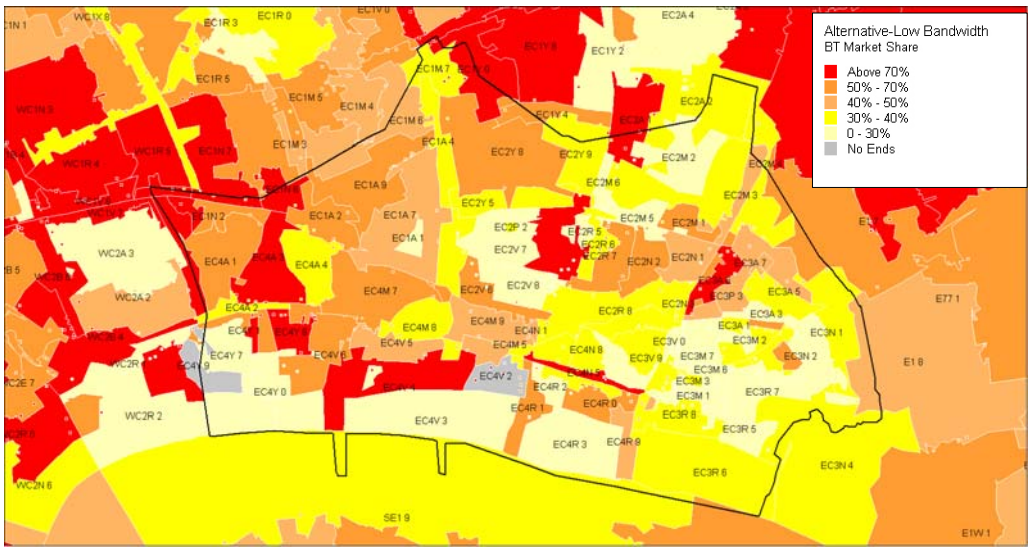


Figure 31: Low bandwidth alternative interface retail leased lines service shares: City of London



4.73 These figures show that there is variation in BT's service share when considered on a postal sector basis. However, as noted above for other markets, we have again calculated these service shares on the basis of retail market information which reflects the provision of regulated wholesale inputs. As such the picture may be different absent such upstream regulation. However, in the context of low bandwidth alternative interface circuits, this market review is concerned with the wholesale level. Therefore it is not necessary to come to a definitive view of the precise scope of the retail geographic market.

BT pricing policies

4.74 As noted above, BT is under no obligation to publish its prices in the low bandwidth alternative interface leased lines market it is not possible to say whether it offers geographically differentiated prices.

Conclusion on geographic market definition in the low bandwidth alternative interface retail leased lines market

4.75 Similar to the low bandwidth traditional interface retail leased lines market, analysis of the service shares in the low bandwidth alternative interface leased lines markets appears to show that there exist geographic variations in competitive conditions. However, this may in part be due to the presence of regulated wholesale inputs, which we have not been able to extract form in our analysis. However, as this market review, for the purposes of low bandwidth alternative interface services, is concerned with assessing the relevant wholesale markets, it is not necessary to come to a conclusion on this question.

High bandwidth alternative interface retail leased lines (at bandwidths above 1Gbit/s).

4.76 Again there is no comparable previous geographic market definition for the low bandwidth alternative interface leased lines market as the LLMR concluded that there was a single alternative interface retail leased lines market which included all available bandwidths. However, as mentioned above, the LLMR defined the alternative interface market as national in scope and BT does not have any

obligation to publish its retail prices in this market so it is not possible to say whether it offers geographically differentiated prices.

Service share analysis

4.77 The following maps show the share of BT on a postal sector basis in the high bandwidth alternative interface retail market. Figure 32 shows the UK as a whole and Figure 33 shows the London area with the outer black boundary line identifying the Central London Zone (CLZ).

Figure 32: High bandwidth alternative interface retail leased lines service shares: UK

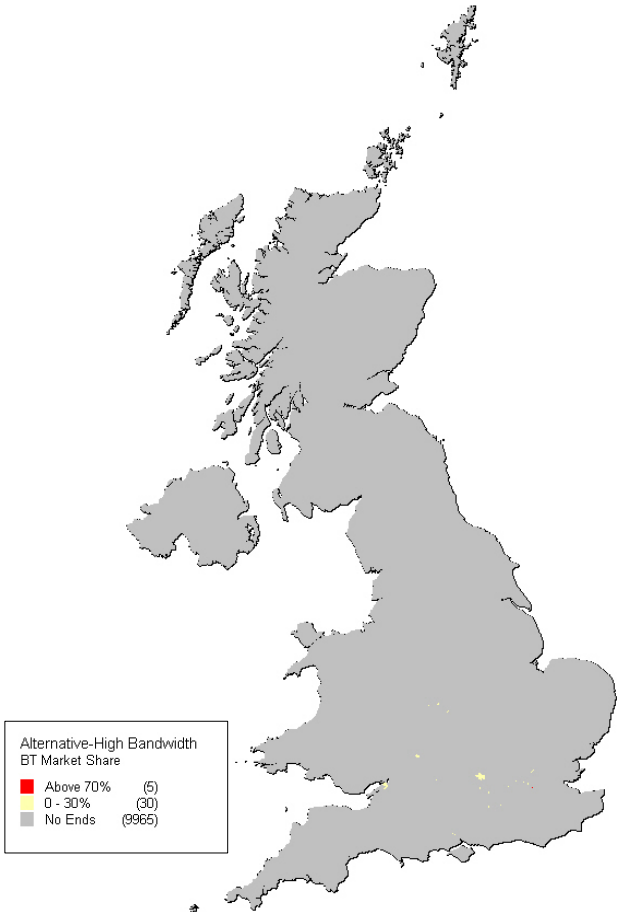
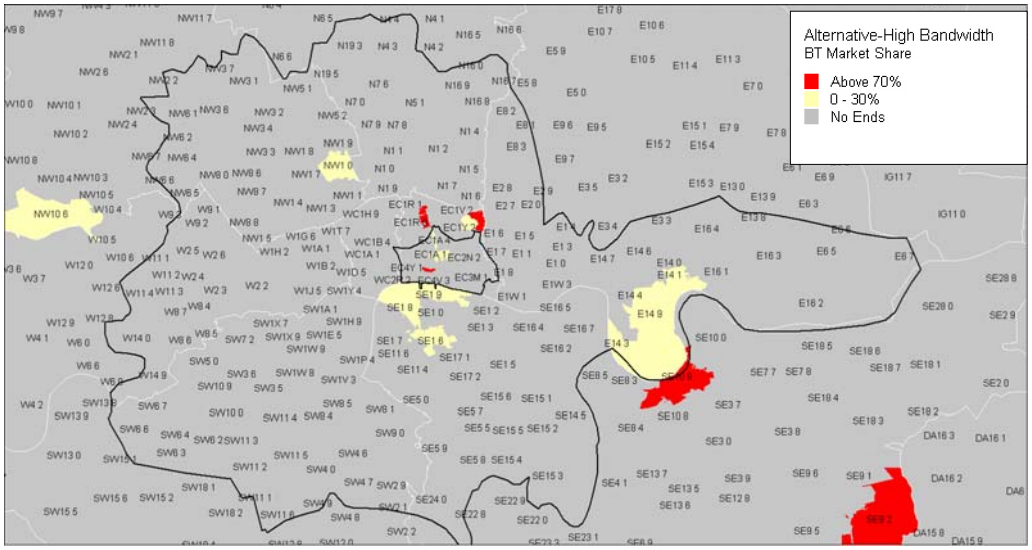


Figure 33: High bandwidth alternative interface retail leased lines service shares: CLZ



4.78 These Figures show that there are very few postal sectors which include ends of high bandwidth alternative interface retail circuits (35 postal sectors in total) suggesting that any geographic variations in competitive conditions are likely to be limited. However, as this market develops further such variations may become more pronounced and Ofcom will revisit this question in the next market review

BT pricing policies

4.79 As noted above, BT is under no obligation to publish its prices in the high bandwidth alternative interface leased lines market it is not possible to say whether it offers geographically differentiated prices.

Conclusion on geographic market definition in the high bandwidth alternative interface retail leased lines market

4.80 There are currently very few services being offered in the high bandwidth alternative interface leased line market. As such, there is no evidence that there exists, or could be expected to exist significant variations in competitive conditions which would warrant the definition of separate local geographic markets. However, as this market review, for the purposes of high bandwidth alternative interface services is concerned with assessing the relevant wholesale markets, it is not necessary to come to a definitive conclusion on this question.

Question 4: Do stakeholders agree with our proposed retail geographic market definition?

Section 5

Wholesale product market definition

Introduction

5.1 This section discusses the relevant wholesale product market definitions in the light of the retail markets identified in the previous Sections.

5.2 We propose the following wholesale market definitions:

- a market for trunk segments;
- a market for low bandwidth traditional interface symmetric broadband origination up to and including 8Mbit/s;
- a market for high bandwidth traditional interface symmetric broadband origination above 8Mbit/s up to and including 45Mbit/s;
- a market for very high bandwidth traditional interface symmetric broadband origination over 45 Mbit/s;
- a market for alternative interface symmetric broadband origination up to and including 1Gbit/s; and
- a market for alternative interface symmetric broadband origination over 1Gbit/s.

General approach to wholesale market definition

5.3 As discussed in section 3, the relevant market boundaries are determined by identifying constraints on the price setting behaviour of firms. Our assessment of competitive constraints at the wholesale level has been informed by the proposed retail markets definitions. This is because the demand for the wholesale service is a derived demand, i.e. the level of demand for the wholesale input depends on the demand for the retail service.

5.4 In some cases a wholesale leased line service may be used as an input to a number of markets that are defined as separate at the retail level (and potentially outside the scope of the retail leased line market). We have therefore sought to take into account the possible use of these wholesale inputs in downstream retail markets.

5.5 Our market definition assessment has also been conducted in the absence of any wholesale SMP regulation in the relevant leased lines markets under review. However, any wholesale regulation upstream of leased lines markets (e.g. Local loop unbundling) and/or that exists independently of a finding of SMP in the markets being reviewed has been considered.

Market definition assessment

5.6 Ofcom's assessment of wholesale markets is set out below. We consider the following issues, reflecting where the possible breaks may exist in wholesale markets:

1. **Wholesale access and backhaul markets**: does a combined market for access and backhaul exist?
2. **Symmetric broadband origination (alternative versus traditional interface)**: can specific SBO product markets be identified for AI and TI services?
3. **Symmetric broadband origination (to support other retail services)**: should wholesale services used to support LLU and RBS backhaul be included in relevant SBO markets?
4. **Wholesale trunk market(s**): does a separate market for trunk segments exist and where should the break between trunk and SBO be idenitified?
5. **Trunk versus alternative conveyance**: do other forms of "core" connectivity such as broadband conveyance provide a competitive constraint on trunk services used for leased lines?
6. **Bandwidth**: what are the appropriate bandwidth breaks, if any, for trunk and SBO services?

Issue 1: Wholesale access and backhaul

5.7 Under this issue, we have considered whether a separate market exists for access and backhaul for wholesale alternative interface and traditional interface services.

5.8 Access services are defined as running from an End-User's premise (at the network termination point) to a Local Access Node (e.g. local exchange). Access services support the provision of copper-based access services and fibre-based access services to End-Users.

5.9 Wholesale backhaul services are defined as runnning from a Local Access Node to:

- another Local Access Node (on the same CP's network); or
- a Trunk Node (on the same CP's network); or
- another Communications Provider's point of handover.[60]

5.10 Under this issue, we first discuss our 2003/04 Review product definition, which previously identified a combined access and backhaul market. We then consider whether developments since the last review or going forward might suggest that separate access and backhaul markets should be identified. In particular, we assess the introduction of separate access and backhaul products since the 2003/04 Review and any changes that have occurred in the demand for access and backhaul products.

2003/04 Review

5.11 The 2003/04 Review defined a combined market for access and backhaul services which were referred to as wholesale symmetric broadband origination (SBO) services. We defined these services as providing symmetric bandwidth from a

[60] Although backhaul would not include an interconnection circuit or interconnection service provided over that circuit.

customer's premises to an appropriate point of aggregation or a node, in the network hierarchy. In this context, a customer referred to any public electronic communications network provider or end user. Although SBO referred to origination services, traffic can also be terminated over these services.

5.12 The definition of SBO services was intended to provide a functional definition that reflected the way in which communication providers demand wholesale leased line services. In particular, it reflected the fact that, in the majority of cases, access and backhaul services were acquired together.

5.13 Given the basis for the 2003/04 Review definition, we consider below whether there have been any changes since the last review that are likely to test this. In particular, we consider whether access and backhaul continue to operate in a single SBO market on the basis that they are still generally acquired together, and is this likely to be the case over the lifetime of the review.

Availability of separate access and backhaul products

5.14 There have been a number of developments since the last review (in particular in respect of the BT Undertakings) that necessitate a re-assessment of SBO services and might have been a driver for a greater number of OCPs buying access and backhaul separately.

5.15 As foreshadowed by Ofcom's Telecom Strategy Review (TSR), BT's Undertakings are intended to promote infrastructure competition at the deepest level where such competition is likely to be effective and sustainable. In the TSR, Ofcom concluded that the nature of fixed telecommunications networks was such that there were enduring economic bottlenecks – parts of the network where effective and sustainable competition would not emerge. It was unlikely that such bottlenecks would disappear in the short to medium term. Therefore companies who wished to provision retail services would have to continue to rely on BT for access to parts of the network where infrastructure competition was not sustainable.

5.16 The Undertakings have potentially opened up different ways in which OCPs can procure services within terminating segments. For example, separate access and backhaul products for Ethernet services (WESA and WESB) have been offered to OCPs on an EOI basis. This separation of products gives the opportunity to acquire a single (aggregated) wholesale backhaul product from BT to serve multiple customers. By purchasing access product separately for each end-user an OCP can potentially add sites and different downstream services incrementally while aggregating traffic onto a single high capacity backhaul link.[61] If an OCP were restricted to purchasing multiple end-to-end WES circuits for each site, such aggregation benefits could not be exploited, as each circuit would be sold on a standalone basis. The provider would also have limited opportunity to add further sites incrementally by purchasing access separately. By contrast an OCP with sufficient backhaul capacity (using WESB) would be able to add the additional traffic simply by purchasing an additional WESA circuit.

5.17 The question is therefore whether in the presence of these arrangements, a combined access and backhaul market (i.e. a market for SBO) still exists. To answer this question, Ofcom has first considered the trends in the demand for

[61] For example a CP may rent a high bandwidth backhaul link capable of supporting numerous downstream services in a particular metro area. In these circumstances, it would want to procure separate access products in order to add sites and different downstream services incrementally.

separate wholesale access and backhaul products relevant to this review, namely: WESA and WESB services discussed in the above paragraph and also LLU backhaul services. Although the latter are used predominantly as inputs into asymmetric broadband origination services, they are also used to provision symmetric broadband origination services (e.g. SDSL) relevant to the leased lines market review.

5.18 If the demand for these products has changed to appreciable extent since the last review this might justify separate access and backhaul markets. However, a number of these separate access and backhaul products have only been available for a relatively short period of time. Therefore the extent of demand to date might be limited. This does not necessarily mean that there will not be growth in demand for separate access and backhaul services within the timeframe of this review. We have therefore also considered the underlying drivers and opportunities for CPs to take advantage of separate access and backhaul to help inform the likely demand for these services going forward.

Trends in access and backhaul demand

5.19 In terms of other wholesale leased line services, there has been very little use of access or backhaul specific products:

- Alternative interface services: WESA and WESB products were introduced in late 2006, and are only available as a 21CN product with limited geographic availability: currently they are available only in some parts of South Wales and some parts of the Midlands; for a significant roll-out geographically, OCPs will have to wait at least two to three years.

- Traditional interface leased lines access and backhaul products ("TILLAPS" and TILLBPS") are not yet available; it is therefore difficult to assess the extent of likely OCP take-up for these services.

5.20 The only market that has seen appreciable growth has been the LLU backhaul market. This market growth has been fostered by retail broadband demand and the growth of LLU. As set out in Annex 5, BT Openreach was selling 7475 Backhaul Extension Services (BES) circuits[62], compared with 316 in the first quarter of 2004. BES revenues now constitute one third of all of BT's revenues within its portfolio of wholesale leased line services. BT's BES revenues were around £23 million in the last quarter of 2006.

5.21 The above evidence suggests that there has been LLU take-up (i.e. use of LLU products in the local access segment). This has led to increases in the demand for separate backhaul circuits. The disaggregated purchase of access and backhaul is happening in these circumstances due to remedies such as LLU upstream of the wholesale leased line market. BES is the wholesale Ethernet product currently used as an input to downstream retail services based on ADSL and SDSL. But the growth in LLU has not generally resulted from significant changes in the competitive condition of backhaul services itself. BT remains the main provider of backhaul as well as access services. The competitive conditions between access and backhaul therefore remain fairly similar.

[62] These BES services are the predominant means by which OCPs backhaul their LLU traffic from the local exchange to their relevant point of interconnect with BT.

5.22 As discussed above, the take-up of separate access and backhaul (such as WESA and WESB) to address retail traditional and alternative interface services has been limited to date. Ofcom has considered below whether the conditions for aggregating backhaul traffic currently exist or are likely to develop within the timeframe of this review.

Aggregation opportunities

5.23 As a separate access and backhaul product has not been made available for PPCs (i.e. Traditional interface leased lines access and backhaul products (TILLAPs and TILLBPs), the discussion of possible demand for separate access and backhaul refers to WES products. Nevertheless, the discussion of demand for separate access and backhaul products is, in principle, likely to apply to traditional interface as it does to alternative interface wholesale services.

5.24 To understand the drivers of demand for separate access and backhaul it is useful to consider economics of such a purchasing decision. Starting with an operator considering how to supply an individual point to point retail circuit. Where it is reliant on wholesale inputs, it would have the choice of purchasing:

- combined access and backhaul products for individual point to point routes; or
- separate access and backhaul products.

5.25 In the case of a purchasing decision for a single point to point circuit, the combined access and backhaul product should always be priced more favourably. This is because, in purchasing disaggregated access and backhaul products the OCP must also invest in its own equipment to connect the access circuits to the backhaul circuit and has to purchase, from BT Wholesale, accommodation for its equipment at the local exchange.

5.26 Hence, if the operator only required a single point to point circuit, this would not be economic. In order for the disaggregated purchase to be economic, the OCP must connect enough local access connections onto a single backhaul circuit to make more efficient use of the backhaul network. These aggregation benefits also need to be sufficient to offset the additional cost of the accommodation and the investment in its own equipment.

5.27 At present, many OCPs are unlikely to adopt this approach as it faces a number of issues some economic and some related to the current availability of separate access and backhaul products. For example, investing in separate access and backhaul requires them to take the risk of absorbing the cost of paying more up-front costs (i.e. paying for assets they do not own, such as leased backhaul circuits and space) against a potentially uncertain future return. This uncertainty emerges from the fact that even where it has an existing customer base, such customers may have relatively short retail contracts. Therefore, even where a CP has a concentration of existing customers, there are barriers to using separate access and backhaul services. In such circumstances, demand is likely, in the most part, to be for combined access and backhaul product.

5.28 Even if a fully effective disaggregated product were available, the scope for CPs to realise such benefits will be limited to the geographic locations where aggregation opportunities exist. Hence, in areas where there is a low density of businesses it is unlikely that demand for separate access and backhaul services will emerge.

5.29 The above factors mean that even in the presence of separate access and backhaul products (arising from the Undertakings), the majority of circuits purchased by CPs are likely to continue to be aggregated access and backhaul WES and WEES products.

5.30 For other backhaul products, such as BES, clearly the observed growth in demand from LLU operators has been strong as operators have extended their geographic coverage. However, the scope for further exchange roll-out by LLU operators will be more limited. For example, in Ofcom's review of Wholesale Broadband Access markets, based on the forecast roll-out plans of the Principal LLU[63] operators, the number of exchanges unbundled by operators is likely to stabilise in the next year or so. The number of exchanges where the Principal LLU operators have presence is forecast to increase from 1,478 in July 2007 to 1,589 in June 2008. In addition, the coverage (in terms of number of households) is likely to increase from 76% to 79%. This suggests that growth in demand for separate backhaul products is likely to stabilise based on the natural limits of retail markets and LLU roll-out as broadband demand matures. Although the use of BES for symmetric retail broadband services (such as SDSL) might prompt further growth in demand for this wholesale service.

5.31 Apart from BES products, the assessment above otherwise noted the limited take-up of separate access and backhaul services, which may to some extent reflect the these products only becoming available relatively recently. And in some cases the nature of the products have been a relatively unattractive proposition. This is likely to be particularly relevant in the case of AI services, which up until very recently has been sold as a single (combined) product.[64] While it is important that BT does not impede the development of separate access and backhaul markets in the future, there is little evidence that OCPs are viewing these products as sufficiently effective (at present) to encourage widespread purchasing of separate access and backhaul products.

5.32 One of the key drivers for demand for disaggregated access and backhaul will, in any case, be the development of converged backhaul products, which Ofcom considers will take time to emerge. This is likely, at least initially, to be limited to demand in geographic areas where aggregation opportunities are more clearly available. We discuss the likely opportunities for converged backhaul services below.

Converged backhaul assessment

5.33 The above discussion highlighted the need for OCPs to gain sufficient demand to be able to exploit the economies of aggregated backhaul products. That discussion only assessed the opportunities to aggregate individual traffic types (i.e. Alternative interface) within the backhaul segments. However, if there were a possibility to groom different retail traffic onto the same backhaul link (i.e. converged backhaul) this might enhance the potential demand for separate access and backhaul products. Ofcom considers below whether the conditions necessary for the emergence of such a converged backhaul product exist at the present time, or are likely to do so in the near future.

[63] The 8 principal operators are defined as BT, Virgin media and 6 LLU operators expected to achieve more than a minimum coverage threshold. See http://www.ofcom.org.uk/consult/condocs/wbamr07/

[64] The current versions of WESA and WESB products are uneconomical for most CPs because they are offered only in some geographic areas and because in charging terms they double the amount of equipment required as the access and backhaul products charge for both ends.

5.34 The focus of the analysis is whether there is likely to emerge a single backhaul product suitable as a single wholesale input to all or most of an OCP's retail services e.g. retail traffic from leased lines, broadband, PSTN voice, mobile voice and data. Even if these conditions are present, Ofcom has also considered other factors that may prevent a market for converged backhaul developing.

5.35 Ofcom considers that a key impediment to the emergence of a converged backhaul product is the fact that the characteristics and specifications of the required wholesale inputs differ according to the different type of traffic. Although there is considerable overlap in the key functional characteristics of the backhaul inputs which different retail services utilise, at this stage the only wholesale products which could satisfy the technical requirements of all services are SDH/PDH and WDM technologies. These technologies have higher functional specification in certain respects (particularly in regard to delay variation) than other backhaul inputs. As examined in the discussion of AI and TI retail leased lines, these specifications are desirable in so far as the provision of certain retail services are concerned, but are not necessary for other products. Ethernet technology could not currently be used to provide a common wholesale backhaul input, largely because of its inability to offer a deterministic service.[65] However, Ofcom notes that a number of CPs are actively migrating to next generation networks based on ethernet technology which will offer the full range of retail services and it is clearly likely that within the timeframe of this review technical solutions to these difficulties will be deployed allowing ethernet to provide a common bearer technology for the support of converged services.

5.36 A further barrier to the emergence of a converged backhaul product is the limited extent to which access and end points of the backhaul links for different services are co-located. Currently interconnect is provided on a service-specific platform at distinct geographical nodes. In many cases nodes for different services are not in the same place which greatly restricts the ability to use converged backhaul.

5.37 One final factor to bear in mind here, as mentioned above, is that many OCPs appear to envisage migrating to Ethernet networks in the near future. This reduces the incentives they have to build out their SDH/PDH networks where there is a risk that such assets could become obsolete over an investment timeframe of 3-5 years. This is reflected in the fact that relatively few operators would have invested in their own backhaul products since the last review.

5.38 These factors all imply that currently converged backhaul does not exist on a sufficient scale to merit separate access and backhaul market. For the majority of CPs access and backhaul services are likely to continue being acquired together in the timeframe of this review. The emergence of a converged backhaul product will create greater economies of density in backhaul products and by providing separate access and backhaul products this will enable parties to be able to obtain the benefits of economies of scale and scope by buying aggregated capacity directly.

5.39 The number of CPs self-supplying new backhaul links (and hence buying access on a stand-alone basis) is likely to be limited. While it still remains a possibility (depending on the level of traffic at which economies of scale or scope are exhausted, as well as the levels of traffic across a particular area), in practice, the enduring nature of bottlenecks as suggested by the Undertakings suggests that this is likely to be limited. The sources of demand for separate access and backhaul would also make it very cheap to use a BT backhaul product (such as WESB).

[65] Predictability is linked to the concepts of latency and delay variation.

Proposed definition

5.40 Ofcom proposes to retain a wholesale definition for symmetric broadband origination services (i.e. a combined access and backhaul definition) as they are likely to be continue being procured together over the timeframe of this review. This reflects the fact that demand for separate access and backhaul will be limited to areas of sufficient scale or until greater opportunities for converged backhaul emerge.

Issue 2: Wholesale symmetric broadband origination: alternative versus traditional interface

5.41 As outlined above we propose a symmetric broadband origination market definition. Under this issue, we consider whether separate markets exist for alternative interface and traditional interface symmetric broadband origination. Ofcom therefore presents relevant demand and supply-side analysis below..

2003/04 Review

5.42 In the LLMR 2003/04, Ofcom identified separate wholesale SBO market for alternative interface and traditional interface services ("AISBO") and ("TISBO") services. This was based on a lack of demand side and supply side substitution opportunities between the two services.

Provision of wholesale AI and TI circuits

5.43 At a wholesale level, traditional interface circuits are supplied using PPCs. Alternative interface circuits are currently often supplied over short distances by means of a single direct end-to-end fibre. However, other configurations are possible for example via WESA and WESB circuits and, going forward, on fibre based rings on Openreach's proposed Orchid network.

5.44 Ofcom considers it appropriate to understand whether, given the way in which wholesale services are currently provided and potential developments, distinct markets for alternative and traditional interface symmetric broadband origination exist.

Demand-side analysis

5.45 In our retail assessment in Section 3 of AI and TI services, we proposed separate AI and TI markets, based on the following factors:

- Deterministic nature of SDH/PDH services;
- Price and trend analysis; and
- Possible switching costs.

5.46 We consider that the definition of separate retail markets is likely to be reflected in the corresponding wholesale markets, since the demand for the wholesale services is a "derived demand" dependent on demand at the retail level. As AI and TI circuits are in separate markets at the retail level, there is no indirect demand-side constraint on a SSNIP in the price of wholesale AI or TI services arising from substitution at the retail level.

5.47 In addition, as an AISBO circuit cannot generally be used to provide a retail TI circuit or vice versa, a SSNIP in the price of one would not be constrained by direct wholesale level substitution.

5.48 Given this analysis and the technical differences between AISBO and TISBO services, the two are therefore not likely to be effective demand-side substitutes for one another.

Supply-side substitution

5.49 Under our assessment of retail product markets, we considered whether supply side substitutability would lead to a widening of the existing market definition to include both SDH/PDH-based and Ethernet-based circuits. Such supply side substitutability would exist if, in the absence of wholesale regulation, the suppliers of alternative interface circuits were able to provide SDH/PDH-based circuits at low cost and within a relatively short period of time. However, since the majority, if not all, of the suppliers of alternative interface circuits already supply SDH/PDH-based circuits (and vice versa), alternative interface suppliers would not place any additional constraints on a hypothetical monopolist supplier of SDH/PDH-based circuits (and vice versa).

5.50 Ofcom considers that the same reasoning applies to supply side substitution at the wholesale level. Ofcom does not, therefore, consider that supply side substitution would lead to a widening of the TISBO market to include AISBO.

Proposed definition

5.51 Ofcom proposes separate wholesale SBO market for alternative interface and traditional interface services: (“AISBO”) and (“TISBO”) respectively. This is based on a lack of demand side and supply side substitution opportunities between the two services.

Issue 3: Symmetric broadband origination services to support other retail services

5.52 Given our proposed definition for separate wholesale AISBO and TISBO markets, we also need to consider a number of other retail services (other than analogue/digital SDH/PDH and Ethernet circuits) that potentially make use of similar AISBO or TISBO inputs (either directly or when combined with other wholesale inputs).

2003/04 Review

5.53 In the 2003/04 Review concluded that the product market for TISBO also covered the following uncontended and contended services:

- services using SDSL technology
- radio base station (RBS) backhaul circuits and other leased lines used for mobile operator’s networks;
- local loop unbundling (LLU) backhaul services

5.54 A further assessment of the inclusion of the remaining services in the AISBO or TISBO market is presented below.

ADSL and SDSL services

5.55 In our assessment of retail product markets in section 3, SDSL-based services were considered in the traditional interface market.

5.56 On the other hand, ADSL services were found not to be in the same market due to asymmetry and quality differences. At the retail level our view was that the differences in functionality and competitive prices of ADSL and traditional interface services is such that the two are unlikely to be substitutes.

5.57 At the wholesale level, Ofcom remains of the view that SDSL-based circuits are sufficiently substitutable for traditional interface leased lines services for them to be viewed as being in the same economic market as SDH/PDH-based services. As with our retail market assessment, the ability of SDSL to provide dedicated, symmetric, origination and the likely prices that would arise in a competitive market should mean that the two can be viewed as demand side substitutes and as such should be in the same economic market.

5.58 We note that at a wholesale level uncontended SDSL-based services can be used to provide the same functionality as a terminating segment, that is, dedicated symmetric transmission capacity with each circuit providing a maximum of up to 2Mbit/s.

5.59 In relation to whether a distinction should be made at the wholesale level between uncontended and contended SDSL, we considered that a chain of substitution is likely to exist at the retail level for SDSL. In this way the same logic should apply on a symmetric broadband origination service and it would be inappropriate for Ofcom to specify a contention threshold whereby separate wholesale markets for contended and uncontended SDSL services were identified. This is particularly the case given that the same wholesale inputs could be used to provide each service.

Proposed definition

5.60 We propose that SDSL is a symmetric broadband origination service and that it should be included within the TISBO market. This proposed conclusion has been informed by the assessment of demand and supply-side substitution opportunities at the retail level, which we consider are also relevant at the wholesale level.

Mobile Network Operators' network connectivity

5.61 Mobile Network Operators (MNOs) acquire a substantial number of SDH/PDH circuits from BT and OCPs for the purpose of building their networks i.e. as inputs to the supply of retail mobile voice and data services. In the last market review, sales of fixed circuits to MNOs were treated as part of the wholesale (TISBO) market on the grounds that these services were technically the same as the PPCs acquired by OCPs.[66]

5.62 In the following paragraphs we examine whether these circuits should be included in the TISBO market. We first discuss the network connectivity requirements of MNOs. We then explain relevant leased lines products used by MNOs before assessing whether these services belong in the TISBO market. Finally, we assess whether

[66] As is discussed further below, this view has also been expressed by Oftel in the past. See: http://www.ofcom.org.uk/static/archive/oftel/publications/broadband/leased_lines/btvo0603.htm

any other wholesale inputs used by mobile operators (e.g. microwave links) also form part of the wholesale leased lines markets.

Network connectivity requirements

5.63 The majority of circuits acquired by MNOs are used for 'Radio Base Station (RBS) backhaul', which provides transmission capacity between an MNO's RBS premises and its Base Station Controllers (BSCs), and between its BSCs and mobile switching centres (MSCs). The RBS to BSC layer is characterised by a very large number of low capacity circuits. The BSC to MSC layer has considerably fewer circuits, but of higher capacity (typically 155 Mbit/s links).[67] MNOs also acquire circuits in order to connect their MSC sites (referred to as 'inter-MSC' or 'core' connectivity). These sites are typically connected by very high capacity links (mainly 155 Mbit/s links).

5.64 Historically, MNOs met their third-party connectivity requirements predominantly acquiring two products from BT under the 'Netstream' tariff. These products continue to be acquired in some instances by MNOs:

- 'Netstream 16 LongLine' (NS16LL) is a product that is designed for the tree and branch backhaul networks of MNOs. It provides transmission capacity between an MNO's multiple RBS sites and its core network, aggregating multiple individual circuits of typically low capacity at an aggregation point managed by BT and generally then presented at the point of handover as a single 155Mbit/s connection. It appears that NS16LL passes through to MNOs at least some of the savings arising from aggregation within the backhaul part of the network.[68]

- The other product is 'Netstream 16' (NS16), which is a 155 Mbit/s link intended for inter-MSC connectivity.

5.65 Both services are subject to eligibility criteria which in practice only MNOs can meet.[69]. It is unclear whether BT brands NS16LL and NS16 as retail or wholesale tariffs.[70]

5.66 Over time, MNOs have generally migrated away from NS16LL tariffs onto specific 'RBS Backhaul' tariffs. RBS backhaul is a product that BT is required to supply at cost-oriented prices to MNOs (although unlike PPCs it is not subject to a charge

[67] MNOs acquire/use few 34/45 Mbit/s links.

[68] By minimising the number of distinct paths required, the amount of physical path devoted to individual circuits is reduced and correspondingly the amount of transport infrastructure that can be shared over a large number of circuits is maximised. For example, traffic from 31 base stations, each with a bandwidth requirement of two 2 Mbit/s (not atypical for many GSM base stations) can be aggregated onto a single point deep in the network and then carried over a single pair of fibres using an STM-1 (i.e. a 155 Mbit/s link) rather than being transported over 62 separate copper or fibre pairs.

[69] In the case of NS16LL customers must have a minimum number (8) of major sites and must satisfy very high minimum bandwidth requirements that could not normally be met by business users.

[70] Although these services appear on the BT Retail price list, they appear to be sold by BT Wholesale. In any event, irrespective of their designation NS are technically identical to BT's PPC products. In 2002, then Oftel stated:

"In effect, the retail circuits currently provided [by BT] to Vodafone could be reclassified ('migrated') to wholesale products analogous to PPCs without any physical adjustment to the circuits "

It is likely that these services appear on the BT Retail price list merely for legacy reasons (i.e. they were first made available at a time when infrastructure sales to Communication Providers were sold on a 'retail minus' basis).

control). The migration from NS16LL to RBS backhaul has typically not led to any change in the underlying nature of the service provided and RBS backhaul is provided over the same physical infrastructure as before.

5.67 Apart from these services, MNOs acquire SiteConnect71 and digital (Megastream and Kilostream) and analogue leased lines from BT. The fact that these services are acquired in relatively high quantities by some MNOs (relative to the quantities of these services acquired by a typical business user) suggests that they are generally acquired as infrastructure, rather than for ordinary business connectivity purposes.72 MNOs also acquire circuits from OCPs although almost all these sales are in respect of very high bandwidth (i.e. 155 Mbit/s) services.[73]

5.68 Apart from acquiring circuits, MNOs self-supply links both for RBS backhaul and for inter-MSC connectivity. Microwave links are used both for 2 Mbit/s and 155 Mbit/s links, whereas fibre is used to supply 155 Mbit/s links. In recent years, various MNOs have switched away from third party-provided lines to self-provided fibre.

Market definition assessment

5.69 Having described MNOs' network connectivity requirements, in the paragraphs below we examine why the connectivity services used by MNOs should be treated as wholesale services, and we then assess which of these services should be included in the TISBO market.

Wholesale versus retail products

5.70 Consistent with the 2003/04 Review, we consider that all fixed circuits used by MNOs should be treated as wholesale products (whether these are acquired or self-supplied). This applies even to those circuits sold to MNOs notionally under retail tariffs. Like PPCs, the circuits that MNOs acquire from BT and OCPs are used as inputs into downstream markets. In contrast, retail business customers acquire an end-to-end service which provides direct connectivity between their various sites. The differences between the circuits acquired by MNOs and the retail services acquired by end-users are therefore similar to the differences between retail services and the wholesale services acquired by OCPs.

5.71 This is supported by the fact that the competitive conditions of serving MNOs and retail customers differ significantly. The so-called retail tariffs are in practice only available to MNOs and may reflect the option of purchasing RBS backhaul on wholesale terms, an option also not available to non-MNO retail customers. The

[71] 'SiteConnect' is designed similarly to the NS16LL service but suited to particular network requirements. Up until recently BT labelled its SiteConnect product as a retail service, but BT changed the classification of this product in 2006/07 and it now appears on the BT Wholesale Price list. This change was not accompanied by any change in the substance of the product.

[72] For example, in 2006 one MNO acquired just under 4,000 analogue and digital leased lines alone from BT, whereas the end-user research indicated that most business users had less than 100 business connectivity connections (including ADSL).

[73] MNOs have consistently stated that OCPs cannot viably supply them with any significant number of low bandwidth circuits. Unlike BT, OCPs do not have physical infrastructure that is located in the geographic areas where MNOs require low bandwidth connectivity and (when building new network infrastructure) OCPs appear to have difficulties in obtaining way leaves from landlords. It appears that OCPs do not always participate in MNO tenders to supply low bandwidth connectivity; when they do so, it is sometimes only in respect of those geographic locations where they have in place existing infrastructure. By contrast, MNOs have consistently stated that OCPs are able to supply high bandwidth lines on competitive terms with BT.

lower prices paid by MNOs may also reflect the different nature of the products acquired by this set of customers (and in particular the aggregation possibilities that are inherent in the services acquired by MNOs). In other words, such prices are reflective of bulk wholesale purchases.

Demand and supply-side substitution: RBS backhaul and PPCs

5.72 It is not possible to infer from MNOs' and OCPs' wholesale purchasing activities whether RBS backhaul (and the other fixed services acquired by MNOs) and PPCs might be viewed as substitutes. This is because sales of RBS backhaul and NetStream services are restricted to MNOs (so the fact that OCPs do not acquire these services does not indicate that OCPs do not consider these services to be equivalent to PPCs). MNOs may also face some restrictions in acquiring PPCs. For example, various MNOs have in the past sought to acquire PPCs instead of NS16LL but have apparently been unable to do so.[74] MNOs' interest in acquiring PPCs does however indicate that MNOs are likely to view PPCs as equivalent to the wholesale inputs that they currently acquire (or at least would be likely to do so in a competitive market).

5.73 Consistent with this, the last LLMR stated (when comparing PPCs and the wholesale inputs required for the provision of retail mobile telephony services) (p 310):

"A radio base station can be viewed as equivalent to an end user's premises, with traffic being carried to the appropriate point of interconnection between the communications provider's and the mobile communications provider's networks. Because they are technically equivalent, these services are essentially the same product and ought therefore to be part of the same relevant product market, however they are labelled."

5.74 The same view was expressed by Oftel in 2003 when comparing the differences between NS16LL and PPCs.[75]

5.75 There are some differences in the presentation of some of the wholesale inputs sold to MNOs and OCPs by BT. As noted above, it appears that NS16LL (if sufficient quantities of circuits are acquired) passes efficiencies resulting from backhaul aggregation through to MNOs. In contrast, OCPs are offered individually bundled access and backhaul inputs i.e. the pricing scheme applied to these products means that efficiencies resulting from aggregation within backhaul may not be fully passed on to OCPs.

5.76 However, these differences do not apply to RBS backhaul services and in any event the price differences applied are unlikely to be explained either by fundamental differences in the network configurations of OCPs and MNOs or by differences in the underlying nature of the product sought by these two sets of customers. Further, these differences will be eroded if BT introduces Traditional Interface Leased Lines Backhaul Products (TILLBPs) and Traditional Interface Leased Lines Access

[74] http://www.ofcom.org.uk/static/archive/oftel/publications/broadband/leased_lines/btvo0603.htm

[75] Various MNOs have informed us that they believe that they are not entitled to acquire PPCs for the purposes of RBS backhaul (explaining why they do not currently acquire this service from BT). In the past Vodafone complained to Ofcom about BT's refusal to supply it with PPCs (BT instead required it to acquire NS16LL). O2 also submitted a response at the time that supported Vodafone's position. See http://www.ofcom.org.uk/static/archive/oftel/publications/broadband/leased_lines/btvo0603.htm (see paragraph 2.7)

Products (TILLAPs), which will enable OCPs to acquire access and backhaul separately[76]. In relation to next generation networks, it is also envisaged that separate access and backhaul products will be made available to OCPs.

5.77 Moreover, competitive conditions in the supply of these services to MNOs and OCPs (as indicated, for example, by market share data) are essentially the same, both in respect of low bandwidth sales and in respect of very high bandwidth sales.[77] This suggests that circuits sold to MNOs should be considered to be supplied in the same market and be subject to the same bandwidth splits that apply in respect of circuits used by OCPs.

5.78 Ofcom therefore considers that fixed circuits acquired and self-supplied by MNOs are essentially the same as PPCs. Both sets of wholesale inputs are used for the same purpose (i.e. to provide fixed connectivity) and both are provided over the same technical input (i.e. fixed circuits provided over SDH/PDH technology).

Supply of microwave connectivity

5.79 The discussion above indicates that (internal and external) sales of 2 Mbit/s fixed circuits to MNOs belong in the low bandwidth TISBO market and that sales of 155 Mbit/s fixed circuits to MNOs belong in the very high bandwidth TISBO market. It is also important to consider whether either of these markets should be expanded so as to include microwave links, which are often the basis for self-supplied inputs by MNOs and which appear to provide the same quality of service and can provide a similar range of bandwidths as links provided over fibre.

5.80 An MNO that already has in place a fixed link would incur various costs in switching from fibre to microwave. These arise from the line-of-sight requirements of microwave technology. As was noted in the 2003/04 Review:[78]

> *This is because many of their [i.e. MNO] sites would not necessarily have line of sight that could enable microwave radio technology to be used. Hence these operators would find many of their sites unsuitable for self-provision through radio. They would need to incur significant investment costs in acquiring new sites to provision RBS backhaul circuits through microwave radio. Hence the threat of self-provision by these operators will only become effective if the costs of self-provision are below the costs of buying from BT.*

5.81 Our recent discussions with MNOs suggest that the costs of switching to microwave are likely to prevent microwave links being an effective substitute to fibre links in respect of low bandwidth links. While switching costs still apply in the very high bandwidth market, they are relatively small in the context of the value of the products being used and so are less likely to impede microwave and fibre being

[76] The availability of TILLAPs and TILLBPs would, in principle, enable parties to connect multiple access tails to and aggregate this traffic across a single backhaul circuit.

[77] Specifically, BT's share of 2 Mbit/s sales to OCPs alone is about 87% of the market. Less detailed information is available in regard to BT's share of 2 Mbit/s sales to MNOs. Indicative data provided by BT and OCPs indicates that BT has around 97% of sales to 2 Mbit/s lines to MNOs, but this excludes sales from at least one OCP which could somewhat dilute BT's market share. We believe that BT's share would not fall significantly, however, once these sales were included because most MNOs have informed us that they do not acquire substantial quantities of low bandwidth circuits from OCPs. For very high bandwidth sales, BT's share of 155 Mbit/s sales to OCPs alone is about 17%. Its share of sales to MNOs of 155 Mbit/s circuits is around 20%.

[78] See paragraph B.229

substitutes. In addition, as higher bandwidth links tend to be employed over longer distances any initial switching costs are likely be offset by the potential efficiencies of microwave links. Therefore Ofcom considers that only the very high bandwidth TISBO market should be expanded so as to include microwave links.

Proposed definition

5.82 We propose to include fixed circuits acquired and self-supplied by MNOs within the TISBO market based mainly on the following:

- Both sets of wholesale inputs are used for the same purpose (i.e. to provide fixed connectivity);
- These are technically equivalent, as both provide fixed circuits using SDH/PDH technology from an RBS (end-user) to a relevant point of interconnection;
- MNOs have sought to procure PPCs (rather than NetStream services) to deliver their network connectivity requirements;
- the competitive conditions of serving MNOs and OCPs (for example, as indicated by market share data) are essentially the same, both in respect of low bandwidth sales and in respect of very high bandwidth sales.

LLU backhaul

5.83 The final wholesale services that we consider might be included within relevant symmetric broadband origination markets are LLU backhaul services. We discuss below the nature of LLU backhaul services before assessing whether or not LLU backhaul should be classed as a symmetric broadband origination service.

LLU backhaul services

5.84 LLU backhaul services provide a link between OCP's LLU co-location facility and its core network nodes. Backhaul is required to connect the end users' local loop traffic to the communications provider's core network for subsequent connection to the relevant service provider. Although LLU backhaul is predominately used to convey asymmetric broadband access, this asymmetry is associated with the local end. The backhaul of traffic is provisioned on a symmetric basis and LLU backhaul services may be used as inputs to the supply of a variety of retail services, such as leased lines, symmetric broadband internet access or other data services. LLU backhaul services can in theory be provided using traditional or alternative interfaces, but demand has been for alternative interface circuits using BES services.

Assessment of LLU backhaul

5.85 LLU backhaul and SBO are not identical as LLU backhaul does not include a local end. If Symmetric Broadband Origination markets were defined to always include access and backhaul components then there would appear to be a lack of substitutability between LLU backhaul and SBO services (where these are defined to include both access and backhaul segments) as LLU backhaul would not include a local end. Supply side substitution analysis does not modify the conclusion of absence of substitution.

5.86 On the other hand, it might be possible for WES service to be demand-side substitute for an LLU backhaul link as a WES service could be used to link the local exchange to a CPs point of interconnection. Therefore, while LLU backhaul and SBO are not identical, both AISBO and LLU are used for the same purpose (i.e. to provide fixed connectivity) and both use fixed circuits using Ethernet technology from a local exchange or end-user to a relevant point of interconnection. [79]

5.87 In addition to both services providing similar functions, it is worth assessing the competitive conditions between the two services. In the 2003/04 Review, Ofcom argued that there were similarity of competitive conditions between SDH/PDH-based LLU backhaul links and TISBO and between Ethernet-based LLU backhaul links and AISBO. The 2003/04 Review argued that this arose because the same technology was involved between an operator's point of interconnection and a point in the local access network, which meant that the same type of entry barriers and economies of scale and scope are faced, especially those relating to digging and ducting. Ofcom further noted that competitive conditions for SDH/PDH-based LLU backhaul links and TISBO varied by bandwidth category (low/high/very high) whereas those for Ethernet-based LLU backhaul links and AISBO did not. Our assessment of competitive conditions based on market shares for WES and BES services shows these similarities in competitive conditions still apply.

5.88 As explained in Section 3, market definition is also not an end in itself, but a means to undertake an analysis of competitive conditions, for the purposes of determining whether ex-ante regulation is required or not. As noted earlier, demand-side and supply-side substitution are not always the most informative mechanism for the purposes of defining leased line markets. Neither the inclusion of access and backhaul in the TISBO and AISBO definition nor the geographic expansion of the market to cover circuits connecting to customer premises in different locations have been justified by appeal to demand-side and supply-side substitution. Therefore, the inclusion of LLU backhaul in the market on the grounds of similar competitive conditions and the similar functionality of LLU backhaul to AISBO is consistent with this underlying logic.

Proposed definition

5.89 Ofcom proposes to include LLU backhaul within AISBO market. This is based on:

- the two services, while not being identical, do provide the same functionally and fixed point to point bandwidth; and
- our assessment of competitive conditions, which suggests LLU backhaul faces similar competitive conditions to other origination services.

Issue 4: Wholesale trunk markets

5.90 Under this issue, we consider whether there are separate markets for wholesale trunk and symmetric broadband origination and where this break should be defined. We consider below the basis for finding separate markets in the 2003/04 Review. We then consider whether other relevant evidence such as competitive conditions and/or the bundling of access and backhaul products suggests separate trunk market.

2003/04 Review

5.91 In the 2003/04 Review, Ofcom noted that on the demand side, trunk and symmetric broadband origination were complements: the view was that they were not demand-side substitutes since they relate to dedicated capacity provided across different elements of BT's network.

5.92 On the supply side a hypothetical monopolist in the provision of either trunk segments or symmetric broadband origination would not be able to substitute into the other input without incurring the significant sunk costs (and amounts of time) required to build a distinct network. Given this lack of demand and supply-side substitution and the apparent absence of a common pricing constraint, we previously considered trunk and symmetric broadband origination constituted distinct wholesale markets.

Assessment of trunk versus symmetric broadband origination

5.93 As concluded in the 2003/04 Review, the complementary nature of the products provided a basis for considering trunk and origination in separate markets. It is worth examining a two factors relevant to market definition:

- The different competitive conditions between trunk and access/backhaul; and
- The fact that a significant number of OCPs do not acquire trunk together with access/backhaul services (i.e. these services do not operate as a cluster market).

5.94 These factors are viewed as being inter-related because the existence of competing trunk services will reduce the extent to which trunk and access/backhaul are acquired on a bundled ('end to end') basis. Where OCPs have built their own trunk network, they might be expected to provide retail services by self-supplying trunk facilities and only acquire access and backhaul services from BT. Even where an OCP does not have its own trunk network in place, the presence of competing trunk services from other OCPs was also considered to potentially explain the unbundled acquisition of trunk and access/backhaul services.

5.95 Ofcom has considered below whether these factors (i.e. variations in competitive conditions and the nature of trunk and access/backhaul procurement) are likely to continue to place trunk in a separate market to symmetric broadband origination services.

Competitive conditions

5.96 Turning to the first of these factors, trunk services are potentially more competitive than access/backhaul because of the ability to aggregate various traffic streams across a core network. This means that the economies of scale which may impede investment for terminating segments in some locations should not be present in core networks to the same extent. As shown in the geographic market assessment below, many OCPs have substantial core networks used for the bulk transmission of traffic. By contrast, the more limited ability to aggregate traffic in the local access network means that access segments cannot generally be economically replicated and this is also likely to apply (albeit to a lesser extent) to backhaul.

5.97 The different competitive conditions across trunk and access/backhaul markets are best illustrated by way of an example. Taking a CP that wished to deliver a retail service to connect two remote rural offices, one in the Midlands and one in the

Southeast. That CP could find that it could potentially choose amongst a number of wholesale competitors when it came to obtaining trunk services. In contrast, there would be lower likelihood that any facilities-based competition would exist from the core nodes onwards to more rural locations.

5.98 This point made in the above example may also apply to urban areas (where it was previously thought more access investment was viable). In discussions with CPs, Ofcom has been told that the cost of digging trenches in urban areas has risen in recent years. Installing cables in footpaths – a lower cost option – is now less viable because of the large amount of cabling/piping already in city centre pathways. Digging in the carriageway is more expensive not only because of costs that need to paid to local councils for disruption (e.g. for traffic diversions, bus lane closures), but also because the cost of digging the trench itself is much higher.[80]

5.99 In other representations some CPs have noted that it will become relatively less efficient to build out in the future. For PPCs the cost of SDH/PDH equipment dominates, and all operators buy similar equipment placing them on an equal footing. But under 21CN and in relation to Ethernet services the equipment costs reduce, resulting in costs that are increasingly accounted for by fibre and maintenance. This means that a greater proportion of costs are likely to be accounted for by inputs subject to economies of scale.

5.100 On the other hand, the discussion above in relation to access and backhaul under issue 1 explained that converged backhaul developments may well increase aggregation opportunities and scope for competitive provision, although it is likely that scale and scope opportunities will also benefit BT. In any case, within the timeframe of this review, the above factors point to variations in competitive conditions that are likely to exist between trunk and symmetric broadband origination services such that they are likely to fall in separate markets.

Bundling of trunk and access/backhaul services

5.101 Turning to bundling, as explained above, if it is found that operators generally acquire services together, these services might be viewed as a cluster market. In these circumstances, where a retail circuit would naturally require a trunk segment (for example where it is delivered over longer distances) it may be the case that an OCP buying an SBO product would also buy a trunk segment from the same operator.

5.102 To assess this, we compared the proportion of retail services that are likely to require a trunk component against the percentage of PPCs sold by BT to OCP which include a trunk segment. If trunk and SBO are generally sold as a bundle then it might be expected that these proportions would be approximately the same. On the other hand, if trunk is more often competitively (self-) supplied by the OCP than is SBO, the proportion of BT's sales of PPCs which include trunk will be lower than the proportion of retail sales which include a trunk segment. The results of this analysis are set out in Table 9 below.

[80] For example, trenches in the carriage have to be dug deeper, and filled with concrete (rather than the cheaper ballast used in path trenches). Further, trenches in carriageways are able to accommodate a greater number of ducts, which increases the efficiency of using existing trenches rather than building out to particular sites.

Table 9: Proportion of PPCs using a trunk segment

	Retail market requirements (OCP)		BT sales of PPCs to OCPs	
Circuit type	No trunk	With trunk	No trunk	With trunk
TISBO – low	48%	52%	55%	45%
TISBO - High	41%	59%	43%	57%
TISBO – Very High	39%	61%	32%	68%
All TISBO	47%	53%	55%	45%

Source: Ofcom

5.103 The above table shows that, on average more than half (53%) of OCPs' retail circuit sales include a trunk element. This is higher than the proportion (45%) of PPCs sold to OCPs by BT which include a trunk segment. This suggests that, whilst in the majority of cases, both trunk and SBO are purchased from BT, in a significant number of cases, the trunk element is not provided by BT as part of a bundle with SBO

5.104 Our analysis has also considered differences across bandwidths. At high bandwidths the proportion of PPCs which include trunk segments is slightly lower than the proportion of retail circuits with trunk requirements. This pattern is not seen however to the same extent at Very High Bandwidths (interestingly Ofcom has found the very high bandwidth TISBO market to be effectively competitive) where the proportion of BT PPCs including trunk segments is higher than the proportion of retail circuits which include trunk.

5.105 However for sales of PPCs that also include a trunk element, it is not necessarily the case that BT supplies the total distance of the required trunk segment. OCPs may have their own core network but they may not have built out to all Tier 1 nodes. OCPs might therefore purchase a PPC with a trunk element, but this trunk segment might be over a relatively short distance from BT's Tier 1 node to their own point of interconnection at another Tier 1 node nearby. Hence, OCPs that have not interconnected at all Tier 1 nodes may still provide a significant proportion of the required trunk using their own core network.

5.106 To assess this issue we have analysed the above PPC sales excluding sales of trunk segments over short distances. This analysis grouped together any intra-City traffic and Tier 1 nodes in close proximity[81]. This would mean, for example, that any traffic between Tier 1 nodes in London would not be counted as trunk. This assessment suggests that the estimated proportion of retail circuits requiring trunk would fall significantly. If short distance trunk routes are excluded, then only around 18% of OCPs' retail circuit sales would still require a trunk segment.

[81] This is based on Ofcom's analysis set out under our geographic assessment, which identifies 39 "aggregation nodes" in mainland UK and a separate node in Belfast.

5.107 Undertaking the same analysis for BT's sales of PPCs would suggest that only 10% of PPCs would require a trunk segment. This compares to an estimated 18% of OCPs' retail circuit sales would still require a trunk segment (once short distance trunk circuits are excluded). The comparison of these two figures suggests that in much more than 50% of cases (where a trunk segment is required) a PPC will still be sold with trunk segments.

5.108 The above results suggest that where OCPs acquire access/backhaul services then often, though in by no means all cases, this also includes a trunk segment. Our analysis suggests however that OCPs' purchases of PPCs often only include a small trunk component (for example from a T1 node to a point of interconnection nearby). However, important differences still exist between the two markets, such as the greater opportunity for traffic aggregation which generally makes it more likely to be economic for OCPs to self provide trunk segments and suggests that competitive conditions differ from those in SBO markets.

5.109 Our analysis suggests that the extent to which SBO and trunk segments are purchased together, although significant, is not sufficient to justify treating them as part of a single "cluster" market.

Supply-side analysis

5.110 On the supply side a hypothetical monopolist in the provision of either trunk segments or symmetric broadband origination would not be able to substitute into the other input without incurring the significant sunk costs (and amounts of time) required to build a distinct network.

5.111 Given the lack of demand and supply-side substitution described above, and the apparent absence of a common pricing constraint, Ofcom considers that trunk and symmetric broadband origination continue to constitute distinct wholesale markets.

Location of the breakpoint between trunk and symmetric broadband origination

5.112 In the 2003/04 Review, the breakpoint between symmetric broadband origination and trunk segments was specified as BT's Tier 1 nodes. The equivalent nodes on other communications providers' networks were then used to identify the relevant breakpoint between origination and trunk markets services on those networks.

5.113 The choice of Tier 1 as the breakpoint was based on evidence BT supplied to Ofcom as part of the 2003/04 Review regarding the extent of other communications providers' networks. This evidence showed that a significant number of other communications providers had built their networks to within close proximity of many of BT's Tier 1 nodes on BT's SDH/PDH network, whereas there was a relatively small amount of interconnection at other nodes. Handover therefore took place, in the main, at Tier 1 nodes.

5.114 Although many OCPs did not always build their own core networks to all of BT's Tier 1 nodes, on a practical basis, Ofcom considered that it would be difficult to find a sufficiently generic market break that is consistent with the actual locations where operators choose to interconnect their networks and reflects the differences between the cost and competitive conditions associated with trunk and backhaul. This led us to consider that BT's Tier 1 nodes as providing the appropriate cut-off point.

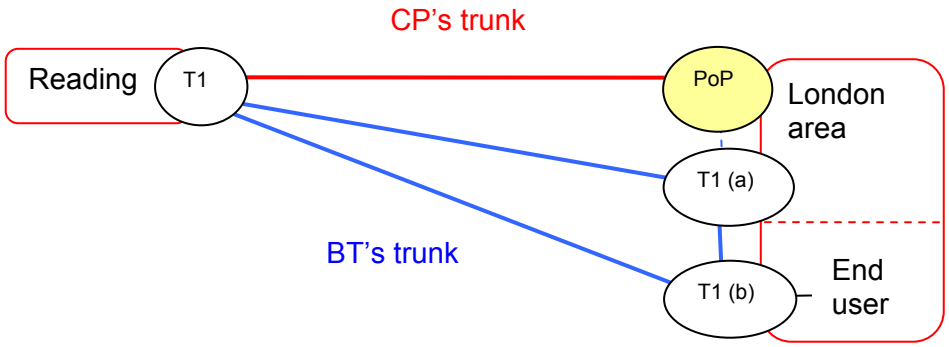
5.115 We consider below whether it is appropriate to redefine the break between terminating and trunk segments. This is considered both in terms of BT's current network topology and how this might change on a forward looking basis (i.e. until 2012).

Assessment of the trunk definition based on Tier 1-nodes

5.116 As discussed in our assessment of trunk versus SBO, the fundamental differences between the two network elements relate to the opportunities for OCPs to compete for trunk segments. In particular, the nature of transport between major network points generally should provide CPs with greater (potential) opportunities to realise greater economies of scale and scope than is possible for terminating segments. This is consistent with the view in the TSR which identified access and backhaul as enduring bottlenecks, whereas trunk capacity was not. On the basis of this distinction between trunk and backhaul, the trunk market definition should be expected to capture these differences.

5.117 We have used a simple example of network provision in Figure 34 below to explain why defining trunk on the basis of circuits between BT's Tier 1 nodes may not allow us to accurately estimate potential competitive conditions for trunk.

Figure 34: Trunk definition based on Tier 1 nodes



5.118 In the above example, a CP wishes to provide a low-bandwidth retail leased line between an end-user premises in the London area and another premises in Reading. It is assumed that the CP requires a terminating segment, purchased from BT, to connect the London premises to the parent T1 node (T1 (b) in the figure above). The CP has its own trunk capacity from its point of presence (PoP) in London to the Tier 1 node in Reading, so it can self-provide the trunk element across this route. As the CP is interconnected to another T1 node in the London area (T1(a)), if it is to provide the retail circuit required by the customer, it would need to purchase a circuit connecting the two London T1 nodes T1(a) and T1(b). Under the definition of the trunk market adopted in 2003/04 Review, this latter circuit would be regarded as a trunk circuit.[82].

5.119 Ofcom believes it should reconsider, in this review, whether treating circuits connecting Tier 1 nodes within a single urban centre as trunk circuits is appropriate for the purposes of assessing SMP in the trunk market(s). Given that the market definition exercise is a means to an end; that end being the assessment of market

[82] The wholesale circuit between T1(a) and T1(b) would therefore also be charged at rates applying to trunk circuits.

power, it is important that our market definition captures the key competitive differences between trunk and SBO markets.

5.120 It is useful to begin by considering the nature of competitive constraints at the retail level. The retail customer's requirement is for a circuit linking its two premises in London and Reading. This customer is presumably indifferent to the route taken by the circuit between these two points, except insofar as this affects price and quality. At the retail level, there is therefore likely to be a common pricing constraint between the "BT trunk" route to Reading shown in the figure above, and the CP trunk route, provided the additional cost caused by the CP's need to route the circuit via T1(a) is not too large (for example, not larger than a SSNIP on the retail price).

5.121 This suggests that it would not be correct to define each route between pairs of T1 nodes as a separate market. This is likely to be too narrow a definition because it would take no account of the constraint on the price of a circuit between one pair of T1 nodes (such as between T1(a) and Reading in the figure above) provided by the existence of a circuit linking a different pair of nodes which are located adjacent to the first pair at either end of the circuit (such as T1(b) and Reading in the figure). If it is economic from the CP's perspective to backhaul traffic from the end-user premise to its PoP in London then it would be able to compete to supply retail circuits between London and Reading using its own trunk capacity. This would suggest widening the definition of the trunk market to appropriately capture the ability of the CP to compete against BT (which of course is connected at both T1(a) and T1(b)) to supply leased circuits between London and Reading, using its own trunk capacity, by including in the market circuits between Reading and both T1(a) and T1(b).

5.122 In order to consider further the appropriate treatment of circuits between Tier 1 nodes within an urban centre, we now turn to the wholesale level. Earlier in this section we identified separate markets for SBO and trunk segments, after considering possibilities for demand and supply-side substitution and competitive conditions. In particular, Ofcom concluded that

- On the demand-side, trunk and SBO are complements rather than substitutes. It is clear from the figure above that a trunk link between London and Reading, for example, would not be a substitute for the connection between the end user premises and the first T1 node:

- On the supply-side, the significant sunk costs and time necessary to build an access or trunk network would prevent supply-side substitution from the SBO market acting as a constraint on trunk prices and vice versa:

- There are significant differences in competitive conditions between trunk and SBO, with the potential for competition in the former being generally greater. This conclusion was informed by a comparison of the proportion of OCP's retail circuit sales which include a trunk segment with the proportion of BT's sales of PPCs to OCPs which include a trunk segment. The former was (materially) higher than the latter which suggests that trunk capacity is not simply purchased from BT as part of a bundle with SBO. In addition, it was the similarity of competitive conditions between access and backhaul which led Ofcom to place them together in a single set of SBO markets.

5.123 A similar approach can be applied to links between Tier 1 nodes within an urban area. From the point of view of the CP in the example above, which has its own trunk capacity between T1(a) and Reading, it is clear that a circuit linking T1(a) and

T1(b) is not a demand-side substitute for any of the other elements needed to create an end-to-end connection in order to supply the retail circuit. Rather, this link is likely to be seen as complementary to SBO and its own trunk capacity on the route to Reading, and possibly also to trunk capacity on routes from T1(a) to other urban centres, if the operator has any (although it is conceivable that, under some circumstances, it could also be seen as a substitute for a circuit linking T1(b) and another T1 node in London, if such a node exists sufficiently close to the end user premises). Supply-side substitution is also unlikely to be relevant, for the reasons set out above, that is, the sunk costs associated with building new network capacity.

5.124 This suggests that the key issue is likely to be that of competitive conditions, as with the distinction already made between trunk and SBO. That is, do competitive conditions in the supply of links between T1 nodes within an urban centre, such as that between T1(a) and T1(b) above, more closely resemble those in the SBO market or those in the trunk market (for circuits between urban centres)?

5.125 Ofcom believes that competitive conditions in links between T1 nodes in the same urban area are more likely to resemble those of backhaul (within the SBO market) than those of inter-urban trunk. This is because of the greater possibilities for aggregation of traffic, and hence ability to benefit from economies of scale which exist within the core of networks, which would generally be used to provide the latter.

5.126 CPs such as the one in our example will attempt to compete for retail circuits between two distinct urban areas, perhaps from a single PoP located in each urban centre. This is in order to maximise utilisation of its capacity between the two areas and so minimise costs. In general, CPs will not see merit in locating points of presence at all BT's Tier 1 in a single urban centre. If there are Tier 1 nodes where CPs are not located (as it is not economic to roll-out further network) then this suggests that competitive conditions in the inter-T1 links within an urban area are closer to that of backhaul. For example, if node T1(b) above served very few end-users, then given that the CP has a PoP in close proximity at T1(a), it would not be economic for the CP to further invest in building out its network to connect at T1(b) as well.

5.127 This is consistent with Ofcom's analysis of the proportions of retail circuits and PPCs which contain a trunk element set out above. In paragraph 5.103, we noted that, if trunk circuits are defined as those between T1 nodes, then some 53% of retail circuits contain a trunk element compared to 45% of PPCs. In paragraph 5.107, it was noted that, when trunk circuits were defined as excluding links between T1 nodes within an urban centre, these proportions dropped to 18% and 10% respectively. This suggests that where an inter-urban trunk link is required, the likelihood that it will be purchased from BT along with SBO (55%) is significantly lower than the average likelihood for all circuits requiring a connection between two T1 nodes (nearer to 85%).

5.128 A consequence of defining trunk as inter-Tier 1 circuits may therefore be that some routes are labelled as trunk when they share more of the characteristics of terminating segments (i.e. routes that are more likely to be enduring bottlenecks). This will tend to overstate BT's market power for trunk segments, considered as a whole. On this basis, it would be preferable to treat circuits between Tier 1 nodes within an urban area as terminating segments reflecting the fact that it is most economic for the CP to backhaul any traffic to its point of presence using a BT wholesale circuit.

5.129 So far our discussion has only set out conceptually why (in the context of our example in figure 26) the inter-Tier 1 definition may be inappropriate. Clearly, it important to examine in more detail the extent to which this issue is likely to be material. And, if so, it would also be important to determine an alternative break between trunk and symmetric broadband origination other than Tier 1 nodes.

5.130 However, as leased lines have an inherent geographic element (i.e. given their point to point and location specific nature), examination as to whether the Tier 1 node remains an appropriate boundary between trunk and SBO cannot be undertaken without further examining specific geographic market conditions. We have therefore discussed under our geographic analysis the precise basis for identifying defining the boundary of the trunk market in Section 6.

Proposed definition

5.131 As per the 2003/04 Review our market definition identifies a separate market for trunk segments. This is based on:

- the complementary nature of trunk and SBO services and purchasing of trunk and SBO; and
- fundamental differences in the economics of trunk versus SBO which are likely to result in prospectively more competitive trunk.

5.132 Given the inherent geographic nature of trunk routes, it is only possible to assess the appropriate basis for identifying the break between trunk and SBO based on a detailed geographic market analysis (which is discussed in Section 4).

Issue 5: Wholesale trunk versus broadband conveyance services

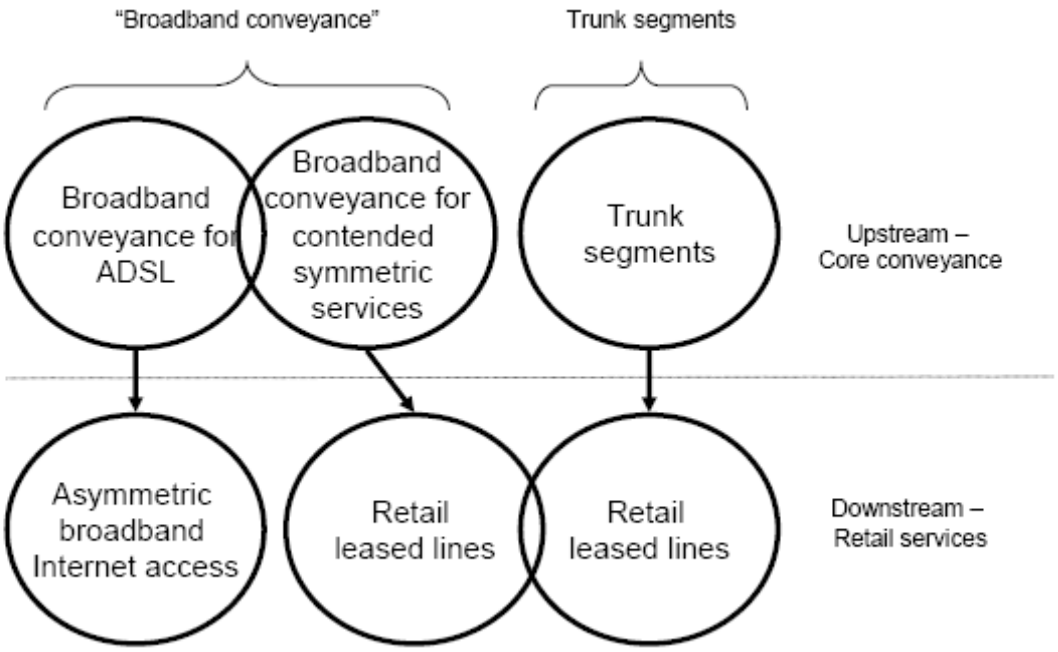
5.133 Under issue 5, we assess whether the trunk market relates to circuits for SDH/PDH traditional interface services only or whether a wider market exists including other forms of core connectivity such as broadband conveyance. We consider first the approach adopted in the 2003/04 Review before undertaking a revised assessment of the scope of the trunk market. This assessment is based on developments since the last review and a forward-looking assessment of relevant markets.

2003/04 Review

5.134 In the last market review, Ofcom's view was that there were two types of conveyance (trunk segments and broadband conveyance) which could be used as inputs to retail leased lines and other business connectivity services. For example, for SDSL services, the review noted that contended services were typically offered across the ATM network (defined as broadband conveyance), whereas uncontended services were typically offered across the SDH/PDH network (trunk). Because retail SDSL (contended or uncontended) and traditional leased lines services were substitutes at the retail level, there was a question whether trunk and broadband conveyance were both in the leased lines market.

5.135 The interrelationship between trunk and conveyance markets was set out in the last market review in the following diagram.

Figure 35: LLMR 2003/04 markets for trunk and conveyance



5.136 The LLMR concluded that broadband conveyance was in the wholesale broadband access market. The implication of identifying distinct economic markets was that the "core" network element of leased lines (e.g. contended leased lines offered over SDSL) that are conveyed by means of virtual paths (e.g. over ATM networks) fell within the broadband conveyance market, which at the time formed part of the wholesale broadband access ("WBA") market (broadband conveyance could also be used to deliver retail asymmetric broadband access services).

Assessment of trunk versus broadband conveyance

5.137 We have considered below the appropriate definition of trunk and conveyance services:

- changes to the definition of broadband conveyance as part of the WBA market review; and
- potential developments in network provision as part of the transition to NGNs.

5.138 We discuss the potential significance of these developments in turn below. Following this, we have undertaken an assessment of demand and supply-side substitution possibilities between trunk and other conveyance services.

Proposed changes to asymmetric broadband origination

5.139 In Ofcom's WBAMR, it has proposed to define the market as access and any necessary backhaul to a CPs point of interconnection. The implication of this proposal is that a separate market has not been proposed for wholesale broadband conveyance, which is upstream of the wholesale broadband access market definition. The proposals in the WBAMR reflect a forward looking view of inputs into the wholesale broadband access market. Operators providing retail broadband

services either use LLU-based remedies (combined where necessary with Backhaul Extension Services and/or their own network), or otherwise provision on the basis of BT's wholesale end-to-end services (i.e. currently known as IPStream products).

5.140 However, given that the provision of contended SDSL services would rely on broadband conveyance across the ATM network, we have considered the implications of this for the LLMR product market definition. At the retail level, we have proposed to include retail SDSL services within the TI market. The question is whether the relevant wholesale conveyance services used to deliver contended SDSL should be included in the trunk market. In addition other services that are in separate retail markets such as Virtual Private Networks would also make use of conveyance networks (ATM or IP based networks) to deliver "core" segments.

Potential changes to the nature of core connectivity

5.141 Potential developments in network provision are occurring, in particular the transition to NGNs. One of the main implications of an NGN is its ability to support multiple services over a common set of infrastructure. This may therefore reduce the need for different forms of interconnection at different locations.

5.142 The nature of conveyance on an NGN may well enable greater ability to "emulate" dedicated leased line services due to improved management of priority traffic and increased support for SLAs on latency and jitter. In the case of BT's NGN, the IP-based conveyance will sit above an underlying SDH-based network. It is unclear however on the precise development of products using IP-based conveyance going forward. However, it does appear that BT will offer the ability to access directly the SDH-layer. This may suggest that there will be ongoing demand for SDH-based trunk services.

Assessment of trunk versus other conveyance markets

5.143 This section assesses whether the trunk services that form part of the leased lines trunk market are constrained by other conveyance services. As with other leased lines services, it is necessary to identify all relevant products which provide a sufficient constraint on each other. Generally, this involves assessing direct constraints by assessing demand-side and supply-side substitution opportunities. However, when defining wholesale product markets it is also possible that substitution at the retail level provides an indirect constraint on the pricing of wholesale products.

5.144 Accordingly, Ofcom's approach takes into account the effect of indirect substitution through applying the SSNIP as if it were passed through to the retail market. The impact of the upstream SSNIP is 'diluted' as the wholesale trunk is only one input into a retail leased line service. Hence, the question is whether a SSNIP at the trunk level (which would translate to a more limited price increase at the retail level) would prompt sufficient retail switching to make such a trunk SSNIP unprofitable.

5.145 For the purposes of market definition, we have started with a relatively narrow definition based on dedicated SDH/PDH capacity used to support relevant traditional interface markets. The potential substitute services to these wholesale trunk segments are referred to collectively as "broadband conveyance" services (including ATM or other IP-packet based services). Within the timeframe of this review, there is also a potential for "native Ethernet" conveyance services to be available. We have therefore included an assessment of alternative interface trunk services within our forward-looking assessment.

5.146 In the 2003/04 Review, BT pointed out that many communications providers had already built their networks to the majority of BT's Tier 1 nodes in order to interconnect with voice switches at these nodes. Ofcom took the view then that interconnection at voice switches was insufficient to constrain BT's pricing of trunk segments. This was primarily because interconnection at BT's DMSU sites would not enable a communications provider to buy PPCs from the corresponding Tier 1 node unless it has PPC/PSTN interconnections at these points, or it has co-sited PPC interconnections at the location. In any case it would be necessary to incur additional costs to convert a PSTN interconnect to a PPC/PSTN interconnect. Ofcom's view is that this continues to be the case at present and for the time period relevant to this review. Although, as discussed earlier, this may change once fully converged (NGN) networks are built out PSTN conveyance is regarded as outside the market for trunk segments in this review.

Direct constraints

5.147 In this section, we consider whether a direct constraint exists between trunk and broadband conveyance. In particular, we consider whether a hypothetical monopolist of trunk segments would be constrained from imposing a SSNIP by demand or supply-side substitution by CPs between trunk and broadband conveyance.

Demand-side substitution

5.148 We consider below demand-side substitution based on a qualitative assessment of functionality of trunk and other conveyance alternatives. We then consider the potential impact of a SSNIP on trunk in terms of direct and indirect constraints.

Functionality of trunk and other conveyance

5.149 The distinguishing characteristic of services within the broadband conveyance market, as opposed to trunk segments, is that they offer a high degree of flexibility, using virtual paths, principally for contended services. In BT's case, the services that it offers in the broadband conveyance market are currently conveyed over its ATM network, via the DSLAM, although alternatives to ATM may be used on a widespread basis in future. In particular, BT's 21-CN would provide packet-based conveyance services.

5.150 Across BT's networks, trunk segments and broadband conveyance are in the main offered over the same underlying infrastructure, with a degree of extra investment having been made in the relevant layer in order to run the ATM protocol in the case of broadband conveyance. ATM is currently used in the conveyance of ADSL and SDSL based services because it offers flexibility and allows, on a per user basis, virtual paths to be offered at low unit cost.

5.151 At least technically, conveyance services can be used to provide services to retail customers that are presented as uncontended due to routers offering traffic prioritisation or the use of dedicated paths. In many cases, the performance that could be offered using either SDH-trunk or dedicated paths across other conveyance networks should be broadly acceptable for most users.

5.152 However, it is less clear that traffic prioritisation would deliver the same quality of service for those users that value low latency services. Evidence from BT's planned roll-out of products on its 21CN tends to support this view. It appears that BT is planning to offer trunk services based on access to the the underlying SDH-layer

that underpins the 21CN infrastructure as well as IP-based trunk services. Therefore, this ongoing demand for direct access to SDH-trunk services reflects the perceived higher quality of service. Hence, there appears that there will be continued demand for TDM based services. Although it might be possible for some current users to use "emulated" services which rely on QoS and prioritisation in the IP layer to deliver leased lines services.

5.153 However, to the extent the factors that impact on separate markets for dedicated SDH/PDH services at the retail level using TDM are likely to continue to be reflected in demand for services using SDH trunk.

Hypothetical monopolist test

5.154 Ofcom considers that demand-side substitution at the wholesale level would be unlikely to occur when viewed from the perspective of broadband conveyance switching to dedicated SDH-trunk. This is because switching from providing a retail service using contended conveyance capacity to providing SDH-trunk would erode the main benefits (such as flexibility and the efficiency advantages of shared capacity) of using contended conveyance services.

5.155 In the case of a SSNIP on SDH-trunk segments, as discussed above, a user could switch to using a dedicated path across a broadband conveyance network. However, in doing so, a CP would be by-passing the contended aspect of the packet-based conveyance service. The other functionality offered for example by ATM (i.e. flexibility) would be less valuable in the case of “traditional” dedicated leased lines as these services do not seek flexibility to the same extent as contended conveyance services.

5.156 In addition, for some users of SDH/PDH services with very strict quality of service requirements, it may not be possible to replicate SDH/PDH-trunk over dedicated broadband conveyance capacity. Therefore, in response to a SSNIP on trunk services, Ofcom consider that wholesale providers would be unlikely to switch using SDH/PDH-trunk to other conveyance services in order to deliver traditional interface services.

Supply-side substitution

5.157 Ofcom’s view is that supply side substitution is not a relevant consideration in this context. This is because a hypothetical monopolist in the provision of broadband conveyance is likely to also be a supplier of trunk segments, and vice versa. This means that supply side substitution is unlikely to provide sufficient additional competitive constraints to justify broadening the market definition.

Barriers to switching

5.158 There may be other barriers to a CP currently purchasing trunk switching to an alternative conveyance service. Take for example an OCP currently using SDH-trunk to deliver a traditional interface retail service. Under the above hypothetical monopolist test, we considered whether an OCP would switch to using dedicated paths over its own conveyance network (or provided by another wholesale provider). Clearly, for the purposes of a SSNIP test, it would only be relevant to consider an OCP using its existing capacity as there would be considerable fixed costs to deliver new capacity.

5.159 If an OCP sought to use its own existing conveyance capacity as a potential substitute to a trunk segment it would potentially need to interconnect or backhaul traffic to relevant ATM nodes. These ATM nodes might not coincide with the current interconnections (i.e. at SDH Tier 1 nodes or, more correctly, the "aggregation nodes" proposed under Ofcom's trunk definition).

5.160 Hence, if a hypothetical monopolist imposed a SSNIP on trunk, it would not necessarily be easy for a CP to simply migrate those dedicated trunk segments to traffic over a conveyance network without incurring significant costs.

5.161 Looking at the available evidence on possible barriers to switching, in many cases CPs have built extensive conveyance networks. However, our assessment of BT shares of trunk routes suggests that OCPs are not using these networks to provide SDH/PDH trunk to the extent that might be expected by this network presence. This tends to support the view that there are potential barriers to switching capacity from the provision of other services in order to self-supply trunk segments.

5.162 In order to understand this further, we asked CPs what barriers they face in relation to trunk interconnection. One major CP highlighted that the investment required in new interconnect and associated infrastructure is very large. This would include circuit rearrangement costs associated with interconnection; as well as costs associated with the transmission infrastructure to support traditional interface services on their own network. The CP also highlighted current uncertainities regarding the development of traditional interface services (particularly its status on the NGN), which would result in relatively short payback periods for investment in any self-provided trunk. Such barriers to switching might therefore significantly limit the use of existing network capacity to provide SDH/PDH trunk.

5.163 It is less clear however in relation to next generation networks whether such barriers would exist to the same extent. This is because NGN networks will offer the potential for multi-service interconnection. On this basis, an operator with its own conveyance network that had interconnected at the major nodes should in principle be able to backhaul traditional interface traffic and broadband traffic to the same interconnection points. This should help reduce (although may not completely eliminate) switching costs.

5.164 However, as noted in our Wholesale Broadband Access Market Review[83], while there is expected to be migration of wholesale broadband access products to next generation infrastructure, we noted in that review the inherent unpredictability at this time of the precise method by which these services will be delivered. It is also difficult in the context of this LLMR to assess at this stage the precise implications of the migration to next generation networks and the ability of CPs to achieve multi-service interconnectivity.

5.165 While in principle the potential removal of these barriers to switching might occur within the within the timeframe of this review, the precise nature of NGN interconnection for a number of different services is unknown. In any case, we have not relied only on the presence of these switching costs to define separate markets for SDH-trunk and broadband conveyance.

[83] http://www.ofcom.org.uk/consult/condocs/wbamr07/

Indirect constraints

5.166 We have also considered within our market definition of SDH-trunk versus broadband conveyance whether any possible indirect constraints exist. Indirect constraints can arise because competition between services served by trunk and other conveyance inputs can take place further downstream at the retail level.

5.167 Retail prices can be regarded as being comprised of a number of input costs and one of these input costs can be characterised as the cost of a wholesale service. If the price of this wholesale service were to increase, and all other elements of the retail service were priced at the competitive level, this would translate into a price increase at the retail level. However, such a price rise would be "diluted" somewhat as the retail cost stack includes retail costs as well as the costs of wholesale inputs (with the result that a 10% increase in the wholesale price results in a less than 10% increase in the retail price).

5.168 As wholesale trunk price increases will have an impact at the retail level and retail level switching could impose an indirect constraint on a hypothetical monopolist of trunk segments. This could occur if the resulting price rise at the retail level prompted sufficient numbers of users to switch from retail services using trunk to a retail service that relied on broadband conveyance as an input.

5.169 It is therefore relevant to consider any services that we proposed to find in the same market at the retail level but that use different conveyance to deliver their core connectivity. At the retail level, Ofcom found leased lines in separate market to VPNs and ADSL. On the other hand, at the retail level contended SDSL and digital PDH/SDH services are found in the same market (via a chain of substitution) and therefore indirect constraints could still be relevant here.

5.170 However, it is unlikely that a SSNIP at the wholesale level would be sufficient to prompt switching from a dedicated SDH or SDSL service to a contended SDSL service. This is because a SSNIP on trunk (conveyance) would not result in as large an increase in the retail price of SDH (SDSL). To assess this, Ofcom has considered below the potential impact of a 10% SSNIP on trunk segment. This is based on an estimated price of wholesale trunk segments as 25-50% of the total price of end-to-end wholesale service. Given the impact of a SSNIP on trunk, on wholesale input prices, we then consider how this would feed through into a price rise at the retail level. For the purpose of this calculation, we have assumed that the sum of the prices of the wholesale inputs is approximately 85% of the end-to-end retail price.[84]

[84] Within the WBAMR – Ofcom estimated that a SSNIP on a wholesale broadband access product would represent approximately 85% of the retail price. If this percentage is reflective of the retail uplift for broadband conveyance services, then it can provide a basis for estimating the likely dilution factor for an SDSL service.

Table 9a: Estimated impact of 10% SSNIP on trunk on retail prices

		Indicative trunk costs as % of wholesale price	
		25% of wholesale price	50% of wholesale price
Impact of 10% SSNIP on trunk segments:	At wholesale level	2.5%	5%
	At retail level (assuming 85% dilution factor)	2.1%	4.2%

5.171 The above table suggests that a 10% SSNIP on trunk segments would result in a price increase of 2-4% at the retail level. We have compared this to the results of our end-user research to consider whether such a price increase would be likely to prompt sufficient switching at the retail level to render the SSNIP on trunk unprofitable.

5.172 From the results of our end-user research[85], it is possible to infer the impact of a 2-4% price increase on switching between digital SDH/PDH and SDSL services. These results suggest that a 2-4% retail increase would cause between 7 to 14.5% to switch to an alternative service, which would be below the estimated critical loss range that was applied in Section 3.[86] This suggests that a SSNIP on trunk segments would be profitable and that therefore indirect constraints from broadband conveyance would be too weak to justify placing it in the same market as trunk segments.

Forward looking assessment

5.173 Based on the above discussion, our current assessment is that there is a separate SDH/PDH-trunk market for circuits used to support relevant downstream TI services. Therefore, our proposed definition of trunk would be in relation to SDH/PDH capacity used for the purpose of traditional interface services between relevant nodes.

5.174 Within the timeframe of this review, there are potential technology developments that would support the provision of “native” Ethernet services. We have therefore assessed whether these potential developments might impact on the above trunk definition.

5.175 As noted under Issue 2 of our retail product market definition, a key driver for improving the relative performance of AI versus TI services will be the deployment of Carrier-class Ethernet by CPs. This is a superior Ethernet standard developed to overcome the traditional limitations of the current Ethernet standard such as the ability to support carrier-class SLAs/SLGs. Currently, AI retail services are not

[85] For all digital SDH/PDH users, our end-user research suggests that around 34% of users were likely to switch in reality to avoid a 10% SSNIP at the retail level (which is above the critical loss factor likely to render a SSNIP unprofitable). Using this result (i.e. 34% of users switching in response to a 10% price rise) and if a “linear relationship” were assumed between price and the volume of switching would imply that each percentage point increase in the retail price would prompt a 3.4% increase in switching.
[86] This was estimated at between 16-21% at the retail level. We have therefore applied a similar critical loss factor for the purposes of this analysis.

available using trunk segments (although Ethernet can be supporting over longer distances (e.g. using Ethernet over SDH; and Megastream Ethernet using ATM network).

5.176 In our assessment of retail substitution between traditional interface and alternative interface products, we highlighted that the capability to support SLAs/SLGs over Ethernet to PDH/SDH standard is yet to be realised. However, it was considered likely that within a timeframe of 3 or so years, at a technical level, the issues are likely to have been overcome. However, in our retail assessment, we considered that this did not necessarily imply that Carrier-class Ethernet will have been rolled-out to a sufficient degree to impose a sufficient constraint on existing SDH/PDH services.

5.177 Ofcom notes that the precise deployment of carrier-class Ethernet is highly uncertain and depends on both the technological issues as well as BT and CP's migration plans. Over the next three years the available evidence suggests that technology issues will persist. In addition, it is unlikely that a fully realised wholesale product (or OCPs moving to greater self-supply of trunk circuits) capable of providing a direct constraint on SDH/PDH trunk will emerge within the timeframe of this review. On this basis, we consider that a separate SDH/PDH trunk market will remain for the duration of this review.

Proposed definition

5.178 Ofcom proposes to define a separate market for trunk segments used to support digital SDH/PDH services. This is based on lack of direct or indirect constraints and potential barriers to switching. As we noted above, some of these issues might be overcome within the timeframe of this review. However, the precise timing of the development of core connectivity for example in relation to AI markets remains highly uncertain. On this basis, we propose to keep these developments under close review. If major changes were to occur within this period, we would be minded to undertake a further market review.

Issue 6: Wholesale bandwidth breaks

5.179 Under this issue, we consider whether or not the bandwidth breaks identified at the retail level for AI and TI markets map onto the separate wholesale market for AISBO, TISBO and trunk services. We therefore consider below whether the demand and supply-side analysis used to inform our retail definition is relevant to inform potential bandwidth breaks at the wholesale level for Trunk, AISBO and TISBO markets.

Demand-side analysis

TISBO and AISBO

5.180 Ofcom considers that for access segments of SBO service market bandwidth breaks will correspond to the breaks that apply to the associated retail product, based on a derived demand approach. Therefore, the bandwidth of such an origination circuit is determined by the bandwidth of the retail leased line.

5.181 The fact that backhaul services are still generally acquired alongside access services means that the derived demand approach will also apply to backhaul

services. In other words, retail bandwidth breaks will also apply to the wholesale symmetric broadband origination products.

5.182 Therefore, following the bandwidth breaks we identified at the retail level, Ofcom is of the view that (on the demand side) there is a chain of substitution (multiples of lower bandwidth circuits constraining the price of higher bandwidth circuits) resulting in the following bandwidths breaks for AISBO and TISBO services:

- TISBO segments at speeds up to and including 8Mbit/s;
- TISBO segments at speeds between 8Mbit/s and up to 45Mbit/s;
- TISBO segments at 45Mbit/s and above; and
- AISBO segments at speeds up to and including 1Gbit/s; and
- AISBO segments at speeds above 1Gbit/s

Trunk segments

5.183 Ofcom does not consider it appropriate to define distinct markets for trunk segments at different bandwidths. This is because, unlike in the SBO market, in which the bandwidth of symmetric broadband origination is determined by the bandwidth of the relevant retail leased line, trunk segment traffic can be aggregated so that higher order systems can be used at the trunk level to deliver services at any relevant service bandwidths.

Supply side analysis

5.184 In the case of SBO services, it is relevant to consider whether supply side substitution may impose a competitive constraint between different bandwidth SBO services. For example in relation to TISBO services the question is whether a supplier of 8Mbit/s (or lower) TISBO services would enter the market for 34Mbit/s TISBO services in response to a significant price increase by a hypothetical monopolist supplier.

5.185 For supply-side substitution between bandwidths to be present there would need to be communications providers that supplied, for example, TISBO segments at high bandwidths but not at low bandwidths, and that would enter the supply of low bandwidth if the price of low bandwidths were to rise. However, as for retail leased lines, the biggest communications providers already provide both low and high bandwidth segments, so there is little or no additional competitive constraint beyond that already captured in the demand-side market definition, and supply side substitution is not relevant.

5.186 Therefore, Ofcom believes that supply-side substitution on this basis is so limited that it does not represent an effective constraint and, as such, does not justify the inclusion of high (defined as 34Mbit/s and above) and low (defined as 8Mbit/s and below) bandwidth TISBO services in the same market.

5.187 Ofcom considers that the same reasoning applies across other bandwidths and in relation to AISBO services (i.e. because of the sunk costs that communications providers would need to incur, and in particular suppliers of low bandwidth services

are likely to already be present in the provision of higher bandwidths and vice versa).

The market for wholesale trunk and SBO in the presence of upstream wholesale regulation

5.188 As described in Section 3, SBO and trunk services components are the furthest upstream of the various retail and wholesale products considered in this review. It is therefore necessary to consider the wholesale (product and geographic) market definition for services once only as Ofcom has not reviewed any of the possible markets that are further upstream of the wholesale markets for trunk and symmetric broadband origination.

Wholesale product market definition

5.189 Ofcom proposes the following wholesale market definition:

- a market for low bandwidth traditional interface symmetric broadband origination up to and including 8Mbit/s;
- a market for high bandwidth traditional interface symmetric broadband origination above 8Mbit/s up to and including 45Mbit/s;
- a market for very high bandwidth traditional interface symmetric broadband origination over 45 Mbit/s;
- a market for alternative interface symmetric broadband origination up to and including 1Gbit/s;
- a market for alternative interface symmetric broadband origination over 1Gbit/s; and
- a market for trunk segments.

Question 5: Do stakeholders agree with our proposed wholesale product market definitions? In particular, do you agree with Ofcom that: i) a separate market now exists for high bandwidth AISBOs, and ii) the very high bandwidth TISBO market now includes circuits at bandwidths above 140/ 155 Mbit/s?