Next Generation Networks

Responding to recent developments to protect consumers, promote effective competition and secure efficient investment

Consultation

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Contents

Section 1

Summary

1.1 The adoption of Next Generation Network (‘NGN’) technology promises to be a positive yet disruptive trend in the telecoms industry. The technology has the potential to bring significant benefits to citizens and consumers through new and improved services, and lower prices due to the likely greater efficiency of a multi-service network. It also has the potential to alter the prevailing model of competition in the telecoms sector. For these reasons, understanding NGN developments continues to be of vital importance to consumers, industry and Ofcom, and to the design and implementation of effective and sustainable regulation.

1.2 In 2004, when details first started to emerge of BT’s plan to build an NGN through its 21st Century Network (‘21CN’) programme, NGNs were seen as perhaps the most important development in telecoms since privatisation. At the time, it was thought that they might represent a change of such magnitude as to require a different approach to regulation.

1.3 Since that time, with experience of real-world implementations of NGN technology, it has become apparent that the move to NGNs is not likely to occur as the step change that was once expected. It now seems more likely that NGNs will be adopted gradually, forming part of the wider evolution of network technologies, and with many opportunities for changes in direction along the way.

1.4 NGN technology is being adopted alongside fixed and mobile access network upgrades, and alongside equally important developments outside the telecoms sector, perhaps most notably in IT. It is within this revised outlook that Ofcom is now considering the potential impact of NGNs on regulation.

1.5 The purpose of this consultation is twofold:

1.5.1 First, to present our response to recent NGN developments, including the latest revisions by BT to its plans for 21CN, and to the related concerns raised by stakeholders.

1.5.2 Second, in the light of recent developments to provide an update on our thinking as to how consumers should be protected during the migration to NGNs.

1.6 In addition, we discuss some of the possible longer term implications for regulation of a widespread adoption of NGN technology. In particular, we consider whether there is anything Ofcom should be doing today to cater for this future world, and hence to better serve the interests of citizens and consumers.

1.7 We recognise that the interaction between NGNs and Next Generation Access (‘NGA’) technologies, which can be used to provide super-fast broadband services, raises important regulatory issues about the future model of competition in the UK telecommunications market. In particular, it is not yet clear what sort of regulated wholesale products should provide the basis for competition where fibre is used in the access network, on either a fibre-to-the-cabinet (‘FTTC’) or fibre-to-the-premises (‘FTTP’) basis. This is a fundamental strategic issue which is not addressed in this consultation, but which will begin to consider in the forthcoming Wholesale Local

Access and Wholesale Broadband Access market reviews. We expect to publish consultation documents on these market reviews in the near future.

We think the existing regulatory priorities for NGNs continue to be appropriate

1.8 Our last consultation and Statement on NGN issues, in 2005[1] and 2006[2] respectively, focussed on the impact of 21CN on consumers, regulated access and interconnect products, and the consequences for the model of equivalence as implemented in the Undertakings offered by BT and accepted by Ofcom in September 2005.[3] The main policy objectives established in these documents can be summarised as follows:

- to provide incentives for efficient investment in NGNs;
- to promote effective competition based on NGN infrastructure; and
- to protect consumers from disruption during the transition to NGNs.

1.9 We consider that these objectives remain the priority for NGN regulatory policy, and they underpin our consideration of the issues raised in this consultation.

Super-fast broadband is being prioritised over NGN investment

1.10 NGNs are generally understood to refer to networks using the Internet Protocol ('IP') capable of being used for both voice and data, and in which there is some control over Quality of Service ('QoS'). At a more technical level, NGNs feature a common transport layer which physically carries packets of data, and a separate control layer which provides the intelligence to specify, control and manage the services contained within the data packets.

1.11 The business case for building an NGN generally rests on two benefits it brings to operators. First, a single network is cheaper to build and run than the current approach of having a separate bespoke network for each service. Secondly, NGNs can make it cheaper and faster to develop and deploy new services, thus making NGN operators more responsive to customer demands and therefore more competitive.

1.12 With the downturn in the economy, and increasing restrictions on the availability of capital, Communications Providers ('CPs') are having to re-prioritise investments. The cost savings brought about by NGNs only become apparent after a period in which costs may increase. In addition, the benefit of being able to develop new products faster will only have a material effect if there is a market opportunity for these as yet unidentified new products. In the short term, therefore, there are risks that NGN investment will deliver neither cost savings nor new products. As a result, CPs are increasingly looking for safer investment opportunities, focussing on projects which are more likely to deliver new or enhanced services, and extending the lives of existing assets.

[1] 'Next Generation Networks: Further Consultation', 30/06/2005. See http://www.ofcom.org.uk/consult/condocs/nxgnfc/.
[2] 'Next Generation Networks: Developing the regulatory framework', 07/03/2006. See http://www.ofcom.org.uk/consult/condocs/nxgnfc/statement/.
[3] For further details on BT's Undertakings see www.ofcom.org.uk/telecoms/btundertakings/.

1.13 As noted in our recent statement on super-fast broadband[4], 'super-fast broadband services, and the networks required to deliver them, continue to grow in importance and interest to consumers, industry and politicians alike.' This growing interest has seen Next Generation Access ('NGA') become the priority for future network investment. The shift in priority away from standalone core NGNs partly reflects the acceptance that the future of access networks will be increasingly fibre-based, and therefore any new investment in copper-based networks, and products that are dependent on copper access, will have a limited life-span.

BT has fundamentally changed its plans for 21CN

1.14 These developments have culminated in a fundamentally different outlook for NGNs in the UK. For the past five years, since BT announced its intention to build 21CN, the expectation has been that in the not too distant future, BT would replace its Public Switched Telephone Network ('PSTN') in its entirety. Following a strategic review of its plans for 21CN, BT has decided to step back from this vision of a complete replacement of its PSTN.

1.15 It is now expected that parts of BT's PSTN will be replaced as and when needed, for example when equipment reaches the end of its useful economic life. The focus for future investment is on upgrading the access network with FTTC and FTTP. These deployments are likely to be accompanied by core NGNs to deliver telephony and other services. However, the design of this future all-fibre NGN could be very different from the architecture originally envisaged for BT's 21CN and also used by other fixed-network CPs.

1.16 This change in outlook has created considerable uncertainty. Although most CPs expect NGN technology to be adopted in the future, it is no longer possible to say with any degree of certainty how or when this will happen. In addition to the uncertainty itself, three other issues have been raised by CPs which concern regulation. These relate to the impact of NGNs on the voice interconnection regime, the impact of 21CN on the Undertakings, and the possible need for a new voice-only access product from Openreach.

BT's revised plans for 21CN are likely to have implications for the Undertakings

1.17 Under BT's original plan for 21CN, it was to deploy Multi Service Access Nodes ('MSANs') in local exchanges throughout the country, to provide both voice and broadband services on copper lines. This deployment would have represented a significant change from today's network in which these services are provided on physically separate voice and broadband equipment.

1.18 This 'converged' MSAN approach is not fully compatible with BT's Undertakings. The Undertakings require that BT use an Equivalence of Inputs ('EoI') product from Openreach in producing its wholesale services. BT currently uses Shared Metallic Path Facility ('SMPF') on an EoI basis in the provision of wholesale broadband. SMPF relies on the fact that a copper line is split to allow the use of physically separate equipment for voice and broadband. The converged MSAN combines the functions of the separate voice and broadband equipment, and therefore no longer requires a split copper line. This convergence would have meant that it was no longer

[4] 'Delivering super-fast broadband in the UK', http://www.ofcom.org.uk/consult/condocs/nga_future_broadband/.

possible for BT to use SMPF, or an equivalent broadband only product, on an EoI basis.

1.19 Under BT's revised 21CN plan, the converged MSAN approach is only likely to be used in a small number of exchange areas. For this reason, in most parts of the country, the current model of competition established by the Undertakings, based on Wholesale Line Rental ('WLR'), SMPF and Metallic Path Facility ('MPF') products, can continue. In terms of upcoming developments, however, it should be noted that BT's plans to build NGA networks are likely to have implications for this model of competition.

1.20 To cater for those exchange areas in which converged MSANs will be deployed, BT and Ofcom will need to agree a change to the Undertakings. The process for dealing with such variations to the Undertakings is well established, and Ofcom will consult on this as soon as there is a firm proposal from BT.

1.21 Some of the issues raised by BT using converged MSANs could also have consequences for the model of competition established by the Undertakings. For example, if BT Wholesale were to launch a new 21CN-based voice product, or a converged voice and broadband product, it would be necessary to consider what the upstream inputs to those products should be. We will address issues of this sort as and when they arise.

The case for a new voice access product from Openreach will depend on demand

1.22 For some time it has been suggested that there should be a voice-only passive access product from Openreach – the voice equivalent of SMPF for broadband. Whereas MPF provides access to the whole copper line, SMPF provides access to just the broadband part of the line, but is only available on lines with voice service enabled. This voice service is always based on WLR – one of the EoI products provided by Openreach.

1.23 In addition to these services, some CPs have suggested that there is a requirement for a new product which would provide access to just the voice part of a line, but only on lines where broadband is being supplied using SMPF. In essence, it is the passive copper access service which Openreach implicitly uses to create WLR on lines with SMPF. This potential new product has been, and is here generally referred to as xMPF.[5]

1.24 Based on discussions with stakeholders, we understand that the most important benefit to CPs from using xMPF would come from an increased margin relative to using WLR. However, it has also been suggested that in order to make xMPF financially viable, a greater margin would be needed between MPF and WLR.

1.25 Due to the close physical similarity of the products, it seems possible that the costs for xMPF and MPF would be very similar. Therefore, pending further analysis, it appears reasonable to assume that, if xMPF was offered by BT, its price would be similar to that of MPF. This would suggest that an increased margin for CPs using xMPF might be achieved by either increasing the WLR price or reducing the MPF price. Neither of these suggestions are considered in this consultation since the

[5] Although the general concept of xMPF is well understood, consideration of its practical implementation leads to a number of different potential products. In this consultation we focus on just the most immediately relevant and best understood cases.

regulation of MPF charges has been recently covered in the Openreach Financial Framework review[6], and our proposals for the WLR charge control are currently out to consultation.[7]

1.26 There remains the question of whether, given MPF pricing and our current proposals for the pricing of WLR, and assuming that the price of xMPF would be similar to MPF, there would be sufficient demand for an xMPF product. Our preliminary view is that, if there is sufficient demand at these prevailing prices, the matter could be resolved through the existing Statement of Requirements ('SoR') process which CPs use to request Openreach to develop new products. Equally, we believe that the current SoR process should be sufficient to cater for future variants of xMPF not explicitly considered in this consultation. We would, however, welcome stakeholder views on this assessment, and we will be keeping the matter under review.

Interconnection arrangements should not act as a barrier to investment in NGN technology

1.27 NGN deployment will also bring about a transition from interconnection of voice services based on Time Division Multiplexing ('TDM') to IP-based interconnection.

1.28 From a technical perspective, there has been significant progress. Against a challenging timescale, NICC Standards Limited ('NICC') (the UK forum for interoperability standards) has delivered two releases of an entirely new suite of interconnection standards for IP interconnection.

1.29 Under BT's original plan for 21CN the rapid migration of voice services would have set the pace of the transition to IP interconnection. BT's revised plans mean that TDM and IP will coexist for the foreseeable future, and other operators may lead the adoption of IP interconnection.

1.30 The arrangements for interconnection between networks using different technologies are set to become an increasingly important issue. In addressing this issue, we need to ensure that regulated interconnection products, and regulation of interconnection more generally, does not act as a barrier to efficient investment in new technology.

1.31 Accordingly, we would welcome stakeholder views on the following issues:

1.31.1 In a mixed TDM/IP environment, which network should provide the interworking function to convert traffic between the two standards, and how should the costs of providing this function be recovered? This issue arises in relation to both traffic between BT's 21CN and other CPs' TDM networks, and traffic between BT's TDM network and other CPs' NGNs.

1.31.2 Should BT be required to offer an IP equivalent to TDM interconnection and, if so, when?

1.31.3 Does the principle of reciprocity continue to be appropriate in a mixed TDM/IP environment? The principle of reciprocity is based on the idea that

[6] The Statement can be found at http://www.ofcom.org.uk/consult/condocs/openreachframework/statement/statement.pdf. This decision has been appealed in *The Carphone Warehouse Group plc v Office of Communications*, case number 1111/3/3/09, http://www.catribunal.org.uk/237-4154/1111-3-3-09-The-Carphone-Warehouse-Group-plc.html.
[7] See http://www.ofcom.org.uk/consult/condocs/wlrcc/.

the regulated charges of the incumbent are a reasonable proxy for the costs of an efficient network operator. However, if BT continues to originate and terminate most of its traffic on a TDM network, its regulated charges may not reflect the efficiently incurred costs of another CP with an NGN.

1.31.4 What further technical standards work is required to enable the transition to NGNs?

1.32 Our intention is to develop our thinking in relation to these issues. This will help to inform future work on interconnection in the context of relevant market reviews.

Uncertainty surrounding BT's plans could have a negative effect on investment by other operators

1.33 It has long been recognised that BT's plans for 21CN, and network development more generally, have a significant impact on investment by competing CPs. All CPs need to interconnect with BT, and the majority also need to use BT's network to access customers. Therefore, changes to the design of BT's network have a direct impact on the businesses of competing network operators.

1.34 BT's recent change to its plans for 21CN has created considerable uncertainty. It has become very difficult for CPs to know what an efficient design will be for their networks given the uncertainty about the topology of the BT network, the geographic location of the points of interconnect, and the technology for interconnection.

1.35 BT is now adopting a much shorter planning horizon. Whereas previously it had planned 21CN on a rolling five year timeframe, it is now looking only 12-18 months ahead. Beyond this time horizon there is no confirmed investment or network upgrade plan. This may be a realistic and optimal approach for BT's own needs, but it also has consequences for investment planning by other CPs.

1.36 More generally, the industry is having to cope with uncertainty created by the current economic climate; greater costs of financing investments; technology risks around the future of telephony; and considerable technology and commercial risk associated with building NGNs and NGAs. Many of these factors have contributed to BT's change in strategy.

1.37 Due to the combination of the general economic climate and the lack of knowledge of BT's future network architecture, there is a risk that BT's fixed network competitors defer investment in NGNs. We are therefore considering what options there might be to improve the investment incentives for all CPs. In making this assessment, we will need to gauge the extent of the risk to investment.

Convergence and bundling during the transition to NGNs will also raise challenges for consumer switching processes

1.38 It is already evident that the transition towards NGNs will be accompanied by a trend towards service bundling at the retail level, and an increasingly complex range of wholesale products. In this situation, there is a risk that the process of switching between retail providers will become more difficult for consumers, and that this could deter switching and harm competition. This risk is exacerbated by the fact that there are already different switching processes for landline, broadband and mobile services.

1.39 Ofcom is undertaking a separate project as part of its migrations work, which will consider the extent to which there is a need for harmonisation of switching processes across different services. The project is examining a broader set of issues around optimal switching models for transferring services between different CPs. We will seek to ensure that decisions made in relation to the design of NGNs and NGAs take into account the emerging evidence from the broader project on migration processes.

NGNs represent a significant technology change, and consumers must be protected from undue disruption

1.40 When Ofcom last consulted on NGNs in 2006, one of the key areas of focus was the potential impact on consumers. As a result of this work, we agreed the following three principles to guide our activities:

- the services offered to consumers on NGNs should at least be equivalent to their existing services;
- consumers should not suffer any detriment during the transition to NGNs, for example, due to loss of access to emergency services or degraded call quality; and
- any changes to end-user services should be fully explained to consumers.

1.41 These principles can be seen as a response to BT's original 21CN plans. These included the proposal that the migration of lines to 21CN would be provider-led, with BT transferring wholesale services to the new network while minimising disruption for consumers. Although BT now appears to be adopting a slower approach to migration driven by individual customer demand for new services, we feel that the principles continue to be appropriate to ensure consumers are adequately protected.

1.42 Although the roll-out of NGNs has been much slower than expected, extensive testing of customer equipment has taken place in recent years. This has highlighted a number of compatibility issues. For example, a significant proportion of security, fire and social telecare alarms connected to the telephone network are sensitive to the increased end-to-end delay of NGNs, and may therefore not operate reliably in certain circumstances. The relevant industry associations are aware of this issue and are co-ordinating further testing activities while helping their members to assess the risk and to plan mitigation activities. The full extent of the issue is currently unclear, but the move towards a much slower demand-led migration to NGNs certainly helps by providing more time to locate and fix specific customer problems.

1.43 This specific issue highlights our general approach in implementing the principles mentioned above. We will continue to monitor developments concerning customer equipment compatibility very closely, and will work with stakeholders to ensure that appropriate solutions are found before migration to the new networks takes place.

In the longer term, NGNs may drive new models of competition, but this does not necessitate immediate changes in regulatory strategy

1.44 Looking further ahead, the direction of network evolution is highly uncertain. It seems likely that NGN technology will eventually be adopted for voice services, but the manner in which this will occur is not yet known.

1.45 In theory, NGNs increase the scope for non-network based competition. The separation of conveyance from service control that is inherent in NGN design creates the potential for new models of competition. In these new models, innovation is controlled and delivered by software development rather than the network infrastructure investment which is required today. In the extreme, the competition model in the telecoms sector may begin to resemble that found on the Internet more closely. This envisages network operators focussing on the provision of generic conveyance services, whilst a multiplicity of independent service providers develop and deliver rich applications which run over these generic conveyance networks.

1.46 However, the NGN designs proposed by CPs to date would tend to indicate that the separation between conveyance and service control will be less than complete. Network operators are likely to retain control of some services, such as guaranteed-quality voice, in a manner similar to today. In this way, there would continue to be significant benefits to vertical integration, and so it may be less likely that an independent application-based service market will develop.

1.47 Our preliminary analysis suggests that the intense competition in value added services that run over networks, which has been made possible by the Internet, is a powerful force that will shape a market-led outcome without a need for regulatory intervention. We would, however, be interested in stakeholder views on the future direction of change, and the regulatory issues to which it may give rise.

Section 2

Introduction

Background and scope

2.1 This document considers how competition and consumers are being affected by the adoption of Next Generation Network ('NGN') technology, and what this implies for regulation in the telecoms sector. NGNs use technology initially developed for the Internet to deliver a wide range of services over a single Internet Protocol ('IP') network, in contrast to the multiple single-service networks used by most CPs today. These NGN technologies create scope for greater efficiency and offer more flexibility, allowing operators to become more responsive to customer demands. However, it is important to understand that the implementation of the technology is not straightforward, and so these benefits can be difficult to realise.

2.2 Ofcom last consulted on its approach to NGNs in 2004 and 2005 following BT's announcement of its 21st Century Network programme ('21CN') to build an NGN over the subsequent 5-7 year period. Both consultations, and the policy statement which followed, focussed on the impact of 21CN on consumers, on regulated access and interconnect products, and on the consequences for the model of equivalence as implemented in the Undertakings offered by BT and accepted by Ofcom in September 2005.

2.3 The policy objectives established during this consultation process were as follows:

- to provide incentives for efficient investment in NGNs;
- to promote effective competition based on NGN infrastructure; and
- to protect consumers from disruption during the transition to NGNs.

2.4 In concluding this process, Ofcom set out a detailed implementation plan to deliver these objectives, including establishing a revised institutional framework centred on a newly created industry body, NGNuk. Through a series of regulatory initiatives, and through the work of NGNuk, Ofcom sought to provide greater certainty over the regulatory and commercial framework for NGNs. This was designed to support and encourage investment in competing NGNs, and led to an expectation of a smooth and relatively swift adoption of the new technologies. In this way, Ofcom sought to create an environment which would allow industry to realise fully the potential benefits of the new technology.

2.5 A great deal has changed over the last three years. There have been considerable delays to the roll-out of BT's 21CN. As a result, there has been less pressure on both industry and Ofcom to develop new commercial and regulatory models for access to, and interconnection between, NGNs. Despite the delays to BT's investments, other operators have moved ahead and built new networks using NGN technology.

2.6 Towards the end of 2008, BT announced that it was reviewing its 21CN strategy. As a result of this review, BT is now adopting a much more cautious approach to 21CN, only investing where there is proven demand, or where the existing equipment needs to be replaced. For voice services, the original vision was that 21CN would eventually replace the BT PSTN completely – albeit with considerable uncertainty over the timing of the migration. BT has now stepped back from this vision and is expected to replace parts of its PSTN when equipment reaches the end of its useful economic life. It is not possible to provide a roadmap for voice services which has a clear end-game.

2.7 This uncertainty has significant consequences for network investment by other CPs. Without knowledge of a likely end point for network design it becomes very difficult for CPs to plan investments, and in particular to build efficient interconnection between networks. This adds to the uncertainty of the current economic climate and the continued rapid advance of technology, with the result that there is considerable risk to investment in telecoms more generally.

2.8 Whereas the previous Ofcom work on NGNs was founded on the expectation of a fairly rapid and orderly transition to NGN networks by BT and other CPs, we are now entering a phase of protracted uncertainty. For the foreseeable future, there will be a variety of different technologies and designs for voice services, all coexisting.

2.9 The purpose of this consultation is twofold:

2.9.1 First, to present our response to recent NGN developments, including the major revisions by BT to its plans for 21CN, and to the related concerns raised by stakeholders.

2.9.2 Secondly, to provide an update in the light of recent developments on our thinking about how consumers should be protected during the migration to NGNs.

2.10 In addition, we discuss some of the possible longer term implications for regulation of a widespread adoption of NGN technology. In particular, we consider whether there is anything Ofcom should be doing today to cater for this future world, and therefore better serve the interests of citizens and consumers.

Approach and consultation outline

2.11 The remainder of this introduction considers how we may now define an NGN in light of the changes to planned next generation network designs in the UK. It also considers whether and why Ofcom should be concerned about these next generation core network upgrades. This section also describes the development of BT's 21CN in some detail, including the recent strategic review and subsequent change of plans.

2.12 Section 3 then considers four specific issues which have arisen in relation to NGN investment, competition and regulation. These ask whether there is anything further that Ofcom can do today in order to promote the interests of citizens and consumers by, where appropriate, promoting competition.

2.13 In Section 4 we examine some of the consumer issues which result from the introduction on NGNs. Again, this considers whether there are specific additional actions that Ofcom should be taking today to better protect consumer interests.

2.14 The final section takes a much broader view considering Ofcom's policy position and general thinking around NGNs. Over the past year and more, Ofcom has been researching the nature and potential impact of NGNs. This section presents some of the results of this analysis for the purposes of discussion. We do not anticipate that it will lead directly to any changes in regulation. However, we feel it is important to provide this opportunity for industry to comment more generally on NGN developments, and to contribute to the development of Ofcom's understanding of the issues.

What is an NGN and are they important?

2.15 A 'Next Generation Network' is generally understood to refer to an IP network capable of being used for both voice and data, and in which there is some control over quality of service. A discussion of the definition of NGNs is provided in Annex 5. The key features of an NGN are that it is a packet-based, multi-service network, which has a clear separation of transport and control, and where the control functions may reside on a physically separate network.

2.16 NGNs are also seen as an example of a more general trend towards the adoption of general purpose computing technologies by the telecoms industry. For example, Ethernet, software based services, 'agile' development techniques, and of course, IP. The advantages these technologies can bring to telecoms are lower costs for equipment and greater flexibility.

2.17 Given the potential scale and complexity of the transition to NGNs, there are potential risks to consumers that need to be addressed to ensure that consumers are protected during the transition process. We discuss this further in Section 4. However, over the longer term, NGNs are expected to deliver efficiency gains, and to allow much faster service creation. In this regard, NGNs could be an extremely positive development for consumers, with the potential to deliver both lower prices and a greater range of services to meet customer needs. These potential benefits to consumers are considered further in Annex 6.

2.18 The introduction of a new technology such as NGNs need not necessarily require a change in regulation. The legal and regulatory framework under which Ofcom operates is explicitly technologically neutral.[8] There are occasions where complete neutrality is not possible, but in general, technology change should not force changes in regulatory policy or strategy. However, new technology can sometimes enable new models of competition, and so indirectly influence regulation. For example, one of the key features of an NGN is the separation of service control from the transport of data.[9] This creates the possibility that a CP could compete by creating services simply by developing their own control layer which is completely independent of the physical network used to deliver the services. That is, a CP would be able to compete effectively without having to build its own network infrastructure. This would represent a significant change from today, where, in order to have full control over services, a CP must invest in its own network infrastructure.

2.19 Clearly, this could have significant implications for the regulatory framework. However, until there is clear evidence of a change in network architecture that enables new models of competition, there is likely to be too much uncertainty to justify significant changes in regulation. The developments of the past few months and BT's change of plans for 21CN provide support for this position.

[8] Ofcom must operate as far as possible in a technologically neutral manner in accordance with Section 4(6) of the Communications Act 2003, by reference to Article 8(1) Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services.

[9] Figure A1 in Annex 5 shows the 3 layers in an NGN. This annex also explains the function of each of these layers.

2.20 We do not yet know the extent to which NGN technology will be adopted or the detailed network architectures that will be used. It still seems likely that operators will deploy NGN equipment, and ultimately head towards a single converged network for all services, but the most immediate trends apparent in the industry are towards extending the life of current generation equipment, and maintaining a non-converged architecture.

2.21 As noted, NGNs potentially enable new models of competition without the need for network infrastructure investment. It could therefore be argued that the role of the regulator should be to encourage take up of a particular technology that would bring about these new models of competition with potentially lower barriers to entry. We consider that the market is better placed than the regulator to make such technology choices.

2.22 Our analysis indicates that although Ofcom must stay abreast of NGN developments, for the foreseeable future, it would appear that NGNs are unlikely to necessitate the need to consider potential changes in the regulatory regime. It is also worth noting at this point that there are a number of other developments in the industry that may drive regulatory change in conjunction with NGNs, and which affect the business case for investing in NGNs. Three such trends are:

- *Investment in next generation access (NGA) networks*. Ultimately, fibre based next generation access networks are expected to replace the current copper access network. In an all fibre world, it makes very little sense to maintain the current generation TDM based voice network. In this regard, NGA and NGN are closely related.

- *Growth in mobile data services*. Much of the focus of the NGN debate revolves around fixed networks. However, mobile network operators are also planning to build NGNs, and may be forced to do so by the growth of mobile data services. These services are also likely to provide increasing competitive pressure on equivalent fixed network services, and so will influence the competitive landscape throughout the telecoms sector.

- *Increased use of software based communications services*. Internet based communications services are developed as software, and this helps to generate a very short time to market for new services. In contrast, traditional telecoms services generally require investment in physical hardware, which can be very expensive and always takes time to build and install. Telecoms operators are increasingly looking to adopt a software based approach, and this is often described as being part of a CP's overall NGN investment strategy.

2.23 All three trends could have very significant consequences for regulation in the telecoms sector through their impact on competition. For this reason, it is not possible to develop a regulatory strategy with regard to NGNs in isolation. At present, with considerable uncertainty over the future direction of network development, the risks of inaccurate predictions appear to be far greater than simply adopting a wait and see policy.

BT and 21CN

2.24 The following section considers BT's plans to build an NGN, and how this has developed over the past five years. For a discussion of the NGN plans of some other UK operators, see Annex 7.

Original plan

2.25 BT announced plans to deploy an NGN called 21st Century Network ('21CN') in 2004. BT expected that 21CN would replace most of its existing core platforms with a single multi-service network. BT's stated aims for the programme were to reduce cash costs, improve speed to market for new services and improve the customer experience.[10]

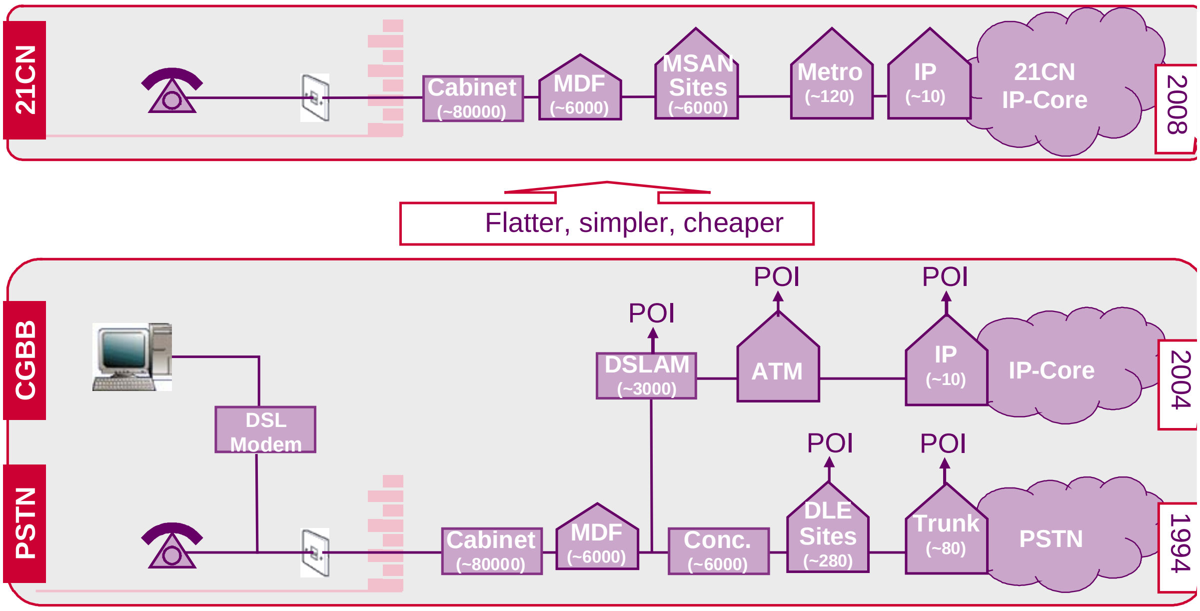
2.26 BT set out several key milestones for its programme:

- trials of the new technology to be initiated during 2004, with next generation voice services being delivered to 1,000 customers by January 2005;
- 99.6% of UK homes and businesses connected to a broadband enabled exchange by summer 2005;
- subsequent growth in broadband services would be met by a new 'Multi-Service Access Node' (MSAN) platform;
- mass migration of PSTN customers expected to start in 2006, and reach more than 50% by 2008; and
- Broadband dial tone expected to be available to most customers in 2009.

2.27 As set out in Figure 1, the proposed network had a much simpler and flatter structure than BT's existing networks, with just three main levels: local access nodes (~6,000 sites at which MDFs and MSANs are located); metro nodes (~120 sites), and core nodes (~10 sites).

[10] BT news release, June 9th 2004.

Figure 1: Comparison of existing BT voice and broadband networks with 21CN



Key:

PSTN	Public Switched Telephone Network	Conc	Concentrator
CGBB	Current generation broadband	DSLAM	DSL Access Module
21CN	BT's 21st Century Network	DLE	Digital Local Exchange
MDF	Main distribution frame	MSAN	Multi Service Access Node

2.28 This reduction in complexity of the network architecture, and associated simplification of IT systems, was to drive cost savings which would underpin the business case for 21CN.

2.29 One of the business drivers for the timing of the investment was the need to replace the PSTN. Some of the equipment used in the voice network dates back to the early 1980s, and was approaching the end of its useful life and consequently the cost of maintaining this legacy equipment had started to rise. For this reason, one of the objectives of 21CN was to remove the PSTN altogether and replace it with modern equivalent assets. This meant building an IP voice network.

2.30 The logistical and commercial difficulty in switching millions of lines from one technology to another led BT to adopt a strategy of emulating the current PSTN based telephony services on the new network, essentially seeking to replicate the existing WLR products on 21CN. In this way, the risk of both wholesale and retail customer disruption and harm could be minimised.

2.31 The technical solution chosen by BT was to deploy MSANs in the access network. These are devices which can terminate a copper pair on a single line card and deliver both DSL broadband and a voice service using the traditional analogue interface. The MSAN therefore replaces two pieces of equipment in the current network design: a DSLAM for broadband and a concentrator for voice.

2.32 From a regulatory perspective, amongst the most interesting 21CN products that BT intended to introduce were Wholesale Voice Connect ('WVC') and Wholesale Broadband Converged Connect ('WBCC'). WVC was to have been an IP voice access service, and WBCC was to have been a converged voice and broadband access product. Although these specific products were proposed to be developed relatively recently, the potential for 21CN to deliver wholesale services with similar functionality had been discussed almost ever since 21CN was announced.[11]

2.33 WVC and WBCC would have allowed a CP to control the way that BT's MSANs handled calls to/from their end-user customers through their own call server. This would have enabled the CP to control call features, and to terminate calls. Therefore, relative to WLR, the products appeared to offer more scope for competition through product innovation. Both products demonstrated one of the key characteristic features of an NGN – that conveyance and control are separate. This allows control functions to reside in equipment which is physically separate from the network it is controlling, such as in another CP's network.

Interconnection

2.34 21CN was, over time, to have had a significant impact on voice interconnection. With the replacement of BT's PSTN, it was expected that the UK would move towards IP interconnection for voice traffic in the long run.

2.35 The migration process was to involve shifting end-user telephone lines from their connection to a DLE to an MSAN, and BT planned a gradual removal of the DLE infrastructure. Since this is used as a point of interconnection for many CPs today, it was recognised that an alternative would have to be found. In 2007, a proposal was agreed within the industry that a CP would be able to either route traffic via its existing TDM interconnects at the tandem exchange or via IP interconnection. BT would provide the conversion between TDM and IP at no additional cost to the CP.

2.36 The agreed proposal also included provision of voice interconnection with 21CN at 27 POSIs (Points of Service Interconnect). This compares with 770+ points of interconnect on the TDM network (669 DLEs, 100+ tandems). This would necessarily lead to the increased use of BT transmission for IP interconnection in comparison to DLE interconnection.

2.37 Full national coverage could be achieved by connecting at 27 POSIs, with two further POSIs made available for resilience and diversity reasons. The POSI is a multi-service interconnection: in addition to voice, other services such as broadband can share the same physical interconnection link.

2.38 To manage the commercial arrangements during migration, BT agreed with industry in 2006 the principle of using an Interim Charging Methodology ('ICM') based on blended rates. The blended rates reflect the charges that CPs pay for traffic on the current network (taking into account DLE, single tandem and double tandem rates and percentages of traffic sent via each of these). The blended rates mean that CPs should not incur additional charges due to the migration of customers on the BT network.

2.39 The intention was that a new charging mechanism would be established once 21CN deployment was better understood. No dates were set for when BT's tandem TDM exchanges, and therefore the ability to interconnect via TDM, would be removed.

Implementation

2.40 Since 2004, BT has made significant progress with many aspects of 21CN deployment. However, replication of existing voice telephony services (both

[11] First as MSAN interconnect, and then as an Openreach product called Voice Line Access.

conventional analogue telephony and ISDN) on 21CN has taken much longer than originally expected, contributing to a significant delay to the voice aspects of the 21CN programme.

2.41 Customer trials of analogue telephony services started in 2006 in South Wales. This is known as the Pathfinder trial, and had to be suspended after problems were encountered in 2007. The trials recommenced in August 2008, and BT successfully completed the first phase of Pathfinder in April 2009. At present, approximately 75,000 customers are now connected to 21CN in South Wales. This number is expected to rise to about 350,000 by July 2010.

2.42 Early in 2008, BT announced a refocus of priorities away from mass migration of voice customers and towards the delivery of higher speed broadband and Ethernet data services. As a result, MSANs were deployed on an overlay basis, alongside the PSTN, to enable BT to provide higher speed ADSL2+ broadband services. Using this platform, BT launched its 21CN based wholesale broadband service Wholesale Broadband Connect ('WBC') in April 2008. It has expanded the footprint of this service so that it is now available at BT exchanges serving approximately 40% of households, and has announced plans to continue growing this footprint to around 55% by March 2010.

2.43 Despite the change of focus to broadband, BT's revised plans in 2008 still envisaged that mass migration of telephony services would start in April 2010 and would take a further 3-5 years to complete.

2.44 In addition to the work on telephony and broadband, the 21CN programme also included building a new core optical transport network, and developing a wide area network Ethernet capability. In this regard, BT has successfully built a new DWDM[12] network, and is also rolling out new Ethernet services which run over this DWDM core to the majority of the UK. Both upgrades allow BT to increase bandwidth at much lower incremental cost than on the legacy network, and to offer better high capacity data services to wholesale and large business customers.

Strategy Review

2.45 In the summer of 2008, BT announced[13] that it was planning to start deploying fibre in its access network, using both FTTC and some FTTP to deliver super-fast broadband services. Later in the year, BT announced the suspension of all work on WVC and WBCC pending a wider strategic review of 21CN.

2.46 The results of this strategy review, presented to CPs via Consult21 in March 2009, are as follows:

- The Pathfinder deployment in South Wales will continue as planned (although it should be noted that the architecture is currently based on separate IP voice and broadband networks, not a converged network);
- The future for access networks will be increasingly fibre-based, and therefore any new investment in copper based networks, and products that are dependent on copper access, will have a limited life-span and restricted returns;

[12] DWDM (Dense Wavelength Division Multiplexing) is a technology which uses different colours (wavelengths) of light to send multiple signals simultaneously along a single optical fibre, and is thereby used to create very high bandwidth transmission systems.
[13] BT press release, 15th July 2008.

- It is also now considered that the existing PSTN network equipment will last much longer than expected, and given the investment climate BT will be migrating to 21CN voice much more slowly than had been planned;

- As a result, WVC and WBCC are not going to be introduced, simplifying the voice portfolio, and BT will move to demand driven roll-out of 21CN Ethernet and WBC;

- Development of IP interconnection products would continue but possibly at a slower pace given the revised plans for voice services;

- As part of the move towards being more demand driven, and in light of the emerging NGA plans, BT will also move away from the *original* long term vision for the speed and scale of migration of voice and broadband services to the 21CN network; and

- Given the economic climate and the developing plans for fibre deployment in the access network, BT would adopt a shorter planning horizon of 12-18 months, compared with 3-5 years previously.

2.47 These developments have created considerable uncertainty – especially in relation to telephony services and voice interconnection. For the past few years there has been a clear vision for the upgrade of BT's network. The precise timing of the changes to the network has always been uncertain, but the assumption that ultimately BT would transfer telephony services to 21CN was not generally questioned.

2.48 It is no longer possible to say with any certainty that BT's PSTN will be replaced in its entirety in the foreseeable future. Undoubtedly, the legacy network will not last forever, but it is now possible that the PSTN will be retained for many years.

2.49 Furthermore, the design of the network is also uncertain. Even in the areas where BT does build 21CN, it is not clear whether it will in fact use MSANs in a converged manner to deliver both voice and broadband simultaneously. Neither the Pathfinder trial of voice services, nor the commercial roll-out of WBC broadband on 21CN currently use the MSANs in this manner. Both sets of services run in parallel with their legacy network counterparts as separate non-converged services.

2.50 BT has given a number of reasons for the change in strategy. Foremost amongst these is the fact that the demand for, and interest in, super-fast broadband services is growing rapidly. In order to meet this demand, BT is now focussing investment on NGA network upgrades. Both FTTC and FTTP would, where they are deployed, initially complement, and in due course start to supersede, 21CN copper access based broadband. Also, looking further ahead, these new fibre based access networks would necessitate a different solution for telephony services from the one envisaged in 21CN. It is unlikely to make sense to invest heavily in aspects of 21CN which will be superseded after only a short time by fibre based alternatives.

Section 3

NGNs and competition

3.1 This section discusses the potential impact of NGNs on regulation and competition in the short to medium term. Several issues are considered, some of which result from BT's change of plans for 21CN, whereas others relate to NGNs more generally. This section focuses principally on the following three issues:

a) the possible impact of NGNs, and in particular 21CN, on the model of equivalence embedded in the Undertakings;

b) whether there is a need for a new passive access product (commonly known as xMPF) to support competition in the voice market; and

c) the implications for voice interconnection of an environment in which both IP and TDM networks coexist.

3.2 Another issue considered, which is closely related to the impact on interconnection, is the level of uncertainty introduced as a result of BT's change of plans. Ofcom is concerned about the level of uncertainty surrounding the future direction of network development in the UK, and the impact that this may have on investment.

3.3 Finally, we also note the potential increase in complexity for customers wishing to switch providers in a world with multiple access and core network technologies.

3.4 All of these issues are presented to allow Ofcom to discuss its latest thinking, and with a view to generating feedback from stakeholders. In all cases, any proposals for changes in regulation would need to be taken forward in separate processes, whether that be through a market review, changes to *ex ante* conditions, consideration of the Undertakings, or otherwise.

NGNs, equivalence and the EoI consumption model

3.5 Following Ofcom's Strategic Review of Telecommunications ('TSR') BT offered, and Ofcom accepted, a set of legally binding Undertakings which established a regulatory framework focusing on the enduring bottlenecks of competition. The full Undertakings, and our reasons for accepting them, are set out in our publication *Final statements on the Strategic Review of Telecommunications, and undertakings in lieu of a reference under the Enterprise Act 2002.*[14]

3.6 The BT Undertakings are a set of obligations on BT that are designed to deliver Equality of Access between BT and its competitors. Equality of Access is broadly based on two fundamental concepts: Equivalence of Inputs and operational separation.

3.7 On Equivalence of Inputs, section 2.1 of the Undertakings states that:

> *'Equivalence of Inputs' or 'EOI' means that BT provides, in respect of a particular product or service, the same product or service to all Communications Providers (including BT) on the same timescales, terms and conditions (including price and service levels) by means*

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

> *of the same systems and processes, and includes the provision to all Communications Providers (including BT) of the same Commercial Information about such products, services, systems and processes. In particular, it includes the use by BT of such systems and processes in the same way as other Communications Providers and with the same degree of reliability and performance as experienced by other Communications Providers*.[15]

3.8 As part of this regulatory framework, BT set up Openreach as a functionally separate division responsible for providing wholesale products based on enduring bottleneck assets. Three Openreach access products have become the primary basis of fixed-line competition in voice and broadband services as a result:

i) WLR (for voice services);

ii) SMPF (for broadband services); and

iii) MPF (for both voice and broadband services).

3.9 The Undertakings require that BT apply the principle of EoI to these products. This implies not only that Openreach make the products available on exactly the same terms and conditions for BT and other CPs alike, but also that BT's downstream divisions use these products. In fact, the Undertakings specify[16] that BT should use these inputs for certain downstream products, namely:

- WLR in relation to retail analogue line rental;
- SMPF in relation to asymmetric (ADSL) IPStream; and
- MPF in relation to symmetric (SDSL) IPStream.

3.10 Assuming BT's downstream divisions use these products in large volumes, BT (plc) should have strong incentives to deliver a high quality of service for these input products. In this way, EoI is designed to help prevent non-price discrimination and ensure that BT and other CPs can compete on a level playing field. Currently, BT uses both WLR and SMPF on millions of lines. However, it uses MPF on less than 20,000 lines. These volumes are important: only if BT's downstream divisions rely heavily on an input product will the incentive effect be strong.

3.11 In the absence of these automatic incentives to deliver a high quality service, there is a greater need for regulation to ensure that the service levels provided by Openreach in relation to these products are appropriate. Some of these issues have been addressed in our work on SLAs and SLGs.[17]

3.12 The rationale behind the choice of the EoI product boundaries for WLR, SMPF and MPF is set out below.

WLR

3.13 Ofcom concluded that having a voice-only passive EoI product upstream to WLR would not be appropriate at that time. A number of factors contributed to this

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[15] http://www.ofcom.org.uk/telecoms/btundertakings/consolidated.pdf
[16] For details, seen Annex 1 of the Undertakings.
[17] See http://www.ofcom.org.uk/consult/condocs/slg/

conclusion. First, a large proportion of the price of WLR contributes towards recovery of the common costs associated with the copper access network. An input upstream of WLR would also need to include these cost elements, and therefore the margin between the price of WLR and the price of the upstream input would likely be small, and perhaps too small to sustain effective competition at that time. In addition, there was very little room for growth in the size of the fixed voice market, and so little opportunity for increased efficiency through economies of scale. Finally, there is relatively little scope for innovation in line rental services.

3.14 Taking these factors into account, competition in voice markets based on an input upstream of WLR would only be possible if WLR connection and rental charges were to increase. These increases would likely be reflected in the retail charges paid by consumers. In light of these factors, we concluded in the TSR that for voice-only services, and given the prevailing circumstances, WLR was the deepest level where it would be efficient and sustainable to promote competition.

3.15 WLR was therefore considered to be a strategic bottleneck product and accordingly Openreach was required to provide it on an EoI basis, and other divisions within BT were required to use it as an input to the associated downstream products.

<u>SMPF</u>

3.16 Ofcom found that it would be efficient for CPs providing (ADSL) broadband services to use an upstream passive access product, and that in situations where BT continues to provide a voice service (WLR) to the end-user, the upstream product should be SMPF. In contrast to the WLR example, the margin between the upstream input cost (SMPF) and downstream wholesale price (IPStream) gave much greater financial and pricing flexibility to CPs. Also, the market for broadband was growing rapidly, offering the potential for all competitors to benefit from economies of scale, and reduce unit costs. And finally, there was much greater scope for product differentiation, for example, by offering higher speed broadband services.

3.17 BT only provides broadband in situations where it also provides a voice service (WLR). Further, given that BT used physically separate access equipment for its voice (WLR) and broadband (IPStream) services, the technical arrangement being used by BT in the provision of its (ADSL) broadband services was equivalent to SMPF.

3.18 SMPF was therefore considered to be a bottleneck product and accordingly Openreach was required to provide it on an EoI basis and other divisions within BT were required to use it as an input to downstream products which would require significant volume.

<u>MPF</u>

3.19 Ofcom also concluded that it would be efficient for competition in converged voice/broadband services, and possibly some business connectivity services, to be based on the upstream access product MPF.

3.20 Indeed, when providing voice and broadband it is generally accepted that for BT’s competitors the economics of using MPF are superior to the economics of using WLR plus SMPF. This is a function of the relative prices of MPF (£86.40) and WLR plus SMPF (£100.68+£15.60). If a CP was to move from WLR plus SMPF to MPF it would thus reduce its payments to BT by £29.88 per line, per year.[18]

3.21 Given that WLR was to be an input to retail analogue lines, and SMPF was to be the input to asymmetric IPStream, it was unlikely that other divisions within BT would use MPF in the provision of mass market voice or broadband services. BT's use of MPF was effectively limited to the provision of its symmetrical (SDSL) services which are predominantly aimed at business consumers.

Basis of competition established by the TSR and the Undertakings

3.22 The TSR and the Undertakings therefore established a clear wholesale input model given the current BT network architecture. This set of wholesale inputs could be expected to lead to a particular model of competition, and in this sense the input model can be seen to establish a basis for competition. For voice-only products WLR is the basis for competition. For broadband only products SMPF is the basis for competition (noting that the end-user is required to purchase a voice product based on WLR). For converged voice/broadband products the basis for competition is either WLR plus SMPF, or MPF.

Table 1: Basis of competition established by the TSR and the Undertakings

	BT	Other CPs
Voice-only	WLR	WLR
Broadband-only[19]	SMPF	SMPF
Voice & Broadband	WLR + SMPF	MPF or WLR+SMPF

3.23 Table 1 summarises the basis for competition established by the TSR and the Undertakings and compares the input products used by BT's downstream divisions with the EoI products available to other CPs. From this table it is apparent that other CPs can compete with BT on an equivalent basis in all three cases in terms of the wholesale inputs used. In addition, other CPs have the option of using MPF for converged voice/broadband services, and this is believed to be more economically attractive.

3.24 BT's plans for 21CN have evolved considerably since the Undertakings were agreed. More recently, BT has also announced plans to invest in NGA infrastructure. The next two sub-sections discuss the potential impact of these developments on the model of competition established by the TSR.

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[18] This margin has recently decreased as a result of the Openreach Financial Framework Review which increased the price for MPF from £81.69 to its present level. At the old price, the reduction in payments to BT was £34.59. It should however be noted that the relative economic attractiveness of these two models is directly driven by the prices of the individual products – all of which are set by Ofcom. For BT (plc) there is unlikely to be any significant difference between these two models, as from BT's perspective in both cases it is simply using a telephone line to support voice and broadband.

[19] It should be noted that broadband is only available on lines that also take a voice service based on WLR. Strictly speaking, therefore, 'broadband-only' refers to situations where a CP provides just the broadband service to an end-user who buys their telephony service from another CP.

Impact of 21CN on the Undertakings

3.25 BT's 21CN investment programme has been wide ranging. It was designed to deliver a simplified and more efficient network architecture based on IP and Ethernet, to reduce operating costs, and to improve time to market for new products. However, its most important element, and what set it apart from business as usual network upgrades, was the shift from TDM to VoIP, the associated investment in MSANs, and eventual PSTN 'switch-off'.

3.26 In the near term, the implications of 21CN for the model of competition established by the TSR will be less far reaching than had previously been expected, because of the change of plans resulting from BT's recent voice strategy review.[20] There will still be some significant effects, notably in relation to SMPF, but beyond that the implications will be more limited, at least for the present.

Implications for SMPF

3.27 BT's plan to use MSANs to provide WLR and wholesale broadband over a single line is not compatible with the Undertakings. As noted in Table 1, the current arrangement is that, in order to provide broadband on lines where Openreach is providing WLR, BT's downstream divisions consume SMPF, which is provided by Openreach on an EoI basis. SMPF connects a copper line to the relevant broadband equipment (a DSLAM), and a splitter then creates a return path for the connection to a physically separate line card for voice services.

3.28 The converged MSAN provides the function of the DSLAM and the line card in a single piece of equipment, and so there is no need to split the line. For this reason, it no longer makes sense for BT's downstream divisions to continue using SMPF which requires the line to be split.

3.29 Unless BT were to use MPF for both broadband and voice, a new input product from Openreach would be needed in place of SMPF. Section 5.46 of the Undertakings requires that Openreach shall not provide any product to any other part of BT unless it also offers that product to other CPs on an EoI basis. In addition, section 11.6 of the Undertakings requires BT to build its NGN on an EoI basis, unless otherwise agreed by Ofcom and BT. The difficulty of complying with these requirements in the circumstances discussed is that it would not be physically possible for another CP to use exactly the same input as BT. The input product implicitly used to create broadband services in the MSAN architecture is half of a line which has not been split. The other half of the line is used to provide WLR, but WLR is also delivered using the same MSAN as broadband. Therefore, assuming that BT is providing WLR, it is not physically possible for another CP to use exactly the same input for broadband as BT.

3.30 Given the impact that any decision by BT to deploy converged MSANs will have on the Undertakings, we would consider all relevant options for addressing the new circumstances, and would consult on the appropriateness of the new solutions.

3.31 Ofcom has noted a number of different possible solutions to this problem. The appropriate place to discuss the relative merits of these will be through consultations once the details of BT's plans are known. However, it is worth noting that, of the options of which Ofcom is currently aware, only one results in BT continuing to consume LLU products on an EoI basis. This would involve BT starting to use MPF

[20] See paragraphs 2.45-2.50.

as an input for lines requiring voice and broadband. The implications of such a change in the EoI products used by BT's downstream divisions would need to be considered carefully.

3.32 In the absence of EoI, the closest approximation would perhaps be achieved by having the input product used by BT Wholesale specified to replicate the SMPF experience. For example, in terms of provision time, price, service levels, ordering process and systems, etc. In industry discussions, this arrangement has been referred to as 'virtual' or 'single jumper' SMPF.

3.33 Following BT's change of plans for 21CN, the extent to which it will use converged MSANs remains unclear, and so the extent of this problem is not yet known. In areas where BT does not use the converged MSAN approach, it can continue to use WLR and SMPF on an EoI basis as described in Table 1. If converged MSANs were to be used throughout BT's entire network then it would be necessary to take a strategic view, taking into consideration NGA developments in addition to NGN, and assessing which models of competition are likely to be sustainable over the long term.

3.34 If, however, the deployment was very limited, then there may be a case for adopting a more tactical approach. This would involve selecting the most appropriate solution on the expectation that a more strategic review of the consumption model would be undertaken once there was greater certainty over both NGN and NGA developments.

Consequences of the BT voice strategy review

3.35 As noted in Section 2, following its recent 21CN voice strategy review, BT has decided not to proceed with WVC and WBCC, and instead will just continue to provide WLR. As a result, the implications of the 21CN programme will be more limited than had previously been anticipated, in two respects.

3.36 Firstly, the expectation was that WBCC would have been supplied by BT Wholesale, and this division would have used MPF as the upstream EOI input to produce it. As a result, it was likely that, for the first time, BT's downstream businesses would have begun to consume MPF in significant volumes. As discussed above, this would have had desirable incentive effects, helping to ensure that BT had a strong incentive to maintain high MPF service levels, and to develop the product in a way that would continue to support effective competition.

3.37 The abandonment of WBCC means that it is now perhaps less likely that BT will use MPF in significant volume, at least in the foreseeable future. In the absence of the associated incentive effects, this will increase the need for active regulation to ensure that MPF is delivered with high service levels, and that the product continues to receive appropriate levels of priority in terms of developing its functionality. We will address these issues in the forthcoming Wholesale Local Access market review.

3.38 Secondly, the introduction of WVC would have changed the consumption model for voice-only competition. The current voice product, WLR, is provided by Openreach and does not consume an upstream EoI product. However, if BT Wholesale had started to supply WVC, the Undertakings would have required there to be an upstream EoI input to this product. In anticipation of this, Openreach had started to develop plans for a new, passive voice-only product known as xMPF.

3.39 As BT no longer plans to introduce WVC, its plans for xMPF have also been shelved. Later in this section we consider whether there is nevertheless a case for requiring BT to offer an xMPF-type product.

3.40 We would note that, if in future BT Wholesale were to launch a new 21CN based voice product, or a converged voice and broadband product, it would be necessary to consider what the upstream inputs to those products should be. We will address issues of this sort as and when they arise.

BT's plans to deploy super-fast broadband

3.41 In March 2009, BT announced[21] the first details of its plans to deploy infrastructure capable of delivering super-fast broadband services to 40% of the UK's population by 2012, using a mixture of fibre-to-the-cabinet ('FTTC') and fibre-to-the-premises ('FTTP') technologies. BT's trials of FTTC began on 6th July 2009.

3.42 BT and Ofcom agreed in June of this year to vary BT's Undertakings to allow Openreach to control and operate FTTC electronic equipment in BT's access network.[22] The Undertakings require Openreach to provide wholesale active FTTC products such as FTTC Generic Ethernet Access on the basis of EoI. BT's obligations in its Undertakings in respect to other wholesale products, including WLR, SMPF and MPF, remain unchanged.

3.43 BT's plans for deployment of super-fast broadband using FTTP are less mature. While many business premises already receive services from BT's network with FTTP, and while BT has used FTTP to deliver services to new Greenfield sites on a small scale, it has so far not deployed or trialled FTTP services to premises currently served by its copper network, referred to as Brownfield sites. It has proposed to conduct trials of FTTP on Brownfield sites between January and March of 2010, with a view to launching commercial services in the summer of that year. We have recently received a request from BT to vary its Undertakings to allow Openreach to control and operate the electronics in its access network that would be required for FTTP. We will consult publicly if, following consideration, we propose to agree to vary BT's Undertakings to this effect.

3.44 On 6th July, Openreach launched a consultation on a proposal for a wholesale product that would deliver voice services over FTTP.[23] Such a product would enable delivery of voice services to premises served by FTTP without use of the copper network.

Question 1: How do you envisage the model of competition changing over the next 3-5 years, and what sort of input products will be needed to support this competition?

xMPF

Introduction

3.45 Over the past year or so, industry has been considering the development of a new passive access product which could be used to provide a traditional analogue telephone service.

3.46 Today a CP can gain access to the whole telephone line, through the use of MPF, and can gain access to the broadband part of the telephone line, through the use of SMPF. However, this leaves a gap in the product set, namely access to the voice

[21] BT press release, 23rd March 2009.
[22] See http://www.ofcom.org.uk/consult/condocs/fttc/statement/.
[23] See http://www.openreach.co.uk/orpg/news/productbriefings/nga/nga02509.do.

part of the telephone line. The term xMPF has been used to describe this passive voice access service.

3.47 In situations where BT provides SMPF to a CP, BT also continues to provide a voice service in the form of WLR. In fact, WLR is a prerequisite to SMPF. Hence, the telephone line is being shared between BT, who provides the voice service, and the CP, who provides the broadband service. The physical arrangement used by BT in this situation is arguably the same as would apply for xMPF, since BT is using just the voice part of the telephone line.

3.48 Given that BT is able to provide a voice service (WLR) in situations where another CP is providing broadband (over SMPF), some CPs have argued that an xMPF type product is necessary to ensure that they can compete with BT on an equal basis.

Different uses of the term xMPF

3.49 In conceptual terms, xMPF is the voice counterpart to SMPF. That is, xMPF provides access to the voice part of the telephone line in situations where another CP is providing broadband.[24] In thinking about how this concept might be implemented as a product, industry has come up with a number of different descriptions of xMPF. For example,

a) Physical access to the voice part of the telephone line when another CP is using SMPF on the same line;

b) Physical access to the whole telephone line with the proviso that another CP could take SMPF on the same line in the future;

c) A method of paying BT for the cost of the access network in situations where WLR has been cancelled and BT is providing wholesale broadband; and

d) Physical access to the voice part of the telephone line when the same CP is purchasing an FTTC based broadband product from BT on the same line.

3.50 Each of these is described in more detail below.

<u>Physical access to the voice part of the telephone line - with SMPF also on the line</u>

3.51 This arrangement would allow a CP to gain physical access to the voice part of a telephone line in situations where another CP is providing broadband over the same line using SMPF. This would allow the CP to provide a traditional analogue voice service by using its own network and equipment collocated in the BT's exchange, rather than by reselling BT's WLR product.

<u>Physical access to the whole telephone line – with proviso that SMPF could be added later</u>

3.52 An LLU operator has the discretion to use MPF to support any services that it chooses. For example, voice-only, broadband only, both voice and broadband or symmetrical broadband services. However, whilst there is a regulatory requirement on BT to provide SMPF to other CPs, there is no such requirement on other CPs.

[24] SMPF provides access to the broadband part of the telephone line in situations where another CP is providing voice.

Thus, once a CP purchases MPF from BT, it has complete control of all the services provided over that line.

3.53 Some CPs have suggested that they would like to change this situation, and provide voice services to end-users, but allow the end-user to take broadband from another CP. They have therefore considered the introduction of an MPF variant which would allow other CPs to provide broadband over the line, using SMPF, should this be required in the future.

3.54 This arrangement is essentially an MPF which has been ‘tagged’ as being available for sharing (using SMPF).

Method of paying BT for the access network – when BT is providing broadband only

3.55 This arrangement results in BT providing a wholesale broadband only service on the telephone line. Such a product is frequently referred to as ‘naked-DSL’.

3.56 Currently, BT only provides broadband where WLR is also being provided over the same line. Some CPs are interested in removing this prerequisite for the purchase of a broadband product from BT.

3.57 However, even if the prerequisite of WLR were to cease to apply this would not necessarily remove the need to pay at least part of its charges. This is because all the common cost of the copper access network is recovered through the WLR charge. This description of xMPF can, therefore, be considered as a method of removing the requirement for WLR to be provided on a line whilst continuing to pay for the common cost of the access network.

3.58 In contrast to the other examples, in this arrangement the CP does not want physical access to the line. Indeed, given that LLU operators could self-provide a ‘naked-DSL’ service using MPF, they are only likely to want this type of xMPF in areas where they are not using LLU. For this reason, we have confined our description of this variant to lines to which BT provides a wholesale broadband service.

Physical access to the voice part of the telephone line - with FTTC based broadband also on the line

3.59 This arrangement would apply in the context of BT’s plans to build an FTTC network to make super-fast broadband services available to about 40% of the UK’s population over the next 3 to 4 years. CPs who want to offer their customers similar broadband services, will either need to build their own super-fast broadband infrastructure, like BT, or use a wholesale broadband product based on BT’s FTTC network.

3.60 This variant of xMPF would allow an LLU operator to self-provide a traditional analogue voice service, based on LLU from the exchange, whilst at the same time selling a super-fast broadband service which is being provided over BT’s FTTC network. There are of course other possible permutations involving NGA network upgrades, but CP’s have expressed specific interest in this approach.

Requirement for xMPF

3.61 Whilst there is a common theme to all of the arrangements described above there are clear differences too. The physical implementation of each one of these arrangements would need to be different. This also implies different processes for migration, and for testing and fault repair. In practice, it is likely that each arrangement would need to be implemented as a separate product.

3.62 Given that all of the different arrangements listed above have been identified and discussed by the industry, it may be that there will be demand for all of them. However, the products which have been discussed most by industry to date are those described in 3.49 (a) and (b) above, and these are the focus of the analysis presented below.

3.63 Some CPs have argued that Ofcom should require BT to provide xMPF in addition to WLR. Their argument is that xMPF is required to allow LLU based CPs to compete effectively with BT. Specifically, xMPF would help them to provide an alternative to WLR in circumstances where MPF is not possible, and therefore to compete on more equal terms with BT in voice markets. The following analysis of the case for requiring BT to introduce xMPF is presented on a purely hypothetical basis in order to stimulate debate and to indicate our initial thinking.

3.64 It is useful for the purposes of the following hypothesis to make the assumption that an xMPF product is likely to fall in the market for wholesale local access ('WLA'). In the WLA market review concluded in December 2004[25], BT was found to have SMP in this market, as a result of which it is under a general access obligation, requiring it to provide network access on reasonable request. CPs needing an xMPF type service therefore have the option of submitting a statement of requirements ('SoR') to BT. Provided the request is reasonable and xMPF, indeed, was in the WLA market, BT would be obliged to meet such an SoR.

3.65 Some CPs, however, have argued that Ofcom should go further, and direct BT to make available an xMPF product. The case for doing so is considered below.

3.66 Currently, in situations where a CP is providing broadband using SMPF, there is no LLU passive access product that would allow another CP to provide its own traditional analogue voice service over the same telephone line. The only option in this situation would be to re-sell WLR. The product described in 3.49 (a) would address this requirement for a voice-only passive access product.

3.67 In situations where the end-user is only consuming a traditional analogue voice service, and thus this is the only service being supported on the telephone line, a CP could use MPF rather than WLR. However, some CPs have indicated that they would not want to provide a voice service in this way as it would prevent the end-user from taking broadband from a different CP in the future. The product described in 3.49 (b) above would address this issue.[26]

Potential benefits of xMPF

3.68 The case for the provision of xMPF in addition to WLR depends on the benefits that the additional product would bring. Currently, CPs can compete in the retail narrowband voice market by re-selling BT's WLR product. However, there is very little scope for CPs to differentiate their services when the input is WLR. With xMPF a CP would be able to use their own LLU equipment and voice network to create a unique voice product offering. Therefore, one of the potential benefits of xMPF would be to help stimulate innovation.

[25] http://www.ofcom.org.uk/consult/condocs/rwlam/statement/.

[26] As noted, this product could be considered as a standard MPF product which has been 'tagged' as being available for sharing (using SMPF), should sharing be required in the future.

3.69 There is, however, a question regarding the extent of the circumstances in which xMPF is likely to be used. If an end-user takes broadband and voice services from the same CP, then MPF would be the appropriate input. Equally, if the end-user takes only a voice service, then MPF could also be used.[27] xMPF is therefore perhaps limited to cases where a customer wants to take both voice and broadband service, but to use different suppliers for each service. These cases appear to represent a decreasing proportion of the market as customers increasingly take multiple services from the same supplier, driven by things like price discounts and the convenience of a single bill. Ofcom research shows that the number of households taking bundled services rose by seven percentage points since Q1 2008 to reach 46%, which is up from just 29% in Q1 2006.[28]

3.70 Although these innovation benefits may, therefore, not extend to many customers, xMPF would allow a CP to offer a common voice product throughout their LLU footprint. In the absence of xMPF, the CP would need to revert to WLR for customers who demand voice, but also want broadband from a different supplier. The CP would, therefore, be forced to offer a different voice service from that sold to customers taking either voice-only, or voice and broadband. For this reason, xMPF would allow a CP to market a consistent voice service to all target customers. To the extent that this would help to increase overall demand, and to the extent that xMPF would replace current use of WLR, the CP would benefit from better utilisation of the LLU equipment and network infrastructure in which it had invested. For these reasons, xMPF would tend to support competition between such CPs and BT across a number of markets. It should be noted, however, that outside a CP's LLU footprint, the CP would still be reliant on BT's WLR product, and would therefore have to offer a different service in these areas.

3.71 If these effects are to be significant, and can therefore reasonably be expected to translate into material differences in competition, and consequently benefits to consumers, then it is likely that the demand for xMPF would need to be significant. As already noted, it may be that the specific nature of the product automatically limits the potential for very high demand. Setting this point aside, the following discussion considers the likely impact of xMPF pricing relative to other services.

xMPF pricing and demand

3.72 As noted above, the following arguments consider a hypothetical case, and are presented as a response to the request from CPs for Ofcom to require BT to provide xMPF, and to allow stakeholders to comment on our latest thinking.

3.73 The economics of using xMPF are likely to be dominated by the margin between xMPF and WLR. The price of WLR is set by Ofcom on the basis of efficiently incurred costs, and it is likely that the price for xMPF, were this ever to become a regulated product, would also be set by Ofcom and on a similar basis. The appropriate place to make such an assessment would be during the relevant market review. The hypothetical argument is presented here merely to demonstrate the likely consequences of adopting certain prices for xMPF and WLR.

3.74 For the purposes of our hypothesis, it seems reasonable to assume that the cost of xMPF is likely to be very similar to the cost of MPF. This is apparent when we

[27] A caveat is that using MPF might limit the scope for the end-user to then take broadband from another supplier in the future.
[28] From Ofcom research, published in various Communications Market Reports available from, http://www.ofcom.org.uk/research/cm/.

consider the arrangement set out in paragraph 3.49 (b), as this is really a standard MPF product which has been 'tagged' as being available for sharing. More generally, the common cost of the copper access network is recovered through either WLR or MPF charges, and forms the majority of these charges. Since the arrangement set out in paragraph 3.49 (a) would be used as a replacement for WLR, charges for the relevant product would also need to recover these common costs. This is likely to result in a charge which is similar to MPF. In addition to WLR, Ofcom is also responsible for setting MPF prices, and on 22 May 2009, Ofcom issued a statement[29] which introduced a new price control regime for MPF as part of the wider Openreach Financial Framework.

3.75 Ofcom is also currently consulting on charge controls for WLR.[30] As part of both assessments, Ofcom must set a price which we believe to be in the best interests of citizens and consumers, taking into account all relevant considerations. As such, these charge control processes are the most appropriate place to consider changes to either MPF or WLR prices. For this reason, we do not consider such price changes in this consultation.

3.76 However, some of the analysis presented in the Openreach Financial Framework review considered issues of direct relevance to the question we are considering in our hypothetical assessment of possible xMPF pricing, and is therefore worth noting. The review considered which cost standard would be most appropriate to use to set Openreach charges.[31] The conclusion was that Fully Allocated Costs ('FAC') based on Current Cost Accounting ('CCA') was reasonable. We noted that, "setting charges primarily on the basis of CCA FAC is broadly consistent with achieving an efficient outcome [in relation to setting Openreach prices]. We therefore consider it to be in consumers' interests."[32]

3.77 Given the hypotheses presented above, it seems reasonable to assume for the purposes of our argument that the MPF price is a suitable proxy for a potential xMPF price. On this basis, we can say that demand for xMPF is likely to be driven primarily by the relative prices of MPF and WLR. It has been suggested that the margin which exists today between MPF and WLR[33] is not sufficient to support effective and sustainable competition using MPF as an input. The same argument would apply to xMPF. For this reason, if xMPF were to be introduced with a view to stimulating competition, then it is likely that a greater margin would be needed, either via a lower price for MPF (and implicitly xMPF), or a higher price for WLR. If these charges were to be set according to CCA FAC, then it seems unlikely that the margin between xMPF and WLR would be sufficient to support effective and sustainable competition.

Summary

3.78 The case for requiring the introduction of xMPF seems to rest on the dynamic efficiency benefits of increased competition offsetting the static costs associated with prices which are either higher or lower than the underlying costs. However, the magnitude of the benefits will be a function of total demand for xMPF.

[29] http://www.ofcom.org.uk/consult/condocs/openreachframework/statement/statement.pdf.
[30] http://www.ofcom.org.uk/consult/condocs/wlrcc/wlrcc.pdf.
[31] For full details, see ibid, Annex A4.
[32] ibid, paragraph A4.3.
[33] In fact, the comments relate to a larger margin which existed before the recent change in MPF prices noted in paragraph 3.74. WLR is currently £100.68 per line per year, and MPF £86.60. Prior to the change MPF was £81.69.

3.79 It seems likely that the demand for xMPF will be limited by two factors. First, since xMPF in its most commonly described form is designed to serve customers who require voice and broadband from different suppliers, and since buying these services from the same supplier often results in lower prices, it is likely that this will continue to be a declining proportion of the market.[34] Secondly, in order to provide a voice service using passive inputs, it is likely that a larger margin would be needed than that which exists today between MPF and WLR.

3.80 On the second issue, although this consultation is not the appropriate place to consider changes in regulated prices, we have noted the conclusion in the recent statement on the Openreach Financial Framework. This notes that, "if the differential between MPF and WLR+SMPF is not cost based, it may result in an inefficient mix of wholesale products being used."[35]

3.81 Given these considerations, we suggest that, at present, the most appropriate method for resolving the issue of xMPF will be through the BT SoR process. As noted above, if there is demand for such a product, then CPs have the option of submitting an SoR to BT, and provided the request is reasonable and xMPF is judged to sit in the WLA market, BT would be obliged to meet it.

Question 2: Do you agree with our analysis of the requirement for xMPF?

Voice interconnection in a mixed TDM / NGN world[36]

Introduction

3.82 This section discusses a range of issues concerning interconnection of voice services between IP based NGNs and TDM networks. In particular, it considers the impact on interconnection of the changes to BT's plans for 21CN. For a summary of these changes, see paragraphs 2.45-2.50.

3.83 Interconnection between two networks must take place using the same technology. If one CP runs an IP voice network, and another uses traditional TDM technology, then the two must agree a common technology to enable interconnection. Either the TDM operator must convert its traffic to IP, or the NGN operator must convert its traffic to TDM.

3.84 Furthermore, an efficient design for physical interconnection arrangements will vary considerably depending on the choice of technology. For example, in IP voice networks the number of routing nodes is generally smaller than the number of switching nodes in a TDM network. This tends to result in a much smaller number of points of interconnection between IP networks.

3.85 The best case scenario is one in which both networks use the same technology: although there would continue to be costs associated with interconnection, the costs of conversion can be avoided altogether, and an efficient design can be adopted for logical and physical interconnect circuits.

[34] See paragraph 3.69.
[35] ibid. paragraph 5.7.
[36] Ofcom has recently received a dispute concerning aspects of the voice interconnect regime. The issues being considered under the dispute are therefore omitted from this consultation. For details, see http://www.ofcom.org.uk/bulletins/comp_bull_index/comp_bull_ocases/open_all/cw_01027/.

3.86 This ideal outcome is not possible in a world where TDM and IP networks coexist, and it is this mixed technology environment that we expect to predominate for the foreseeable future. The consequence is higher costs for interconnection, which will be borne by one or all of the network operators, and potentially consumers. One of the questions considered below is where these additional costs should be recovered.

3.87 In considering this and other related interconnection issues, we take particular note of the effect on investment incentives. We believe it is important to ensure that the arrangements for IP and TDM interconnection do not discourage efficient investment in NGNs. Similarly, it is also important that the approach to interconnection does not drive inefficient investment, or create artificial arbitrage opportunities.

Technical work on NGN interconnection

3.88 To facilitate interconnection between NGN networks, it has been necessary for CPs to develop a completely new set of interoperability standards.

3.89 A great deal of work has been undertaken against a demanding timescale to ensure the technical standards were ready for 21CN based services. The forum for this work in the UK has been NICC Standards Limited ('NICC').[37]

3.90 NICC has developed a suite of interconnection standards designed to support multiple services over a common IP transport infrastructure. NICC has completed its second release (the Green Release[38]) which, in addition to common transport, includes support for:

- PSTN and ISDN voice telephony services;
- voice line control – allowing CPs to use their own call-server to control voice services on another CP's network (these are the standards required to support BT's proposed WVC service); and
- a common numbering database for direct routing of calls to ported numbers.

3.91 NICC is currently specifying the scope of a third release (the Orange Release).

3.92 NICC has indicated to Ofcom that it believes there may be a need for other technical standardisation work to support NGN deployment, namely:

- adoption of a standardised SIP User Network Interface for terminal equipment to maximise terminal equipment compatibility with NGN services;
- agreeing a standard set of testing procedures to assess terminal equipment compatibility with NGNs; and
- developing a standardised approach to handling traffic from 'uncontrolled sources' where the integrity of parameters such as quality of service and Calling Line Identity ('CLI') cannot be guaranteed.

3.93 These issues are discussed in Section 4.

[37] Formerly a technical committee reporting to Ofcom called The Network Interoperability Consultative Committee. In 2008, NICC was reformed as an independent industry owned organisation NICC Standards Limited.
[38] http://www.niccstandards.org.uk/publications/green-release.cfm.

3.94 We welcome stakeholder comments about the need for further technical standardisation work to support NGN deployment.

Question 3: What additional technical standardisation work is required to support NGN deployment?

Original approach to 21CN migration and interconnection

3.95 Under the original plan for 21CN, BT was to transfer all lines from its current TDM based voice network to an NGN over a relatively short time period (3-5 years). As BT migrated lines to the new network, they would have started to offer IP interconnect for traffic to and from these 21CN based lines. Recognising the need for CPs to be able to plan their transition to IP interconnection, BT also planned to continue offering TDM based interconnect for all lines on an interim basis. BT would provide the interworking function, to convert from IP on 21CN to hand over traffic as TDM, at no additional cost to the CP.

3.96 Voice traffic to and from end-users still connected to BT's legacy TDM network (i.e. connected to a DLE) would be handed off directly from the TDM network. That is, BT was not planning to convert this TDM traffic into IP to allow IP based interconnection directly to other CPs' NGNs.[39] Therefore, a CP with an NGN would still have needed to convert from IP to TDM in order to interconnect traffic destined for customers connected to BT's legacy network.

3.97 In summary, the original approach for 21CN interconnect was that,

3.97.1 for traffic from end-users connected to BT's legacy TDM network, only[40] TDM interconnect would be available, but

3.97.2 for traffic from end-users connected to BT's 21CN IP network, both TDM and IP interconnect were planned.

Impact of BT's new approach to 21CN

3.98 Under BT's new plan for 21CN its PSTN infrastructure will continue to be used for voice services, at least in some areas, for the foreseeable future. This means that the period of transition, in which IP and TDM networks will coexist, will be much longer than previously thought.

3.99 As noted above, one of our objectives in conducting this analysis is to understand the impact on investment incentives. In this regard, the shift in expectations to a long period of transition from TDM to IP raises a number of issues:

3.99.1 In this mixed TDM/IP environment, which network should provide the interworking function to enable interconnection, and how should the costs of providing this function be recovered?

[39] In the event that calls were routed to the wrong network, i.e. traffic destined for TDM customers sent via IP interconnection, BT reserved the right to charge a levy for the interworking function. However, it was intended that this function be reserved for exceptional cases. The call routing rules for the NGN Call Conveyance product required that conversion between IP and TDM should be avoided as far as possible.

[40] Strictly speaking, BT would convert traffic from IP to TDM, but wanted to avoid these circumstances. See footnote 39.

3.99.2 Should BT be required to offer an IP equivalent to TDM interconnection and, if so, when?

3.99.3 Does the principle of reciprocity continue to be appropriate in a mixed TDM/IP environment?

Relevant policy principles

3.100 In addressing these issues, it will be important for Ofcom to take account of a range of factors, including:

- the impact on consumers of the various policy options;
- the desirability of incentivising efficient investment; and
- the way these issues would be resolved in a fully competitive market.

3.101 We consider below the implications of these objectives, assuming a general case involving the transition from an old, higher cost technology to a new, lower cost one, where interworking costs are incurred during the transition. For the time being, we also assume that the new technology is being used to provide an equivalent product to that delivered by the old technology.

The ideal case

3.102 The ideal outcome in terms of the efficiency of interconnection arrangements would be for the industry to move rapidly and simultaneously to the new, lower cost technology. A short transition period would minimise the need for interworking, and early transition would minimise the costs of service provision. This is likely to be reflected in lower downstream prices, to the benefit of consumers.

3.103 Challenges to the ideal begin to arise where suppliers move to the new technology at different times, and over different periods. These variations in timing may reflect fundamental differences of view about the benefits of the new technology, but may also be due to coordination issues.

The early mover

3.104 In a hypothetical fully competitive market, firms cannot charge above the cost of the most efficient operator. Any attempt to do so would result in customers switching to a provider that did charge a price which reflected the efficiently incurred costs.

3.105 If a single firm moves to a new technology ahead of the rest of the market, then assuming this technology reduces the firm's cost base, they will be able to price at or below the current 'most efficient operator' rate which is based on the old technology. This should allow the firm to win new customers, and/or earn a higher margin until the rest of the market catches up and adopts the new, more efficient technology.

3.106 If, however, the new technology, for whatever reason, increases the costs of the early mover, then it would not be possible for the firm to recover these costs through increased prices. For this reason, in the hypothetical competitive world, it would be unlikely firms in this position would invest in the new technology.

3.107 This analysis reflects the proposition that it would be unreasonable to expect consumers to pay higher prices to cover the costs of a supposedly more efficient technology. This is supported as a general principle by the Competition Commission ('CC') in a recent determination[41] regarding mobile termination rates. The CC found that the costs of the old technology (in this case 2G) in principle set an upper bound on what it was appropriate to recover through mobile call termination charges for calls terminating on the new technology network (in this case 3G).[42] In reaching this conclusion, the CC noted that,

> *As a general principle, we agree […] that in a competitive market the introduction of a new and more efficient technology should not lead to an increase in price for an existing service*.[43]

3.108 These arguments from the CC refer to situations in which the new technology is definitely more efficient. In terms of our example, we consider that this would equate to a scenario in which the combined cost of the new network and the cost of interworking is less than the cost associated with the old technology. In such circumstances, where the additional interworking costs outweigh the cost savings associated with the new technology, then it is likely that a firm operating in a competitive market would not invest.

3.109 This suggests that the early mover should factor in the costs of interworking when assessing the business case for moving to the new technology. If the savings from moving to the new technology outweigh the interworking costs, then it makes sense to invest. The early mover should be able to earn a higher margin until the new technology is adopted more widely and prices start to reflect the new underlying costs. However, if the interworking costs are higher than the cost savings brought about by adoption of the new technology, then the early mover is less likely to invest based on a short term assessment of the cost recovery. There may be other reasons for investing in the new technology aside from cost savings, but these are not considered in this analysis.

3.110 There are, however, several factors which may complicate this general line of argument. These are discussed in the following sub-sections.

Interdependent investments

3.111 The present case, relating to interconnected communications network providers and associated markets, is more complicated than the hypothetical world considered above. To some extent, the most efficient network architecture for an individual firm is a function of the technology and network design choices of other operators. As noted above, the ideal lowest cost scenario can only be achieved when all operators adopt the same technology standard.

3.112 In certain circumstances, the competitive market outcome fails to lead to the adoption of a more efficient new technology. This would be the case if the interworking costs were to outweigh the efficiency gains from adopting the new technology. This would lead to a higher overall cost base for an individual firm making the first move to the new technology. Since any costs over and above the rate set by the old technology could not be recovered in a competitive market, no individual firm would have an incentive to invest in the new technology. If the market as a whole moves to the new

[41] *Mobile phone wholesale voice termination charges*, Competition Commission Determination, 16th January 2009. Available from, http://www.catribunal.org.uk/files/CC_Determination_1083_H3G_1085_BT_220109.pdf.
[42] See, for example, paragraphs 2.9.74 and 2.9.80, ibid*.*
[43] ibid, paragraph 2.9.10.

technology, everyone benefits; but no individual operator would benefit from making the first move.

3.113 The relevance of this argument turns on the magnitude of the interworking costs relative to the efficiency savings provided by the new technology. Ultimately, this is an empirical matter.[44] If interworking costs are relatively small, then we can continue to operate on the assumption that a competitive market should create incentives which stimulate efficient investment decisions.

3.114 In some cases, one firm's decision to invest in the new technology may be based on the need to interoperate with another firm, plus an expectation that this other firm is going to move to the new technology. In an effectively competitive market, this would be regarded as a commercial risk, which the firms may seek to manage through contractual arrangements. For example, the two parties may agree to repay the costs incurred by the other party in the event that one of them fails to complete certain investments set out in the agreement.

3.115 The position may be more difficult if one of the firms has a dominant position in relevant markets, and therefore the two parties have different negotiating strengths.

The most efficient proven technology

3.116 Another consideration is that regulated interconnect prices should generally be based on the most efficient proven technology. When a new technology is first deployed, it will not yet be proven. During this phase, it is perhaps reasonable for the regulated interconnect charges to be based on the old technology. Consistent with the discussion above, if a firm[45] is able to secure a cost advantage by investing in the new technology (despite the interworking costs), they may be able to earn an improved margin.

3.117 At some point, however, assuming the new technology is a success, it will become proven. There is then likely to be sufficient evidence about the costs of the new technology, and perhaps it then becomes appropriate for the regulator to set the interconnect charges on the basis of the new technology rather than the old. This would be the case regardless of whether or not the regulated firms have invested in the new technology. If not, the process of charge-setting would require a revaluation of the firm's assets on the basis of the new technology (i.e. using modern equivalent assets).

Obligation to provide services based on new technology

3.118 At some point, and possibly before the new technology is proven, it may be appropriate to require the introduction of interconnect services based on the new technology. To the extent that a firm facing this requirement continues to use the old technology, it would then incur the costs of interworking in addition to the costs of the old technology.

3.119 There may be a case for imposing a requirement of this sort in order to minimise the interworking costs incurred across the industry as a whole. To the extent that there

[44] The equipment required to provide the interworking function is discussed below at paragraphs 3.139-3.146.
[45] Through the principle of reciprocity, the regulated interconnect price level is applied to all operators, and therefore these investment signals apply to all operators, and not just individual regulated entities. See paragraphs 3.129-3.133 for further discussion of reciprocity.

are economies of scale in interworking, it may be cheaper for one firm to carry out this function, rather than for it to be distributed between many smaller suppliers.

3.120 If there was such an obligation to offer interconnect services based on the new technology, there is a further question of how these services should be priced. Once the new technology has become established, then as discussed above, the charges should be based entirely on the more efficient new technology. The regulated firm would not therefore be able to pass on the costs of interworking to other firms through its interconnect charges. This is one of the factors that should be recognised when carrying out the Modern Equivalent Asset ('MEA') revaluation.

3.121 If the new technology is not proven, there may be a case for allowing the regulated firm to price the interconnect service at a level which reflects the old technology (which it continues to use) plus the costs of interworking. This could lead to a two-tier charging structure, with charges for interconnect using the new technology potentially being higher than those for interconnect based on the old technology.

3.122 However, the incentive properties of such a charging structure are questionable, since it would tend to encourage firms to continue using the old technology. It may still be justifiable on the grounds, mentioned above, that a single firm might provide a more efficient interworking function than multiple smaller suppliers. In this scenario, a firm which had adopted the new technology would have lower overall costs than if they had provided the interworking function internally.

3.123 Clearly, though, the incentive to invest in the new technology is diminished relative to the scenario in which charges for interconnection using the new technology do not include interworking costs. Once again, the relevance of these arguments in practice will depend on the relative size of the interworking costs.

Possible implications

3.124 The purpose of the preceding discussion has been to set out some of the principles which are likely to be relevant when addressing the interconnect issues identified above. The possible implications for BT and other CPs are considered below.

Basis for regulated interconnect charges

3.125 In the consultation on the Network Charge Control ('NCC')[46], we considered whether BT's wholesale network charges should be regulated on the basis of IP technology, and reached the provisional conclusion that at this stage they should not. Our assessment was that the technology for delivering PSTN voice over IP technology was not yet proven, and that the charge controls should therefore be determined using the existing TDM cost base.

3.126 As this suggests, we are currently at an early stage in the transition from TDM to IP technology for the delivery of voice services. This, in turn, suggests that firms which have invested in IP technology for voice should be regarded as early movers. In line with the preceding discussion, having already made this investment, we could view this as an indication that the efficiency savings associated with the move to IP are sufficient to outweigh the interworking costs. If this is the case, then it may be reasonable that early movers continue to bear the costs of interworking.

[46] See http://www.ofcom.org.uk/consult/condocs/review_bt_ncc/.

3.127 The position may be complicated by the recent change in BT's 21CN voice strategy, as the NGN investments made by some operators may have been predicated on BT carrying out its previously announced plans to move to IP. As discussed above, we would normally expect this sort of issue to be dealt with through commercial negotiation and contractual agreement. However, this may be made more difficult by BT's market position in relation to interconnection, and uncertainty over the potential efficiency gains delivered by the new technology. There is also uncertainty over the most efficient way to providing the interworking function. This issue is discussed further below at paragraphs 3.139-3.146.

3.128 There is clearly an important question as to when IP technology should be regarded as the most efficient proven technology for the provision of voice services. As indicated in the NCC consultation, we think it is reasonable for us to regulate BT's wholesale charges on the basis of TDM costs for the next 4 years. The question of whether, beyond that point, regulation should be based on the costs of IP technology will be addressed in the next NCC review.

Implications for the principle of reciprocity

3.129 In a competitive market, we expect prices to tend towards an efficiently incurred cost in the long run. In markets where an operator has SMP, there may not be sufficient pressure from the market to lead to the same outcome. One of the objectives of regulation can be to mimic the outcome of a competitive market, and thereby ensure that consumers benefit from the efficiency that this brings.

3.130 All fixed network operators have been found to have SMP in wholesale call termination. BT's call origination and call termination services are subject to cost orientation obligations and a charge control. Of the various principles which underpin the setting of charge controls, one of the most important is that the costs should reflect those of an efficient operator. This ensures BT's wholesale customers are protected from excessive pricing for these services, and provides BT with incentives for efficiency and cost reduction in provision of the services.

3.131 However, for other fixed CPs, call termination is only subject to an obligation to set "fair and reasonable" rates. CPs are generally considered to meet this requirement if they match the charges they pay to BT. This reciprocal approach is based on the idea that BT's regulated charges represent those of an efficient operator. In this way, reciprocity ensures that customers of other CPs' termination are protected from excessive pricing for these services, and that these CPs also have incentives to operate efficiently and reduce costs.

3.132 Our initial assessment is that, based on the policy considerations outlined above, the transition to IP technology should not change the incentive properties of the principle of reciprocity in its application to interconnect pricing. As discussed above, we have proposed that BT's interconnect charges will continue to be regulated on the basis of TDM cost projections for the next 4 years. During that time, it is perhaps reasonable that other CPs should be able to price their interconnect services on the same basis. If, as a result of their having adopted IP technology, those CPs are able to provide interconnect services more efficiently than BT, they may be able to secure improved margins.

3.133 As discussed above, at some point, BT's interconnect charges are likely to be regulated on the basis of IP technology. This is likely to happen once IP technology is regarded as the most efficient proven technology. In that case, the principle of reciprocity should continue to be applicable since it will still help ensure that CPs face appropriate incentives to invest in the most efficient technology.

The requirement for IP interconnection

3.134 BT already provides some IP interconnection services on a commercial basis, and is likely to develop additional services of this sort as the proportion of IP voice traffic, and hence demand for such products, increases:

- **BT IP Exchange**: BT currently provides a wholesale service called IP Exchange[47] which allows CPs to terminate on the BT network, or to transit to other networks, and to hand over traffic as IP. Therefore, where necessary, BT provides the interworking function to convert the IP traffic to TDM. IP Exchange is provided on a commercial basis. It uses regulated TDM components as inputs, and then adds interworking functions and a commercial wrap. For this reason, the prices for termination and transit can be higher than the equivalent regulated rates for TDM interconnection.

  However, IP Exchange does not support the full set of regulated voice products, for example, it does not support Carrier Pre-Selection ('CPS'). More generally, it is not yet sufficiently developed to act as a direct substitute for TDM interconnection. For example, signalling on IP Exchange uses a version of the SIP signalling protocol that currently does not support all the features found in regulated TDM interconnection.

- **NGN call conveyance**: Depending on the number of customer lines which are moved to 21CN, BT may introduce a product similar to the proposed NGN call conveyance product. NGN call conveyance (PSTN emulation) was a product concept developed by BT to offer IP interconnection for traffic to/from customers connected to the 21CN voice network.

3.135 From a regulatory point of view, the important question is whether and when BT should be required to offer IP interconnect services which can be used as a substitute for regulated TDM interconnect, and therefore help to support effective competition in voice markets on a national basis.

3.136 Once IP technology has become established as the most efficient proven technology for the delivery of voice services, then it is likely to be appropriate for a network operator with SMP in the relevant market(s) to be required to offer IP interconnection.

3.137 However, there may also be a case for considering whether BT should be required to offer IP interconnect that can act as a substitute for the current set of regulated TDM interconnect products, and to do so before the new technology is used as the basis for setting interconnect charges. One initial consideration is whether an obligation of this sort would be likely to minimise interworking costs across the industry as a whole. This, in turn, will depend on the number of CPs who have invested in NGNs and the extent of scale economies in providing interworking. Some of the practical implications of different forms of interworking are discussed below.

3.138 If an obligation were to be placed on BT to provide IP interconnection, it may be appropriate for the service to be priced on the basis of the (TDM and interworking) costs actually incurred by BT in providing the service, until IP interconnect technology has become more established. If, in the future, IP technology can be regarded as the

[47] For further details, see http://www.btwholesale.com/pages/static/Products/Interconnect/IP_exchange.html.

most efficient proven technology for voice provision, then as noted above, it is likely to be appropriate for IP interconnect charges to be based on the new technology.

Practical implications of IP/TDM interworking

3.139 In circumstances where two interconnected voice networks use different technologies, a key consideration is whether the interworking function should be provided by the TDM or IP network. Although the analysis presented below applies more generally, we use as an example the specific case of BT running its legacy TDM voice network and interconnecting with a CP running an IP voice NGN.[48]

3.140 We consider below the practical implications of requiring the TDM operator (BT) or the IP operator to provide the interworking function. The term 'interworking' is used to refer to the function of converting traffic and signalling between the relevant IP and TDM standards. The equipment used to provide this specific function is referred to as a Media Gateway.

Scenario (a): the TDM operator (BT) provides the interworking

3.141 In this scenario, in addition to the provision of a Media Gateway, BT must build the capability to manage the routing and signalling of IP voice traffic, and maintain security on its network. This requires a session border controller (or similar firewall equipment) and a call server. Effectively, BT must build an IP voice network as an overlay to its TDM network.

3.142 IP interconnection can only be provided at sites where BT provides conversion to IP, and it is likely that this will occur only at a relatively small subset of the total number of points of interconnect for TDM. The same is true of IP networks in general, and is due to the difference in cost structure between TDM and IP networking equipment. The consequence of a smaller number of points of interconnect is that CPs do not have the same opportunity to avoid the costs of using BT conveyance.

Scenario (b): the IP operator provides the interworking

3.143 In the alternative scenario, the CP with the IP network will need to provide a media gateway. No other additional equipment is required since the CP will already have a session border controller and call server as part of its IP network infrastructure.

3.144 Since the CP is interconnecting at the legacy TDM sites, it will continue to have the opportunity to avoid BT conveyance costs by connecting at the DLE layer.

3.145 In both scenarios, there are additional costs relative to the situation in which both operators use the same technology. However, it appears that more equipment is required in scenario (a), where the TDM network provides the interworking function. This need not imply that scenario (b) is more efficient. The extra equipment provided by the TDM operator in the first scenario is effectively an investment in the future technology. As noted above, it is equivalent to building IP voice network capability. Similar investments in IP are already expected to take place at some point in the future. Therefore, the effect of requiring the TDM operator to provide the interworking function may simply be to bring forward investments that were already planned.

[48] In the future, it is likely that BT and other CPs will each have a mixture of TDM and IP connected voice customers, and so we could just as well have considered BT's IP network connecting to a CP's TDM infrastructure.

3.146 In contrast, in scenario (b), the IP operator is investing in equipment which should eventually become redundant, and will certainly become less productive as the volume of TDM traffic declines.

Question 4: What policy positions do you believe Ofcom ought to adopt in relation to interconnection between IP and TDM networks?

Investment and uncertainty

21CN strategy review has created considerable uncertainty

3.147 As discussed in the previous section, BT has fundamentally changed its plans for voice services on 21CN. This has followed a period of around 5 years where its plans have continually been updated and revised, but have at least been consistent in terms of the long term vision for the network: that BT's entire PSTN would be replaced with an IP network based on the use of MSANs in the access network to deliver both broadband and telephony.

3.148 It has long been recognised that BT's plans for 21CN, and network development more generally, have a significant impact on investment by competing CPs. All CPs need to interconnect with BT, and most also must use the BT network to access customers. Therefore, changes to the design of the BT network have a direct impact on the businesses of competing network operators.

3.149 For example, industry had agreed, through discussions at NGNuk and BT's Consult21, that the number of points of interconnection should be reduced from over 700 on the legacy network to just 27 on 21CN. Clearly, an efficient design for a network which reaches 700 nodes is quite different to one that reaches just 27. For this reason, CPs have been planning and investing in their networks today to take account of a future in which there will only be a small number of places to interconnect. This is likely to result in some inefficiency today, but would reduce the risk of stranded investments once the BT network changes. This effect is most keenly felt by operators with growing traffic volumes who need to invest in new capacity.

3.150 The change in plans for 21CN has made this interconnect planning process much more difficult. The move to a smaller number of points of interconnect is now considerably delayed, but it is also no longer the case that all 27 points will definitely be needed. This will depend on the roll-out of the 21CN voice network, and at present BT does not have a stated plan for this migration beyond completing the 350,000 premises in the Pathfinder trial.

3.151 In light of these developments, it becomes almost impossible for a CP to know what an efficient design will be when investing in additional capacity. If capacity already exists, then this is likely to be a much less of a pressing issue. In any event, CPs obviously would like to be able to run their networks efficiently, and be able to plan to maintain this efficiency.

3.152 BT is now adopting a much shorter planning horizon. Whereas previously they had planned 21CN on a rolling 5 year timeframe, they are now looking only 12-18 months ahead. Beyond this time horizon there is no confirmed investment or network upgrade plan. This may be a realistic and optimal approach for BT's own needs, but it does not take into account the consequences for investment planning by other CPs.

3.153 More generally, all industry participants are having to cope with the uncertainty created by the general economic climate; higher costs to finance investments; technology risks around the future of telephony; and considerable technology and commercial risk associated with building NGA networks. Many of these factors will have contributed to BT's change in strategy.

3.154 The combined result of the general climate and the lack of knowledge of BT's future network architecture is a risk of significantly reduced investment by fixed competitors to BT.

3.155 In an ideal world, BT would be able to commit to a particular network design, and thereby allow other operators to plan investments effectively. Ultimately, this is the only way to remove the uncertainty over BT's network design. However, this is not realistic. BT must at least have some flexibility to react to developments beyond its control, such as the introduction of new technologies.

3.156 Any solution, therefore, will need to be a compromise between providing certainty for industry and giving BT flexibility. Ofcom has addressed this issue before in relation to lack of clarity over BT's plans for 21CN. This resulted in a requirement for BT to publish a quarterly plan of record with specific details of its latest proposals for 21CN roll-out.[49] However, this requirement to publish a plan of record does not oblige BT to stick to the plan, and therefore has done little to reduce uncertainty. It seems unlikely, therefore, that the solution in this instance would be to introduce further publication requirements.

3.157 We believe that the most appropriate solutions to this problem of uncertainty are likely to be found through commercial negotiation. This could, perhaps, result in changes to contractual terms and conditions which would encourage BT to take account of the external effect of its investment decisions. By way of example, the System Alteration clause in the current BT standard interconnect agreement[50], requires that if one party makes changes to interconnection, then under normal circumstances, they should expect to pay the minimum costs consistent with good engineering practice for any changes to the other party's systems.

3.158 We acknowledge that commercial negotiation in markets where one party has SMP may not be successful. However, this is perhaps the best starting point for solutions to the problem of uncertainty in situations where CPs are making interdependent investments.

Question 5: Do you have agree with our analysis of investment uncertainty in relation to BT's 21CN plan?

Effective migration processes

3.159 Switching is a vital part of the competitive process. Without effective migration processes, customers may decide not to leave their current supplier, even if the services from a different supplier would better meet their needs. Competition is most effective where customers are able to make their demands and requirements known by moving to the provider which best meets these needs. In this way, the act of

[49] "Variations to BT's Undertakings under the Enterprise Act 2002 in respect of BT's NGN, Space and Power and OSS separation", http://www.ofcom.org.uk/telecoms/btundertakings/exemptionsandvariations/statement071008.pdf.
[50] See section 4 of the standard interconnect agreement, available from http://www.btwholesale.com/pages/static/Pricing_and_Contracts/Reference_Offers/Telephony.html.

switching provider sends signals to the market about what customers want, and this benefits all customers – not just those who choose to switch.

3.160 Given the importance to the competitive process, Ofcom has an objective to ensure that there are no unnecessary barriers to switching, and that customer migration processes are efficient and of high quality. In doing so, our aim is to promote switching and competition, whilst protecting consumers. These objectives reflect our principal duty set out in section 3(1) of the Communications Act 2003.

3.161 With these objectives in mind, Ofcom will act to bring about the following:

- a good customer experience of switching;
- protection against inappropriate sales and marketing activities;
- well-informed consumers able to discipline CPs by making considered choices, based on timely, objective and reliable information; and
- that competition is supported in retail and wholesale markets to the benefit of consumers, particularly by minimising obstacles to switching.

3.162 Given the trend towards convergence and, in particular, an increase in retail bundling, switching is already becoming more complex for customers. This trend is likely to continue, especially as more operators build converged NGNs and look to sell more than one service to each customer.

3.163 We are also entering an extended period of transition as CPs upgrade voice networks to NGN, and upgrade copper access networks to NGA. During the transition a variety of access and core network technologies will coexist, resulting in an even larger variety of wholesale access products. This will add even more complexity to the underlying processes required to switch customers. Despite this complexity at the wholesale level, Ofcom would like to ensure that consumers are able to switch easily between different CPs and different products, regardless of the nature of the migration process and the underlying technologies.

3.164 As CPs upgrade their network infrastructure using either NGN or NGA technology, it is important to take the opportunity to build in effective end-to-end switching processes from the outset. The existence of such processes will be a major factor that contributes to the overall competitiveness of both super-fast broadband and markets based on NGNs.

3.165 Ofcom is undertaking a separate project as part of its migrations work. This will consider the extent to which there is a need for harmonisation of switching processes across different services. The project is examining a broader set of issues around optimal switching models, across all transferable communications services. We will seek to ensure that decisions made in relation to the design of NGNs and NGAs take into account the emerging evidence from the broader project on migration processes.

3.166 Notwithstanding this, in light of the uncertainty over the network developments mentioned above, we would welcome views and comments from stakeholders on issues relating to switching.

Question 6: How do you think Ofcom should take forward considerations relating to switching involving next generation access and core networks, and which areas should we focus on?

Section 4

NGN consumer protection issues

Introduction

4.1 We believe that NGNs should be a positive development for consumers. However, given the scale and complexity of the transition to NGNs, there are potential risks to consumers that need to be addressed to ensure that consumers are protected both during and after the transition process.

4.2 In the 2006 NGN Statement, we established a set of principles for consumer protection during NGN migration and considered how best to address the consumer protection issues that might arise.

4.3 Since the 2006 NGN Statement, significant progress has been made on a number of these issues, particularly in relation to 21CN migration.

4.4 In this section we review each of the consumer protection issues in the light of recent developments and consider how we should address them.

Consumer protection principles and approach

4.5 In the 2006 NGN Statement we established three principles for consumer protection during NGN migration:

- the services offered to consumers on NGNs should at least be equivalent to their existing services;
- consumers should not suffer any detriment during the transition to NGNs, for example, due to loss of access to emergency services or degraded call quality; and
- any changes to services are fully explained to end-users.

4.6 We also considered how best to ensure that consumers are protected during NGN migration. We concluded that there is a balance to be struck between:

- those aspects of consumer protection which ought to be in providers' interest to handle effectively, e.g. avoiding service problems during the NGN migration;
- areas where improved consumer protection ought to be a natural consequence of a well-designed NGN; and
- those areas where there may be a case for greater Ofcom involvement and perhaps formal intervention.

4.7 Therefore, where CPs have some incentive and ability to address consumer protection issues, we decided that our initial approach should be to monitor developments as a critical observer. However, we recognised that although individual CPs should have an incentive to minimise disruption for their own customers, there might be some issues that need to be addressed on a wider basis. One reason is that consumers typically use a number of communications services (for example, fixed voice, mobile and Internet access) from a range of different CPs. Another reason is that many communications services rely on multiple interconnected networks, such as a call which is passed from one CP to another.

4.8 Since the 2006 NGN Statement, we have applied this approach to the consumer protection issues associated with NGN migration. We think this approach has worked well with most of the issues being addressed by CPs without formal intervention by Ofcom. We therefore believe these principles and our approach remain valid and propose to continue to use them as NGN migration progresses.

Question 7: Do you agree that the consumer protection principles and our approach to addressing consumer protection issues are still valid?

Managing potential service disruption during network migration

4.9 In order to transfer telephone and broadband services from existing networks to an NGN, it is necessary to physically disconnect customer lines from the existing equipment before connecting it to the new NGN equipment. This results in a service interruption typically ranging from a few seconds to a few minutes whilst the work is carried out.

4.10 We believe that all CPs have strong incentives to ensure that their customers experience the minimum level of disruption during migration. Given the need for extremely thorough and detailed technical coordination between CPs, in the 2006 NGN Statement we concluded that formal intervention or direct Ofcom management would be unlikely to provide a simple means of ensuring that consumers would be protected during migration. We therefore decided to monitor the established industry mechanism, the Consult21 Implementation and Migration Working Group (‘IMWG’), and to contribute as necessary.

4.11 At the time of the 2006 NGN Statement, BT envisaged that it would transfer most customer telephone lines and broadband services to 21CN using the traditional mass-migration approach. This involves the mass transfer of all customer lines connected to an exchange unit to an equivalent NGN service, allowing the whole exchange unit to be released for decommissioning. Typically such transfers are carried out in the early hours of the morning to minimise disruption. Therefore to date, the main industry focus has been on these mass migration processes for 21CN telephone and broadband migration.

4.12 BT, in cooperation with other CPs that participate in the IMWG, has developed detailed migration procedures and contingency arrangements. These have been tested during the first phase of BT’s Pathfinder pilot in south Wales, where approximately 75,000 analogue telephone lines have been transferred to 21CN. After the first phase has been evaluated, BT plans to transfer a further 275,000 lines to 21CN in a second phase of the pilot, commencing in January 2010.

4.13 BT and other CPs who participate in the Consult21 Communications Working Group have developed a communications strategy to ensure that consumers and businesses get clear and consistent information about 21CN migration regardless of which retail CP they use.

4.14 CPs are responsible for communications to medium and large businesses and can draw on supporting collateral material developed by the Communications Working Group. For residential customers and small businesses, a cross-industry communications plan has been developed. Operating under the ‘switched-on’ brand, information about migration is delivered to households prior to migration and announcements are made in local media. There is also a website[51] and a contact-centre for inquiries.

4.15 A key aim of this communications plan is to raise consumer awareness about the service interruption associated with migration so that consumers, particularly the infirm, can ensure they have an alternative means of contacting the emergency services (such as a mobile phone) in the unlikely event this should be necessary during the short service interruption to telephony services during the switch-over.

4.16 Subject to the successful completion of the Pathfinder pilot, expected in 2010, our initial view is that the 21CN mass-migration processes and the consumer communications arrangements adequately protect consumers, keep disruption to a minimum and ensure that consumers are informed about migration.

Impact of revised 21CN plans

4.17 BT's revised plans for 21CN mean that most telephone lines will remain connected to BT's existing network at least in the short term, thereby reducing the use of the mass-migration processes considerably. However, BT's revised plans envisage that some mass-migration of telephony services may occur in the next few years, perhaps of the order of 1 million lines.

4.18 This change in approach means that in the short term at least, most service migration to 21CN will be customer-led migration. That is, customers will move to 21CN when they order a new service which is based on a 21CN based wholesale product. For example, if a customer orders ADSL2+ broadband from either BT, or another CP who is using the WBC wholesale product which is only available on 21CN. This change will place a greater emphasis on ordering and switching processes.

Migration by other CPs

4.19 In addition to BT, other CPs have already deployed or are planning to deploy NGNs. Early indications are that most of this migration will be customer-led i.e. migration will take place when customers order new services.

4.20 As noted above, we believe that all providers have strong incentives to ensure that their customers experience the minimum level of disruption during migration. We would therefore expect them to minimise disruption and keep their customers well informed throughout the migration process. We therefore plan to continue to monitor migration activities, contributing as necessary.

Terminal equipment compatibility

4.21 Consumers and businesses connect a wide range of terminal apparatus to telephone lines and broadband services, such as telephones, Private Branch Exchanges ('PBX's), fax machines and modems. These in turn support a wide range of applications in addition to basic telephony services, including alarm systems and telemetry applications.

4.22 Although new NGN based telephony services may evolve in the future, the initial services such as those on 21CN have been designed to be equivalent to PSTN based telephony services in order to avoid the need for customers to replace their terminal equipment. However, NGNs such as 21CN do not replicate existing

[51] http://www.switchedonuk.org/

telephony services exactly, giving rise to the possibility that some terminal equipment may not be fully compatible with NGNs.

4.23 For 21CN, BT identified 5 differences between 21CN and the current network that might lead to a risk of terminal apparatus failure. These are:

- Two differences in the electrical interface presented to terminal apparatus:
    - reduced maximum off-hook loop current; and
    - balanced ringing (the ringing interface on 21CN is a type known as balanced ringing, rather than unbalanced which is found on the legacy network);
- Increased end-to-end round trip transmission delay for all voice calls;
- Echo cancellation applied to all voice calls (previously applied only to international calls and calls via NGS[52] trunk nodes); and
- The presence of jitter buffers in the network whose adaptations have the potential to cause data transmission discontinuities.

4.24 The changes to the electrical interface are minor changes that reflect modern equipment practice and are likely to affect only a very small minority of equipment.

4.25 The differences in the transmission characteristics (the last three bullets above) are more significant and stem from the use of IP technology to carry voice calls. They will therefore be exhibited to some extent by all NGNs.

4.26 The increased transmission delay appears to present the greatest risk of terminal equipment incompatibility because the rollout of NGN networks (which will each have greater transmission delay than its predecessor) will significantly increase the level of end-to-end transmission delay typically encountered on calls compared with the current generation of networks. Equipment that has been optimised for the observed transmission delay of the current generation of networks rather than the wider range of values specified in the UK National Transmission Plan[53] is likely to be at particular risk.

4.27 BT has carried out an extensive equipment compatibility testing programme in conjunction with equipment manufacturers. Given the very large range of equipment on the market and legacy equipment in service, BT's approach has been to test a representative sample of each type of equipment (e.g. basic telephones, answering machines or modems) in order to assess the likely compatibility with 21CN.

4.28 Test results indicate that with the notable exception of alarm equipment most types of terminal apparatus are fully compatible with 21CN. Although these results cannot provide a definitive picture about compatibility of terminal equipment with other NGNs, in our view they provide a good indication and have provided equipment manufacturers with valuable information about the sensitivities of terminal equipment to the key end-to-end network parameters such as delay and jitter that will change with the introduction of NGNs.

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[52] Next Generation Switch – one of the switches used in BT's PSTN network.
[53] ND 1701 Recommended Standard for the UK National Transmission Plan for Public Networks (March 2006) http://www.niccstandards.org.uk/files/current/nd1701_2006_03.pdf?type=pdf.

Alarm equipment

4.29 Testing by equipment manufacturers for 21CN has revealed that a significant proportion of security, fire and telecare alarms are sensitive to increased end-to-end transmission delay with the result that some equipment may not operate reliably on NGN networks. This problem arises because some of the proprietary signalling protocols used by these types of terminal apparatus assume levels of network transmission delay that are somewhat lower than may be encountered in an NGN network environment. The sensitivity of alarm equipment to transmission delay varies, with some models being fully compatible with 21CN and others unable to operate on 21CN at all.

4.30 To some extent, testing has highlighted an existing delay-sensitivity problem since some alarm equipment is sensitive to levels of delay that may be encountered in complex call routing scenarios on existing networks.

4.31 In some cases alarm equipment can be reconfigured to use less delay sensitive communications protocols but in other cases it will be necessary to replace terminal equipment prior to NGN deployment.

4.32 It is difficult to gauge the scale of this problem since there are no central records of the equipment in use and the need to replace equipment (at least in the short term) is likely to depend on several factors such as the type of alarm receiving centre equipment, and the networks to which the alarm receiving centre and terminal apparatus are connected. BT's decision to scale back the migration of telephony services to 21CN considerably reduces the scale of the problem, in the short term at least. However, it is estimated there around 1.5 to 2 million security and fire alarms and another 1.5 million telecare alarms currently in use. It seems likely that a significant proportion of this installed base may ultimately have to be adjusted or replaced for NGN operation.

Mitigating risks to consumers

4.33 There is clearly a risk to consumers associated with alarm system failure if the necessary preventative steps are not taken prior to NGN migration. The potential risk to telecare services is of particular concern to Ofcom as these services are used by vulnerable members of society. Ofcom has therefore been monitoring developments in this area closely.

4.34 Fortunately telecare, fire and security alarms normally have monitoring contracts with alarm receiving centres, or in the case of some telecare systems are operated by sheltered housing schemes. Alarm systems should therefore be readily identifiable. Also, terminal equipment is often maintained by alarm providers, or by independent installers, and is often inspected annually.

4.35 For the 21CN Pathfinder pilot, BT has worked closely with organisations involved in the provision of telecare services in south Wales to ensure that steps are taken to avoid the risk of alarm failure following migration. Where necessary, BT has not migrated telephone lines associated with these services. The relevant industry associations (the British Security Industry Association ('BSIA') and the Telecare Services Association ('TSA')) are currently coordinating equipment testing activities and are helping their members to assess the risk and to plan mitigation activities such as equipment replacement or adjustment.

4.36 BT's decision to scale back migration of telephony services to 21CN limits the immediate problem. However, it is important that work to address this problem continues as other CPs are also deploying NGNs. In addition, BT and others are beginning to trial NGA services, which will exhibit similar transmission characteristics as they use IP technology for voice services.

4.37 In our view, it is necessary for the organisations involved in the provision and maintenance of alarm and telecare services to take the lead in identifying equipment that needs to be replaced or adjusted and advising their customers. These organisations already have relationships with users and have the necessary technical expertise to determine what remedial action needs to be taken.

4.38 During this period whilst alarm equipment is being replaced we believe that CPs could take additional steps to inform the alarm community about major changes to their networks such as NGN migration that may affect terminal equipment. In particular we would expect CPs to:

- ensure that the network interface specifications that CPs are required to published under Radio and Telecommunications Terminal Equipment Regulations[54] ('R&TTE Regulations') are kept up to date and are readily accessible on their websites; and

- give as much advanced notice as possible of forthcoming changes to interface specifications and major network changes such as NGN migration that will have a significant impact on key transmission parameters that might affect terminal equipment such as transmission delay, jitter and echo-cancellation.

4.39 We suggest that industry associations such as TSA and BSIA could act as a conduit for dissemination of this information to their respective industry sectors. We would welcome suggestions on this point.

Question 8: Do you agree with our assessment of how the alarm equipment incompatibility problem should be addressed?

4.40 We are also concerned about the potential financial impact of equipment replacement on vulnerable consumers. We therefore plan to explore this issue with those involved in the provision of telecare services during the coming months and would welcome stakeholder comments as a first step.

Question 9: What will be the impact on vulnerable consumers of replacing telecare and other alarm equipment?

Informing consumers about terminal equipment compatibility

4.41 As noted above, we believe that all CPs have strong incentives to ensure that their customers experience the minimum level of disruption during possible migration. We would therefore expect them to assess the likely impact on terminal equipment of any significant changes to network interfaces and key transmission parameters, and to provide their customers with advice about the impact. For the 21CN programme, advice about terminal equipment compatibility is provided through the 'switched-on' communications plan.[55]

[54] SI 2000 No. 730, The Radio Equipment and Telecommunications Terminal Equipment Regulations 2000 (as amended).
[55] See paragraphs 4.14 and 4.15 for further information about this plan.

Visibility of end-to-end network characteristics

4.42 The sensitivity of alarm equipment to transmission delay highlights the need for terminal equipment manufacturers to design terminal equipment to accommodate the full range of end-to-end transmission characteristics of UK telephone networks and for this information to be readily available to manufacturers.

4.43 These parameters are not generally included in network interface specifications published by CPs (under the R&TTE Regulations), since they relate to the properties of all networks over which calls are routed rather than individual networks.

4.44 As these parameters fall outside the control of individual CPs, we consider this is an area that would benefit from cross-industry coordination.

4.45 Ofcom has therefore asked NICC to develop guidance for alarm systems manufacturers on transmission delay over NGNs. NICC hope to publish this guidance in September 2009.

4.46 NICC has flagged that the design of test specifications for testing terminal equipment compatibility with NGNs may also benefit from cross-industry coordination. An agreed set of tests would avoid the risk that CPs use different test assumptions, thereby giving results which may only be representative of specific NGNs, rather than the new networks in general. We would welcome stakeholder views on this.

Question 10: Would it be appropriate to agree a common set of terminal equipment compatibility tests? What would be the most appropriate forum to develop these tests?

4.47 More generally we would welcome stakeholder comments about whether there are any other steps that could be taken to assist terminal equipment manufacturers with NGN compatibility.

Question 11: What other steps could be taken to help manufacturers ensure terminal equipment is compatible with the QoS parameters of NGNs?

Question 12: Do you have any other comments about compatibility of terminal equipment with NGNs and how they should be addressed?

NGN user network interface protocols

4.48 As NGN deployment progresses, it is likely that an increasing proportion of NGN voice services will be delivered to businesses and consumers over IP connections (rather than legacy analogue and ISDN interfaces). Terminal equipment will communicate with the networks using the SIP protocols used by NGNs for this purpose (generally referred to as SIP User Network Interface or 'SIP UNI').

4.49 There has been some debate about the need for further standardisation of the SIP UNI to maximise terminal equipment compatibility. This debate centres around two types of equipment:

- IP PBXs – Although the PBXs are normally compliant with international standards the standards contain a large number of optional features leading to a concern that services offered by CPs may not be fully compatible;

- Terminal adaptors for NGA services[56] – There is a view that further standardisation work before the widespread rollout of NGA networks is needed to maximise the compatibility of CPs' services.

4.50 We welcome stakeholder comments about how the risk of terminal equipment incompatibility could be mitigated.

Question 13: Do you think there is risk of terminal equipment incompatibility that warrants further SIP UNI standardisation? How should this be progressed?

Question 14: Do you have any other comments about compatibility of terminal equipment with NGNs and how they should be addressed?

Application delay sensitivity

4.51 It is possible that some end-user applications, particularly those used by businesses for telemetry/control purposes may be sensitive to the increased end-to-end transmission delay of NGN voice services.

4.52 BT has engaged with a wide range of industry associations in order to raise awareness of its 21CN programme, paying particular attention to essential services such as the utilities that use telemetry applications for control purposes. As a result, water utilities have replaced some telemetry equipment or have asked for lines to be excluded from the Pathfinder pilot.

4.53 There have been no reports of application failures in the BT Pathfinder pilot. The second much larger phase of the Pathfinder pilot should give a further indication about whether end-user applications are likely to be susceptible to such problems.

End-to-end call quality

4.54 Although CPs should have incentives to provide high quality services to their customers, there is a potential externality where the actions of one CP could have a negative impact on the end-to-end quality for other CPs. The existence and extent of these issues may depend on multiple factors such as:

- which network operators roll out NGNs and when;
- the availability of IP interconnect products and the rate of migration from existing TDM interconnect to IP interconnect;
- routing for transit and number portability;
- choice of different coding standards (codecs) by different networks; and
- end-user equipment, such as cordless handsets and hands-free headsets.

4.55 The complexity of this issue means that it is not amenable to a straightforward regulatory solution, for example it would be very difficult and undesirable for Ofcom to specify a particular technical implementation. Recent industry activity relating to this issue has been:

[56] These allow consumers to connect conventional telephone equipment to IP delivered voice services.

- Specification of technical criteria to support end-to-end Quality of Service. As part of its programme of work to support NGN interconnection, NICC has revised the National Transmission Plan[57] to include guidance for interconnection between networks using a mix of TDM and IP interconnect. NICC has also produced a new document[58] giving guidance about fully IP-based NGN interconnection.

- Development of more efficient routing architectures for ported numbers. Following the Competition Appeal Tribunal judgment[59] setting aside our November 2007 statement[60] regarding number portability, we are preparing revised proposals for number portability and expect to publish a consultation shortly;

- Development of IP interconnection for voice services may address some of the QoS concerns, in particular by avoiding the need for protocol conversion for NGN to NGN call routing; and

- NICC is currently developing a standardised approach to handling traffic from 'uncontrolled sources' where the integrity of parameters such quality of service cannot be guaranteed. This may allow CPs to proactively identify traffic that would be particularly prone to poor quality of service and to take steps to maintain call quality.

4.56 As discussed in Section 3, it seems likely that the pace of NGN deployment will be slower than originally anticipated with the result that there will be a prolonged period during which TDM and NGN networks coexist. This implies a need for multiple TDM/IP protocol conversions (particularly in complex call routing scenarios) which previous work by NICC suggested might materially degrade call quality. We would welcome stakeholder comments on the risks to call quality and how they should be addressed.

Question 15: Will a slower transition from TDM to NGN networks pose a risk to voice quality of service? How should such risks be addressed?

Call quality measurements

4.57 In the 2006 NGN Statement, we concluded that it is important that quality is measured before, during and after NGN migration, to help objectively identify the impact of NGNs (if any) on QoS. To this end, we asked BT to make regular QoS measurements including perceptual quality of service measurements. We understand that BT hopes to publish updated measurements shortly, following the completion of the first phase of the Pathfinder pilot.

4.58 We intend to continue to monitor these measurements.

[57] ND 1701 Recommended Standard for the UK National Transmission Plan for Public Networks (March 2006) http://www.niccstandards.org.uk/files/current/nd1701_2006_03.pdf?type=pdf.
[58] ND 1704 End-to-End Network Performance Rules & Objectives for the Interconnection of NGNs (March 2008) http://www.niccstandards.org.uk/files/current/nd1704_2008_03.pdf?type=pdf.
[59] *Vodafone Limited v Office of Communications*, case number 1094/3/3/08, http://www.catribunal.org.uk/238-657/1094-3-3-08-Vodafone-Limited.html.
[60] *Telephone number portability for consumers switching suppliers,* November 2007, http://www.ofcom.org.uk/consult/condocs/gc18review/statement/.

New consumer protection issues

4.59 In our 2006 NGN Statement, we discussed stakeholders concerns that NGNs might give rise to new consumer protection problems that might be similar to those already seen on the Internet such as:

- Mis-use of NGN services that causes harm to consumers, for example 'SPAM over Internet Telephony' ('SPIT');
- Potential for fraud and identity theft; and
- Privacy concerns and potential for mis-use of personal information (e.g. through greater personalisation capability provided by NGNs).

4.60 As the deployment of NGN services has been slower than envisaged in 2006, we have not yet seen any problems of this nature. However, we believe it is important to proactively identify and where appropriate address such problems.

4.61 As the nature of NGN enabled services becomes clearer we will undertake research and analysis to understand and assess any risks to consumers.

Continuity for large business customers

4.62 Large business customers often have much more demanding and complex requirements than residential customers and small businesses. They are also likely to be able to, and want to, engage in a constructive dialogue about future network changes to ensure their needs can continue to be met.

4.63 In relation to 21CN deployment, Ofcom has been monitoring businesses perceptions in conjunction with the Communications Management Association ('CMA'). Ofcom has also co-hosted several workshops in conjunction with the CMA to facilitate the dialogue between large businesses and CPs.

4.64 In 2006, there were some concerns about the flow of information to businesses which were subsequently addressed by CPs. The delays to the Pathfinder pilot and the revisions to the 21CN plans have understandably been a cause for concern for this group who require as much notice as possible to facilitate their own planning and preparations.

4.65 We believe that close commercial engagement between CPs and businesses is the best way to address the needs of this group.

4.66 We will continue to monitor business perceptions in conjunction with the CMA.

Energy industry

4.67 In our 2006 NGN statement, we also discussed the concerns of the energy industry about the potential withdrawal of traditional interface leased line services which are used by energy industry for telemetry purposes.

4.68 As an interim measure, BT gave assurances about the continued availability of the existing services and explored potential replacement options in conjunction with the energy industry.

4.69 Ofcom subsequently considered this issue in more detail in the Business Connectivity Market Review[61], addressing the concerns about short term continuity by:

- requiring BT to support existing circuits until 2014;
- requiring BT to supply new SDH[62] services at 2Mbit/s and above until 2014;
- securing a voluntary undertaking from BT to supply new analogue and PDH[63] circuits until at least 2011 and not to raise retail prices during that period.

4.70 Following discussions with the energy utilities and other groups that use traditional interface leased lines, BT concluded there would be sufficient demand to warrant retaining its SDH network and it has given assurances that it intends to retain it for the foreseeable future. BT is currently exploring the feasibility of offering analogue and kilostream interfaces to SDH services to maintain continuity after the withdrawal of analogue and kilostream services.

4.71 We continue to believe that this issue is best progressed by commercial engagement between the energy industry, BT and other CPs. Ofcom will continue to monitor this process closely, given that the importance of the telemetry circuits to electricity supplies.

Emergency call location

4.72 As we move to NGNs, the introduction of nomadic and fixed-mobile services presents new challenges for the provision of information to the emergency services. Since the 2006 NGN Statement there has been progress on this issue from both a regulatory and a technical perspective.

4.73 There is currently a requirement in General Condition 4[64] for CPs to provide location information for emergency calls to the extent technically feasible. Following stakeholder consultation, in our December 2007 policy statement on VoIP services[65], we issued guidance for CPs setting out Ofcom's expectations in relation to the provision of location information for VoIP services in advance of a technical solution.

4.74 The NICC Emergency Location Working Group has made significant progress on a technical means by which location information could be provided by networks.

4.75 We will continue to monitor progress with the technical work. When the NICC work has been completed, we intend to conduct a formal review with a view to revising our guidance on technical feasibility and setting deadlines for CPs to meet them.

[61] *Review of the retail leased lines, wholesale symmetric broadband origination and wholesale trunk segments markets*, available from http://www.ofcom.org.uk/consult/condocs/bcmr08/.
[62] Synchronous Digital Hierarchy
[63] Pleisynchronous Digital Hierarchy
[64] http://www.ofcom.org.uk/telecoms/ioi/g_a_regime/gce/
[65] *Regulation of VoIP services: Access to the Emergency Services,* December 2007, available from http://www.ofcom.org.uk/consult/condocs/voip/voipstatement/.

Section 5

Policy implications and longer term developments

Introduction

5.1 This section takes a broader view of NGNs and their implications for competition, consumers and telecoms regulation. For the past year, Ofcom has been developing its thinking in relation to NGNs, building a view of where the technology is heading and reviewing existing policy positions.

5.2 This work is inherently forward looking and discursive in nature, and does not lead to specific proposals for regulatory intervention. Despite this, it seems appropriate to publish the results of our analysis to stimulate debate and generate feedback that will help us to improve our understanding of the potential impact of NGNs.

5.3 We believe that NGNs can be an extremely positive development for consumers. Above all else, the increased flexibility that NGNs can bring should allow CPs to become more responsive to customer demands, with services tailored to suit individual needs, and a greater range of options to choose from. In addition, the efficiency gains and cost reductions associated with NGNs should ultimately lead to lower prices for existing communications services such as fixed and mobile voice telephony, broadband and TV. NGNs should also enable improved quality, reliability and security across a range of services, such as VoIP calls, which are currently delivered over the Internet.

5.4 Given these potential benefits, we believe that our aim over the next few years should be to establish a regulatory environment which will:

- provide incentives for efficient investment in NGNs;
- promote effective competition based on NGN infrastructure; and
- protect consumers from disruption during the transition to NGNs.

5.5 The rest of this section starts by considering how NGNs might develop. It then looks at the implications for infrastructure and service competition, and for interconnection.

Longer term development of NGNs

5.6 An NGN is a packet switched network which can carry both voice and data traffic. If the network can cope with the demands of carrying voice traffic, then it will also be able to carry many other services. The multi-service nature of the NGN leads to the need to separate service control (network intelligence) and the transmission of data packets (conveyance). See Annex 5 for a more detailed discussion of the definition of an NGN.

5.7 In discussing longer term developments, it is useful to distinguish between three hypothetical phases of NGN deployment:

- Phase 1: many operators have a converged IP/MPLS inner core network, but elsewhere and for most services there is separate network infrastructure for each service.

- Phase 2: operators extend IP out to metro and access networks. However, voice traffic is still not treated as a converged service, and remains segregated in access and backhaul. This implies that there will continue to be two distinct networks: a multi-service broadband network, and a voice network.

- Phase 3: voice is run as an application over the multi-service broadband network. The network is now technically service agnostic, allowing the introduction of almost any new service without the need to change the underlying network infrastructure.

5.8 The main network providers are all moving towards an NGN-type model in a gradual, phased manner. Most fixed operators have had a phase 1 network for some time, and BT's original 21CN plan followed the phase 2 route. No major UK operator is building a phase 3 NGN today, but something similar is now being discussed as an option by BT as a result of its 21CN strategy review under the label of 'derived voice'. The development of certain NGA networks may also force consideration of this issue if the access network only provides a multi-service broadband path to the end-user.

5.9 The risk for network operators in building a phase 3 NGN is that conveyance becomes a service agnostic commodity, like the Internet. If this service agnostic conveyance layer is exposed to the outside world, the network effectively becomes a dumb pipe. This implies that it would become much more difficult to recover network common costs in different proportions from services which have similar network requirements. This is not true today where services like SMS and voice make a disproportionately high contribution. It also implies that the vertical integration benefits of (conveyance) network ownership are much reduced.

5.10 This means that operators with a substantial voice business may have an incentive to delay the transition to a fully-fledged and open NGN. However, from a policy perspective, some of the consumer benefits of NGNs are more likely to be realised once we have moved to a world with interconnected phase 3 networks. A key question, therefore, is whether Ofcom should be doing something to encourage the development of this environment.

Infrastructure competition

5.11 In terms of economics, NGNs are characterised by: (i) increased economies of scale and scope in the provision of conveyance infrastructure, driven by convergence and the adoption of new transmission technology; and (ii) reduced benefits from vertical integration, associated with the separation (dis-integration) of network and service which reduces entry barriers into service provision.

5.12 There is currently a significant amount of infrastructure based competition between independent core networks in the UK. These perform the very important function of conveying traffic over long distances, mostly between major urban areas. They also provide the foundation for competition across many other telecoms markets, especially in fixed telecoms. Our analysis indicates that, for a number of reasons, competition will continue to be possible in this area despite the increases in economies of scale and scope.

5.13 It has been suggested that NGNs drive a fundamental shift in network economics. The argument is that in moving from bespoke, service-specific networks, to a single shared multi-service network, there will be a dramatic increase in the proportion of common costs. If true, this is likely to have consequences for cost recovery both in terms of market pricing, and for regulated price controls. Ofcom's analysis of the available cost data for NGNs suggests that, in fact, this change in common cost structure is likely to be relatively minor. The bulk of the cost in any fixed network, NGN or otherwise, lies in the duct, trenching and physical plant. Also, in most of the NGN designs Ofcom has seen to date, there continue to be service specific costs for equipment attached to the underlying multi-service network layers. Therefore, in moving to an NGN the bulk of network costs do not change, and of the remainder, a significant proportion remain service specific.

5.14 In terms of the backhaul network, there is likely to be less scope for infrastructure based competition following the rollout of BT's 21CN. This is for two main reasons. First, the efficiency of running very high capacity IP routers tends to lead to a much smaller number of routing nodes in an NGN. So, although the industry agreed plan for 27(+2) points of service interconnect[66] on 21CN may no longer be certain, it is highly likely that any future interconnect arrangement will involve far fewer POIs than the 700 DLEs at 300 exchanges that we have today. This substantial reduction lessens the incentive for CPs to extend their networks in order to reduce the call origination and termination charges payable to BT.

5.15 Secondly, the prospects for backhaul competition are likely to be negatively affected by the greater economies of scale available in an NGN environment. This is driven by the adoption of more efficient transmission technologies such as WDM[67] and Ethernet. As part of 21CN, BT is using much more WDM in the backhaul network, giving them access to considerably lower incremental costs for bandwidth. This drives up the minimum efficient scale in backhaul markets, and therefore will reduce the number of sites where there is sufficient demand for more than one operator to reach the minimum scale.

5.16 The LLU based model of competition established by the TSR was designed with the transition to NGNs in mind: one of the aims was to promote converged service provision based on MPF inputs. NGA developments, however, create a considerable amount of uncertainty for the future prospects of the LLU model. NGNs should allow active access products to provide much greater levels of control over the final service to consumers, and this reduces the relative benefits of using passive access. Also, if active products do become the predominant form of access, then given the economics of backhaul, the most efficient point of handover is likely to move towards the core network. Taking into account all these factors, there is likely to be uncertainty over the long term future of LLU and passive access based competition.

5.17 The reasons for building an NGN fall into three main categories: reducing costs for the provision of existing services; improving responsiveness to customer demands by allowing much faster service creation; and responding to competitive threats from other network operators. The need to become more responsive to customer demands is driven in part by competition from Internet based applications and services. Some of the current plans for investment in NGN infrastructure, including BT's 21CN, can be seen as a response to competitive threats both from these

[66] See paragraphs 2.34-2.39 for further details of these interconnection plans.
[67] Wavelength Division Multiplexing ('WDM') is a general term for the technologies which use different wavelengths of light to send multiple signals along an optical fibre. Dense ('DWDM') and Course ('CWDM') are two different versions of WDM. DWDM offers more wavelengths, and therefore greater capacity, and generally being used in core network. CWDM is more likely to be used in backhaul and metro networks.

Internet based applications, and more immediately from network operators able to offer higher speed broadband services.

Service Competition

5.18 The huge success and unprecedented levels of innovation associated with Internet based services is simultaneously one of the largest competitive threats and opportunities for both the fixed and mobile telecoms industry. Seen in this context, NGNs and the related moves towards software based services are the reaction of the telecoms industry to the latest developments on the Internet.

5.19 The Internet is not suitable for all applications. It can sometimes suffer from a lack of reliability, security, and efficient ways to monetise services beyond advertising. These problems create an opportunity for the telecoms industry to provide more reliable and secure NGN based services which compete directly with the Internet, or to provide suitable wholesale services which effectively improve the performance of the Internet.

5.20 Viewed from an industry-wide perspective, the risk in pursuing the latter option is that it is likely to improve the performance of a significant competitor. It is interesting to note that competition is already driving some operators to follow this approach. For example, H3G are offering free use of Skype on certain contracts on their network, whereas other operators have chosen to restrict access to this potentially disruptive service.

5.21 A second point is that the performance of services delivered over the Internet is improved dramatically by the introduction of fixed and mobile broadband. It will be improved again by NGA networks and 4G[68] mobile. Both of these developments are likely to increase competition to some NGN based services by reducing the constraints on the range of services and applications which will run over the Internet without performance issues.

5.22 The scope for service innovation is likely to increase in an NGN environment due to the separation of the Application and Network Intelligence layers from the Conveyance layer. For a more detailed description of these layers and their functions, see Annex 5. This separation may lead to increased scope for competition based on the creation of rich applications in an analogous manner to the application development on various Internet based platforms today. The creation of similar services on today's networks would generally require investment in network infrastructure. If NGNs were to create a world where new communications services could be created through software application development alone, this would tend to imply lower barriers to entry into the markets for such services relative to today, and therefore bring the prospect of greater competitive intensity.

5.23 Despite this trend, we are not yet aware of much evidence which supports the argument that changes to the underlying network are making it easier to develop applications. There continues to be prolific application and service development on the Internet, but very little change in the way that telecoms operators develop new communications services.

5.24 Ofcom would welcome any increased competition between service providers creating innovative applications. However, in accordance with the views set out in the TSR,

[68] 4G, or fourth generation, mobile is a network architecture that is designed specifically to deliver high speed data services. See Annex 7 for more on 4G technology.

our primary aim is to ensure that there is competition in network access markets. Its strategy in this regard is to aim to correct competition problems, such as enduring bottlenecks, as far upstream as possible. If this is successful, we would expect the downstream markets to take care of themselves. In this case, if network access markets are competitive, then there is less likely to be reason for concern about the prospects for competition in the downstream service/application creation markets. There may be exceptions to this rule, but these should be dealt with on an exceptional basis.

5.25 These increased opportunities for service competition driven by NGNs relate to rich application development – similar to, but distinct from, the rich applications that are available on the Internet. It is, therefore, an opportunity for a new type of competition – not a replacement for infrastructure competition between CPs operating NGN networks.

5.26 As Internet service provision is supported by telecoms infrastructure, the telecoms industry is in a unique position to influence services which run over the Internet. In particular, it may be possible to prioritise certain applications and services in the access network. This represents an opportunity to improve the performance of Internet services in a very beneficial manner, but there is also a risk that this control is used to gain competitive advantage in application markets.

5.27 We consider that assuming there is sufficient competition in Internet access markets, then the ability to gain competitive advantage by restricting access to specific content will be limited. Internet access markets can only function effectively if consumers have sufficient information about the services they are buying, and are able to switch providers without undue difficulty.[69] In order to make an informed choice, it needs to be clear to the consumer at the point of sale whether or not the Internet access service is restricted in any way; and if not, the types of traffic management, and/or service prioritisation that will be used. Therefore, in maintaining effective competition in Internet access markets, it may become necessary for Ofcom to require greater transparency over the description of Internet access services.

Access, interconnect and interoperability

5.28 The signs are that, for the next few years at least, UK operators will continue to use voice-specific interconnect products, reflecting the fact that voice traffic will be segmented on the network as a means of service quality management. Before its strategy review, BT had planned to launch new IP voice interconnect products in 2009, with pence per minute charging, in line with input received from other operators, via NGNuk. Consideration of alternative charging options (e.g. Bill & Keep, capacity charging) appears to have been postponed for the time being.

5.29 In terms of network topology, NGNs will have fewer, larger switching points than the PSTN, reflecting the declining costs of transport (in terms of both bandwidth and distance) and the availability of very high capacity IP routers.

5.30 In the longer term, the transition to NGNs may at some stage be accompanied by a move towards service-agnostic interconnect models, in which interconnect products are designed to deliver traffic according to a set of predefined classes of service (real-time, best efforts, etc). Such a move may bring significant consumer benefits by stimulating service competition and innovation in the manner similar to that described above in paragraph 5.22. However, it would be likely to meet resistance from CPs

[69] For a discussion of switching issues, see paragraphs 3.159-3.166 above.

who depend heavily on revenues from voice call termination. In due course, Ofcom may need to consider whether it wishes to encourage a move in this direction.

5.31 The separation in an NGN between the application and conveyance layers may also have important implications for the call termination bottleneck. At present, this bottleneck arises because terminating providers have control over both (i) the physical bottleneck in the access network and (ii) the translation from user identifier to network address for the recipient of the call. In an NGN, these two aspects of the bottleneck may be separated, particularly if there is a move towards service agnostic interconnection at the conveyance layer. In these circumstances, it is possible that neither the terminating network operator nor the terminating service provider would be in a position to exploit the bottleneck in respect of an individual high value service (such as voice). This is because the network operator charge would be service agnostic, and the barriers to entry should be low for providing the translation service. These issues have been considered at some length in a recent ERG report on NGN interconnection.[70]

5.32 There is the possibility of the development of new bottlenecks relating to interoperability, and the forced adoption of particular standards. One suggestion is that access to network intelligence functions may be needed by other CPs in order to compete effectively. In essence, the suggestion is that ownership of certain network intelligence functions may result in SMP in a manner analogous to SMP in call termination. However, in many cases, network intelligence functions can be recreated without ownership of the relevant network infrastructure. For example, Google has created its own location function for mapping services on mobile networks. This does not rely on access to the network intelligence functions of the mobile network operators.

5.33 It is possible that there may be specific examples where access to network intelligence is needed, but this can and should be assessed using existing ex ante competition regulatory methods of defining the relevant market, assessing market power, and then designing access remedies if appropriate.

Summary

5.34 There is currently considerable uncertainty over the direction of network evolution. It seems likely that NGN technology will eventually be adopted for voice services, but the manner in which this will occur is not yet known.

5.35 As discussed above, NGNs may increase the scope for non-network based competition. The separation of Conveyance from Network Intelligence layers creates the potential for new models of competition. In these new models, innovation is likely to be controlled and delivered by software development rather than the network infrastructure investment which is required today.

5.36 In one extreme scenario, the competition model in the telecoms sector may begin to resemble that found on the Internet more closely than it does today. This envisages network operators focussing on the provision of generic conveyance services, whilst a multiplicity of independent service providers develop and deliver rich applications which run over these generic conveyance networks.

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[70] ERG (08) 26rev1 NGN IP-IC CS 081010: ERG Common Statement on Regulatory Principles of IP-IC/NGN Core - A work program towards a Common Position.

5.37 However, experience to date of real world NGN designs suggests that the separation between Conveyance and Network Intelligence will be less than complete. Network operators are, therefore, likely to retain control of some services, such as guaranteed-quality voice, in a manner similar to today. In this way, there would continue to be significant benefits to vertical integration, and so it may be less likely that a fully independent application based service market will develop.

5.38 Our preliminary analysis suggests that the intense competition made possible by the Internet in value added services that run over networks is likely to be a powerful force that will shape a market led outcome. At this stage, therefore, there does not appear to be a case for any change in regulatory strategy in order to influence the outcome of this process.

5.39 We would, however, be interested in stakeholder views on the preceding discussion of the potential implications of NGNs for competition, consumers and regulation.

Question 16: Do you have any comments on the long-term trends in the evolution of networks to next-generation architectures?

Annex 1

Responding to this consultation

How to respond

A1.1 Ofcom invites written views and comments on the issues raised in this document, to be made **by 5pm on 24th September 2009**.

A1.2 Ofcom strongly prefers to receive responses using the online web form at http://www.ofcom.org.uk/consult/condocs/ngndevelopments/, as this helps us to process the responses quickly and efficiently. We would also be grateful if you could assist us by completing a response cover sheet (see Annex 3), to indicate whether or not there are confidentiality issues. This response coversheet is incorporated into the online web form questionnaire.

A1.3 For larger consultation responses - particularly those with supporting charts, tables or other data - please email Gideon.Senensieb@ofcom.org.uk attaching your response in Microsoft Word format, together with a consultation response coversheet.

A1.4 Responses may alternatively be posted or faxed to the address below, marked with the title of the consultation.

Gideon Senensieb
Floor 4 (Competition Group)
Riverside House
2A Southwark Bridge Road
London SE1 9HA

Fax: 020 7981 3333

A1.5 Note that we do not need a hard copy in addition to an electronic version. Ofcom will acknowledge receipt of responses if they are submitted using the online web form but not otherwise.

A1.6 It would be helpful if your response could include direct answers to the questions asked in this document, which are listed together at Annex 4. It would also help if you can explain why you hold your views and how Ofcom's proposals would impact on you.

Further information

A1.7 If you want to discuss the issues and questions raised in this consultation, or need advice on the appropriate form of response, please contact Gideon Senensieb on 020 7981 3545.

Confidentiality

A1.8 We believe it is important for everyone interested in an issue to see the views expressed by consultation respondents. We will therefore usually publish all responses on our website, www.ofcom.org.uk, ideally on receipt. If you think your response should be kept confidential, can you please specify what part or whether all of your response should be kept confidential, and specify why. Please also place such parts in a separate annex.

A1.9 If someone asks us to keep part or all of a response confidential, we will treat this request seriously and will try to respect this. But sometimes we will need to publish all responses, including those that are marked as confidential, in order to meet legal obligations.

A1.10 Please also note that copyright and all other intellectual property in responses will be assumed to be licensed to Ofcom to use. Ofcom's approach on intellectual property rights is explained further on its website at http://www.ofcom.org.uk/about/accoun/disclaimer/

Next steps

A1.11 Please note that you can register to receive free mail Updates alerting you to the publications of relevant Ofcom documents. For more details please see: http://www.ofcom.org.uk/static/subscribe/select_list.htm

Ofcom's consultation processes

A1.12 Ofcom seeks to ensure that responding to a consultation is easy as possible. For more information please see our consultation principles in Annex 2.

A1.13 If you have any comments or suggestions on how Ofcom conducts its consultations, please call our consultation helpdesk on 020 7981 3003 or e-mail us at consult@ofcom.org.uk . We would particularly welcome thoughts on how Ofcom could more effectively seek the views of those groups or individuals, such as small businesses or particular types of residential consumers, who are less likely to give their opinions through a formal consultation.

A1.14 If you would like to discuss these issues or Ofcom's consultation processes more generally you can alternatively contact Vicki Nash, Director Scotland, who is Ofcom's consultation champion:

Vicki Nash
Ofcom
Sutherland House
149 St. Vincent Street
Glasgow G2 5NW

Tel: 0141 229 7401
Fax: 0141 229 7433

Email vicki.nash@ofcom.org.uk

Annex 2

Ofcom's consultation principles

A2.1 Ofcom has published the following seven principles that it will follow for each public written consultation:

Before the consultation

A2.2 Where possible, we will hold informal talks with people and organisations before announcing a big consultation to find out whether we are thinking in the right direction. If we do not have enough time to do this, we will hold an open meeting to explain our proposals shortly after announcing the consultation.

During the consultation

A2.3 We will be clear about who we are consulting, why, on what questions and for how long.

A2.4 We will make the consultation document as short and simple as possible with a summary of no more than two pages. We will try to make it as easy as possible to give us a written response. If the consultation is complicated, we may provide a shortened Plain English Guide for smaller organisations or individuals who would otherwise not be able to spare the time to share their views.

A2.5 We will consult for up to 10 weeks depending on the potential impact of our proposals.

A2.6 A person within Ofcom will be in charge of making sure we follow our own guidelines and reach out to the largest number of people and organisations interested in the outcome of our decisions. Ofcom's 'Consultation Champion' will also be the main person to contact with views on the way we run our consultations.

A2.7 If we are not able to follow one of these principles, we will explain why.

After the consultation

A2.8 We think it is important for everyone interested in an issue to see the views of others during a consultation. We would usually publish all the responses we have received on our website. In our statement, we will give reasons for our decisions and will give an account of how the views of those concerned helped shape those decisions.

Annex 3

Consultation response cover sheet

A3.1 In the interests of transparency and good regulatory practice, we will publish all consultation responses in full on our website, www.ofcom.org.uk.

A3.2 We have produced a coversheet for responses (see below) and would be very grateful if you could send one with your response (this is incorporated into the online web form if you respond in this way). This will speed up our processing of responses, and help to maintain confidentiality where appropriate.

A3.3 The quality of consultation can be enhanced by publishing responses before the consultation period closes. In particular, this can help those individuals and organisations with limited resources or familiarity with the issues to respond in a more informed way. Therefore Ofcom would encourage respondents to complete their coversheet in a way that allows Ofcom to publish their responses upon receipt, rather than waiting until the consultation period has ended.

A3.4 We strongly prefer to receive responses via the online web form which incorporates the coversheet. If you are responding via email, post or fax you can download an electronic copy of this coversheet in Word or RTF format from the 'Consultations' section of our website at www.ofcom.org.uk/consult/.

A3.5 Please put any parts of your response you consider should be kept confidential in a separate annex to your response and include your reasons why this part of your response should not be published. This can include information such as your personal background and experience. If you want your name, address, other contact details, or job title to remain confidential, please provide them in your cover sheet only, so that we don't have to edit your response.

Cover sheet for response to an Ofcom consultation

BASIC DETAILS

Consultation title:

To (Ofcom contact):

Name of respondent:

Representing (self or organisation/s):

Address (if not received by email):

CONFIDENTIALITY

Please tick below what part of your response you consider is confidential, giving your reasons why

Nothing	☐	Name/contact details/job title	☐
Whole response	☐	Organisation	☐
Part of the response	☐	If there is no separate annex, which parts?	

If you want part of your response, your name or your organisation not to be published, can Ofcom still publish a reference to the contents of your response (including, for any confidential parts, a general summary that does not disclose the specific information or enable you to be identified)?

DECLARATION

I confirm that the correspondence supplied with this cover sheet is a formal consultation response that Ofcom can publish. However, in supplying this response, I understand that Ofcom may need to publish all responses, including those which are marked as confidential, in order to meet legal obligations. If I have sent my response by email, Ofcom can disregard any standard e-mail text about not disclosing email contents and attachments.

Ofcom seeks to publish responses on receipt. If your response is non-confidential (in whole or in part), and you would prefer us to publish your response only once the consultation has ended, please tick here. ☐

Name Signed (if hard copy)

Annex 4

Consultation questions

Question 1: How do you envisage the model of competition changing over the next 3-5 years, and what sort of input products will be needed to support this competition?

Question 2: Do you agree with our analysis of the requirement for xMPF?

Question 3: What additional technical standardisation work is required to support NGN deployment?

Question 4: What policy positions do you believe Ofcom ought to adopt in relation to interconnection between IP and TDM networks?

Question 5: Do you have any comments on our analysis of investment uncertainty in relation to BT's 21CN plan?

Question 6: How do you think Ofcom should take forward considerations relating to switching involving next generation access and core networks, and which areas should we focus on?

Question 7: Do you agree that the consumer protection principles and our approach to addressing consumer protection issues are still valid?

Question 8: Do you agree with our assessment of how the alarm equipment incompatibility problem should be addressed?

Question 9: What will be the impact on vulnerable consumers of replacing telecare and other alarm equipment?

Question 10: Would it be appropriate to agree a common set of terminal equipment compatibility tests? What would be the most appropriate forum to develop these tests?

Question 11: What other steps could be taken to help manufacturers ensure terminal equipment is compatible with the QoS parameters of NGNs?

Question 12: Do you have any other comments about compatibility of terminal equipment with NGNs and how they should be addressed?

Question 13: Do you think there is risk of terminal equipment incompatibility that warrants further SIP UNI standardisation? How should this be progressed?

Question 14: Do you have any other comments about compatibility of terminal equipment with NGNs and how they should be addressed?

Question 15: Will a slower transition from TDM to NGN networks pose a risk to voice quality of service? How should such risks be addressed?

Question 16: Do you have any comments on the long-term trends in the evolution of networks to next-generation architectures?

Annex 5

What is an NGN?

A5.1 The term NGN refers to multi-service packet-based networks with the following characteristics:

- The logical and physical separation between the parts of the network which control services and those which simply transport data packets;
- The use of a common transport infrastructure by all services; and
- The use of traffic management and prioritisation within the transport infrastructure to ensure that the varying requirements of different services are consistently met by the network.[71]

A5.2 The separation between service control and transport of data packets mirrors the architecture of the Internet, and NGNs generally use the same TCP/IP protocol suite on which the Internet is built. Applications and services which run over the Internet are completely independent of the underlying conveyance infrastructure. New applications and services may require new hardware such as user devices, or network-based infrastructure such as data centres; but more often than not, the only changes will involve software. Either way, the development process can take place without regard for pre-existing services and applications running over the Internet. Both factors – the independence of service creation from the underlying conveyance infrastructure, and the fact many services are defined by software rather than hardware – mean that web services can be developed and launched in a very short space of time, and on a relatively low budget. This results in the overall market for web services being highly responsive to customer demands, both in the speed of the response, and the ability to cater for niche requirements.

A5.3 This contrasts with traditional telecoms networks where service control and conveyance are integrated in the same pieces of network hardware. Consequently, new communications services must be provided by designing and building separate networks. For example, the PSTN for voice telephony; cable networks for broadcast television; ATM and Frame Relay for private data communications; and so on. This model has created some highly robust technology and network designs - the PSTN has not fundamentally changed since the move from analogue to digital switching 20-30 years ago. Even today, this still represents one of the best solutions for reliable, high quality voice services.

A5.4 NGNs are designed to bring the characteristics of Internet service development to the telecoms industry by creating independence between service control and conveyance, and moving towards software-based services. New services can be developed and deployed on an NGN without having to invest in, or otherwise interfere with, the underlying conveyance network infrastructure. The economics of

[71] A more technical definition is provided by the ITU:

A NGN is a packet-based network able to provide Telecommunication Services to users and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent of the underlying transport-related technologies. It enables unfettered access for users to networks and to competing service providers and services of their choice. It supports generalised mobility which will allow consistent and ubiquitous provision of services to users.

service creation need no longer be dominated by the large upfront capital expenditure requirements of traditional networks, and instead can start to resemble the business models for Internet applications and software development.

A5.5 The ability to deliver all services over a common infrastructure is potentially a more efficient design compared to the multiple separate networks used by traditional telecoms services.[72] These potential cost savings generally give rise to the strongest incentives to invest in NGN technology. However, the increased flexibility and speed to market for new services may also benefit telecoms operators in the longer term.

A5.6 One issue with delivering all services over a common infrastructure is that different services have different requirements for the transport of data. Voice traffic, for example, is a real time service and requires that packets are delivered to the destination with very little delay, and very little variation in delay, but does not require very much bandwidth. Video streaming can cope with relatively high delays and transmission errors but it is intolerant of delay variations. Web data and e-mails are tolerant of a wide range of network conditions, but customer experience will be improved when transmission errors are kept to a minimum.

A5.7 One can either build the network to deliver the performance required by the most demanding application for all services; or, one can try to differentiate performance and offer different grades of service. The former approach would appear to be inefficient – delivering very high quality network performance can be expensive, and may be unnecessary for many services. For this reason, most NGN designs involve some form of traffic management and prioritisation: to allow network resources to be allocated to the most demanding applications, and away from services which are more tolerant of delays and variations in quality. Although this appears to be more efficient in theory, the complexity of implementing such a scheme in practice may negate some of these beneficial effects.

A5.8 For this reason, there is considerable uncertainty over the precise design of traffic management schemes within NGNs. At one extreme, some operators are considering the use of dedicated network resources for specific services, and therefore effectively moving away from a multi-service NGN design, and back to the traditional telecoms service specific model. This is the approach currently proposed by BT for 21CN voice services. An alternative, which maintains more of the multi-service nature of the NGN, is to use some form of packet labelling technology to identify those packets which should be prioritised by the network.

The 3-layer model

A5.9 It is useful to consider NGNs with reference to the 3-layer model illustrated in Figure A1 below. This model is by no means new: similar models have been used by NGNuk, the ITU and many others when describing NGNs. However, in contrast to some of these other models, we use the three layers to refer to broadly defined functions performed by the network, and not necessarily to specific network elements. Equally, despite close parallels, these three NGN layers do not map directly into the 7 layers of the OSI reference model.

[72] The greater efficiency of NGNs comes from their multi-service nature, which brings the ability to use the same underlying infrastructure to deliver a variety of services. However, if you only intend to deliver a single service, then the dedicated service-specific traditional technologies may actually be more efficient. For example, a PSTN voice circuit uses 64kbps of bandwidth, but most operators set aside considerably more to deliver the same quality service on an IP network.

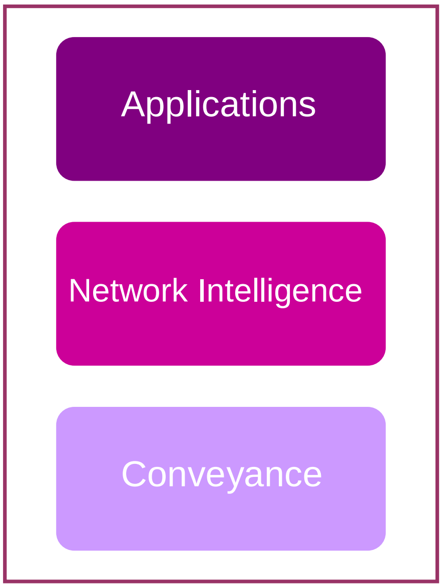


Figure A1: The three layers of an NGN

A5.10 The key feature of the model is the separation between the layers - the Application and Network Intelligence functions which specify and control the communication services, are independent of the routing and switching functions carried out in the Conveyance layer.

A5.11 Conveyance is the basic network function performing the transport of data packets between two or more locations, including necessary routing or switching, and implementing a packet prioritisation (QoS) regime. This layer requires IP routers, and the switching and transmission technologies which sit beneath, such as Ethernet, VPLS/MPLS, Sonet/SDH. All this can be transmitted over a variety of different physical mediums such as copper, fibre, radio waves etc.

A5.12 The Application layer refers to software applications located on users' devices and network based servers. These applications interact with the network intelligence and conveyance layers to create and deliver communication services. Examples of services include voice communications (through VoIP clients on a telephone handsets and other devices, or PSTN emulation), various mail services, TV content delivery, location-based and directory services, instant messaging, or remotely hosted desktop software.

A5.13 Network Intelligence refers to a set of control functions which are needed to coordinate the conveyance of packets for specific applications. It performs session control and optimised routing, and sets the quality of conveyance to be provided for the application. It can also perform security and admission control, by verifying the identity of a user, device or application (authentication), checking the right of a user to access specific network services (authorisation) and verifying the availability of network resources to carry the requested service (admission control).[73]

A5.14 It is important to note that the division of functions between the Network Intelligence and Application layers is by no means clear-cut. Many, if not all, of the network intelligence functions described above can be performed by software-based applications which may reside outside the network, and need not be controlled by

[73] Examples of the hardware and software that could perform these functions are: call servers, session controllers, BRAS, Media Gateways, soft-switches, and Call Agents.

the network operator. This is how communications services work on the Internet.[74] For example, web-based applications such as Instant Messaging, webmail, or VoIP services already incorporate control functions such as authentication, authorisation, presence, and admission control. The applications use the underlying network infrastructure only to route IP packets to the correct destination. All the additional functions are provided "over the top" of the network.

A5.15 In contrast, many of these functions are physically integrated into traditional telecoms networks. For example, signalling capabilities in the PSTN are built into hardware throughout the network, from line cards to switches to telephone handsets. It is therefore controlled by the network owner. Most NGN designs maintain this division between functions performed by the network, and those performed by independent applications.

A5.16 Although the Network Intelligence layer is not a key feature of NGNs in theory, it may yet form an important part of future networks. In order to differentiate services from simple commoditised transport functions, the industry are likely to develop the functionality of the network intelligence layer. In some areas, such as security, a network-based function could offer a significantly better service than an independent software-based alternative. However, in other areas, the advantage of providing the functions from within the network is much less clear.

[74] The only exception being the DNS function, i.e. the control function for resolving URLs (web page names) into IP addresses.

Annex 6

Consumer benefits of NGNs

Potential consumer benefits

A6.1 Overall, the move to NGNs is likely to be positive for consumers for the following reasons:

- Multi-service NGNs should be more efficient than today's separate networks and therefore drive down the cost of providing the current generation of communications services. We would expect that this should ultimately lead to lower prices for consumers.

- NGNs could provide improved quality, reliability and security for a range of services which are today delivered over the Internet.

- NGNs are also likely to allow faster and cheaper service creation, leading to more rapid innovation and ultimately to greater fulfilment of consumer demands. In particular, this should offer the end-user greater flexibility over how, when and where the services are used.

A6.2 The final point provides the link between NGNs and convergence. The long term vision for NGNs is to create a world in which consumers can access any service, anywhere, using any device. On this understanding, NGN technology enables greater flexibility of consumption, and leads to the erosion of the economic and technical boundaries that exist today between many communications services.[75]

A6.3 'Converged' services are already available over the Internet. People can now access the Internet through a variety of fixed and mobile devices, and this gives consumers flexibility over when, how and where they can use web-based services. For example, the most popular webmail applications (Yahoo, gmail, MSN Live Mail) can all be accessed from a desktop based web-browser, through a dedicated mobile application, or through a browser on a mobile phone. The user experience is not identical due to differences between the devices and network connectivity. However, the availability of these options is giving the consumer much greater flexibility. Their presence and use will start to shift customer expectations, and ultimately, this is likely to lead to real demand for converged services.

A6.4 In residential markets for communications services, convergence is most obviously present in the form of retail bundling. An increasing number of consumers are buying all their basic communications services from a single operator, especially across fixed telephony, broadband and TV. By 2009, for example, the percentage of UK households buying "bundled" packages and paying one fee for multiple services from a single provider had reached 46%.[76]

A6.5 The benefits to the consumer are lower prices for the bundle and the relative ease of managing a single account with a single bill. This trend also has important

[75] Strictly speaking, NGN IP technology is neither necessary nor sufficient to deliver this retail convergence vision. However, as discussed in the previous section, NGN can be used to refer to a wide range of investments. It is in this broader sense that NGNs are closely related to, and help drive, convergence.

[76] *The Communications Market 2009*, available from http://www.ofcom.org.uk/research/cm/.

implications for competition, for two reasons. Firstly, competition is likely to drive operators into offering bundles as single products begin to look less attractive, and because customers who buy bundles tend to be less inclined to switch to a competitor, particularly where that competitor does not offer a similar bundle. Secondly, NGN technology allows operators to deliver bundles more easily, and opens the door to further value added services in the future.

A6.6 In business markets, the drive towards convergence started much sooner, and is more clearly driven by cost savings for the customer. NGN technology has allowed many companies to migrate to a single IP network architecture for voice and data within offices. This saves the cost of maintaining and upgrading two networks. More often than not, these businesses will then buy separate services for voice and data connectivity to reach beyond the office, or corporate network. In the future, NGNs may allow these customers to extend the benefits of running a single internal network to the external connectivity, and to benefit from similar economies of scale in buying one generic access service rather than separate voice and data connections.

A6.7 More sophisticated solutions are now being introduced in the UK such as fixed-mobile convergence. This can allow company employees to use mobile phones, but when they are in the office calls will be routed over the local network. This brings benefits from both cheaper call rates and potentially better mobile coverage.

A6.8 As in residential markets, these deployments initially tend to be driven by cost savings for the customer. However, once implemented, the addition of new service features becomes a possibility. For example, unified messaging is now just beginning to become a viable commercial proposition. Unified messaging refers to the integration of a wide range of existing communications mediums (email, fax, voicemail, instant messaging) and presenting these consistently across a range of devices. This has clear productivity benefits for businesses in reducing the delays involved in processing communications received in different formats on different devices. The solution requires relatively complex software manipulation of the stored messages. This is by no means impossible on traditional telecoms networks, but would require a bespoke solution. Since NGNs adopt technology and standards from the Internet, generalised off-the-shelf software solutions are now a possibility for the customer.

A6.9 NGNs bring the opportunity to deploy these and many other solutions. For example, click to call (where a user clicks a link on a PC to make a phone call), unified communications (which concerns delivery in real time of all communications to the most appropriate locations and devices, so for example routing a call to a mobile when someone is not in the office), very fast changes to desk phone configurations within an office, implementing simple voice recognition, flexible and on-demand processing power, or simply having more flexible bandwidth to send large files on an irregular basis.

A6.10 Many of the trends identified above are already available to consumers through the Internet. Given this fact, one may question what added value NGNs will bring. The answer is more flexibility, less need for DIY solutions, greater reliability and greater levels of security. It is quite possible that NGNs will not deliver any truly unique solutions for consumers, but they may be able to deliver the same range of solutions in a better way. Although the Internet based solutions are possible today, many are only accessible to a small group of highly technical users. Using NGNs, the telecoms industry may be able to increase the availability of the solutions, for both business and residential customers. At the same time, by managing the network end-to-end, the telecoms industry can provide a consistent quality of experience for the customer in a way that is not possible on the Internet. This could lead to improved user experience for demanding applications such as voice and video communications which today often suffer from poor quality when delivered over the Internet.

A6.11 Finally, and perhaps most importantly, NGNs can be designed to offer security. By managing and controlling the applications that are available across an NGN, security can be maintained in a way that is not possible on the Internet.

Annex 7

NGN investment in the UK

A7.1 The following annex describes the main NGN investments by UK network operators, excluding BT, and looks at their plans for the future. BT's NGN plans are discussed in the main document at paragraphs 2.25-2.50.

Core network upgrades

A7.2 Over the past 10 years and more, there have been various moves in telecoms to adopt, and adapt, the technology and principles of the Internet to create a multi-service network infrastructure. That is, to create a network that is re-usable across a wide range of services, and which therefore makes the process of service creation and delivery simpler, faster and cheaper.

A7.3 Following this idea, many fixed network operators have started by building high capacity IP/MPLS core networks which are used to transport all services across the long-haul segments of the network, including the most demanding applications such as voice. But while these core networks are multi-service, the rest of the network infrastructure remains service specific. Voice traffic is typically conveyed in TDM format through circuit-switched architectures in the access and backhaul networks. It is then transcoded from TDM to IP by means of soft-switches deployed at the edge of the packet-switched core.

A7.4 Associated with these changes, operators are increasingly using DWDM and Ethernet for the underlying core network transmission, and to a certain extent in backhaul. These technologies, although not necessary to NGN architecture, provide much cheaper and more flexible bandwidth, and almost always form part of a holistic NGN design.

A7.5 The mobile network operators have been slower to deploy integrated IP technology in their core networks. They continue to operate separate core networks for voice and data – TDM for voice and packet-switched architecture for data.

A7.6 Since these upgrades are limited to the core network, the services delivered through the unchanged access network necessarily remain the same. This suggests that investments in NGN core networks have been driven primarily by prospective cost savings rather than the scope for additional revenue from new NGN services. They have offered a cheaper way to deliver existing services, taking advantage of economies of scale and scope inherent in running multiple services over a single transport infrastructure.

Extending NGN technology to the access boundary

A7.7 A number of operators are now in the process of extending their NGN infrastructure out from the core into backhaul and access networks. For those with existing networks, this means replacing the existing PSTN voice network architecture, and running voice services over a common Ethernet and IP infrastructure. Crucially, these operators will already have been building a high bandwidth IP infrastructure to deliver broadband Internet access, and so the financial case for building this part of the NGN can be justified on the basis of efficiency.

A7.8 In general, operators with large legacy networks will benefit most from cost savings, whilst operators with networks built more recently, and those with less infrastructure, are likely to be driven more by the possibility of developing new services. The cost saving business case is strongest when there is legacy equipment at the end of its useful life. If the old equipment still works, and will continue to be supported by the manufacturer, then operators are less likely to plan a substantial change.

A7.9 The cost saving will only be fully realised once the old network is switched off, and this can only happen when the customer base has migrated to the new network. The migration itself represents a very expensive logistical problem, and until it is complete, the operator must run two networks in parallel. So, although there is a strong prima facie case for reducing costs by adopting newer technology, delivering this result is less than straightforward.

A7.10 In order to maintain usability of devices and services which currently run on the old network it is likely that most NGN voice services will need to emulate the PSTN. Several NGN designs today involve continued use of baseband frequencies in the access network for voice services and QoS management through the use of dedicated capacity in the backhaul and core. In effect, this creates a separate, emulated PSTN equivalent over a shared IP core network infrastructure.

The speed of the transition to NGNs varies between operators

A7.11 The adoption of NGN technology varies considerably from operator to operator. Carphone Warehouse ('CPW'), for example, has been at the forefront of NGN deployment in the access network. Since 2005, it moved from a business model based on CPS for voice and IPStream for broadband, and built its own network based on NGN technology. It now uses MPF lines from Openreach connected to converged MSAN devices which provide both voice and broadband services. These link to a converged core IP network. CPW have now installed MSANs at over 1,700 BT exchange sites. Similar to BT's 21CN design, the voice service emulates the PSTN, allowing the customer to continue using existing telephone handsets and in-house wiring.

A7.12 CPW's network consists of four layers: super core, core, edge and access layer. The super core is a fibre-based DWDM network handling all the traffic between the core network and the Internet. It is centred on London and all the Internet peering points. The core network is also a fibre based DWDM network taking in all the major cities of the UK. IP MPLS is used across the core delivering the required QOS. The edge layer uses 10 Gigabit Ethernet and sub-Gigabit Ethernet to connect to the access layer. Voice traffic is broken out in the edge layer at the main core hubs. Ethernet and MPLS are used between the edge and the access layer. The 1700 exchanges are fitted with Multi Service access nodes interfaced to the Edge using layer 2 Ethernet switches. QoS is supported in the access and edge layers using Classes of Service ('CoS') in Ethernet and QoS in MPLS. The core layer, in addition to the data traffic, also supports inter-site voice class 4 transit using VPNs and IP MPLS.

A7.13 Many other operators, even if committed to deploying an NGN core, do not have plans have plans to extend NGN technology further into the network, and to replace existing PSTN infrastructure. If TDM legacy switches are still working efficiently, then there is no immediate driver to replace them. However, most operators are adding IP voice features, and remotely hosted applications, in order to address demand from small and large business customers.

A7.14 One of the reasons for this variety of approach is simply the difference in business models between the competitors. Business services cover a much wider variety than just voice and broadband Internet access, and the scope to derive cost savings by converging voice and data access networks is less than for a residential LLU operator. In many cases, the greatest benefits of NGN technology come from new services and providing customers with greater control over existing services. For example, Ethernet based business connectivity services provide lower cost and more flexible bandwidth than their traditional technology counterparts. Equally, upgrades to IT systems are starting to allow business customers to control aspects of their service directly through web interfaces.

Mobile networks are evolving in parallel

A7.15 The trends in mobile networks to some extent parallels those in fixed. There is no direct mobile equivalent to the deployment of MSANs in the fixed network. However, as in the fixed industry, investment is being driven to a significant extent by the growth in broadband Internet traffic. This increase in demand and traffic volume is forcing operators to upgrade backhaul infrastructure, and to adopt technologies better suited to high bandwidth data traffic such as Ethernet. The mobile operators currently rely on SDH links to connect radio bases stations to their mobile switching centres. However, this becomes prohibitively expensive as it becomes necessary to upgrade to high bandwidths to support mobile data services.

A7.16 For the time being, mobile operators are planning to keep voice and data traffic separate in the access network. Over the next few years we may see greater convergence of voice and data in backhaul, but there remain some technological difficulties to overcome before this is truly viable. Equally, there would need to be a change in technology in the access network before voice and data could be offered in a converged manner.

A7.17 Over the next few years, the main focus of the mobile industry is likely to be upgrading the mobile access infrastructure to provide higher bandwidth mobile data services. UK MNOs have started upgrading their 3G networks to HSDPA, for faster downlink connections (up to 14.4Mbit/s), and to HSUPA, for higher speed uplink connections (up to 5.72 Mbit/s).[77] HSxPA technologies require limited investments compared to the initial roll-out of a mobile access network, as they involve only software and limited hardware upgrades of 3G Radio Network Controllers. In terms of further investments, the next step in the near-term could be HSPA+, a further enhancement of HSxPA, although none of the UK MNOs has yet committed to making such an investment. Thereafter, MNOs may consider moving to a 4G technology such as LTE or WiMAX, which are discussed below in paragraph A7.22.

A7.18 Another NGN related technology that has been considered by many mobile operators is the IP Multimedia Subsystem ('IMS'). IMS is an NGN architecture developed by the GSMA. It creates the capability to manage subscribers and network resources across a variety of different access networks. It effectively creates a platform which abstracts from the detail and complexity of these underlying networks, and is therefore ideal for hosting converged applications. For example, an IMS could be used to implement fixed-mobile convergence solutions by linking the fixed and the mobile access network infrastructure through a common platform.

[77] 2G and 3G networks were originally designed for voice services, so radio transmission using the native standards is not optimised for mobile broadband. HSxPA technologies fill this gap, by improving data connections over the radio medium.

A7.19 Several MNOs are planning to upgrade their core networks at some point, but it remains uncertain whether any MNO will fully implement IMS. The issue with IMS is that it requires considerable investment, but does not itself deliver any new applications – it is merely a platform. For this reason, the business case does not at the present look compelling.

Outlook for UK network development?

A7.20 The design of future networks remains uncertain. Many alternatives are possible, with the main variable being the treatment of voice services. In the very long term, it is likely that voice will be delivered to residential and business customers as an application running over a single converged data access connection. If and when fibre takes over from copper as the preferred medium in the access network, this is essentially a data access connection. Although it would be possible to partition this access connection into voice and data and to recreate a PSTN-like service, there are likely to be more efficient ways to deliver an equivalent telephony service.

A7.21 Within current fixed networks, however, the move to a non-PSTN voice service would require the replacement of existing customer premises equipment (the telephone handset), or the installation of a new device at the customer site to enable interworking. The required investment might not be justifiable for some time, especially when a perfectly workable alternative exists: while copper remains the dominant access medium in fixed networks, operators can continue to use baseband frequencies to provide (analogue) voice access. This does not prevent the operators from then carrying voice and broadband traffic in a fully integrated fashion in the backhaul and core networks.

A7.22 In mobile networks, the most significant future development would be a move towards voice and data convergence in the radio access network. This is a feature of Long Term Evolution ('LTE'), the 3GPP standard for the next generation of mobile networks, 4G. Although presented as an evolution of UMTS, the LTE air interface is a completely new system based on different radio access mechanisms.[78] An alternative 4G technology is WiMAX (formally known as IEEE 802.16). Both 4G technologies are based upon IP, and are therefore inherently data orientated. Voice services must therefore be delivered as an application over the common IP infrastructure. However, as with the fixed network, the option remains to maintain the current voice-specific infrastructure, using 2G and 3G technologies, as this works perfectly well, and to use the new network to accommodate growth in data services.

A7.23 The extension of NGN technology out to the end-user device tends to support a move towards generic wholesale access products, which may have an impact on regulated access products in fixed networks. At present, separate regulated access products are required to support competition in voice (e.g. WLR) and broadband (e.g. IPStream) markets. If NGNs led to a single method of access being used to provide both voice and broadband, this could lead to the emergence of a single, converged market for fixed access.

A7.24 While these are all possible outcomes in the longer term, the more immediate outlook is dominated by the fact that there will be a variety of different access network and core technologies used by various operators, and these will all need to coexist and interoperate. This includes PSTN using the copper access network, PSTN emulation over the copper access network, and voice as an application over

[78] OFDMA in the downlink and SC-FDMA in the uplink.

a variety of data access networks. In effect, there is likely to be an extended period of transition towards the very long term prospect of voice as an application. The expectation had been that this transition period might last 5 years or more, but it now looks likely to continue for considerably longer.

Annex 8

Glossary

21CN (21st Century Network): 21CN is an investment programme, announced by BT in 2004, designed to upgrade its network infrastructure and systems. The original network architecture was designed to deliver a single IP-based NGN, which would replace numerous service specific platforms in the legacy architecture. This included replacing the existing TDM-based voice network in its entirety.

2G: Second generation of mobile telephony systems. Uses digital transmission to support voice, low-speed data communications, and short messaging services.

3G: Third generation of mobile systems. Provides high-speed data transmission and supports multimedia applications such as full-motion video, video-conferencing and Internet access, alongside conventional voice services.

3.5G: 3.5G refers to evolutionary upgrades to 3G services starting in 2005-2006 that provide significantly enhanced performance. High Speed Downlink Packet Access is expected to become the most popular 3.5G technology (see HSPA).

4G: See LTE.

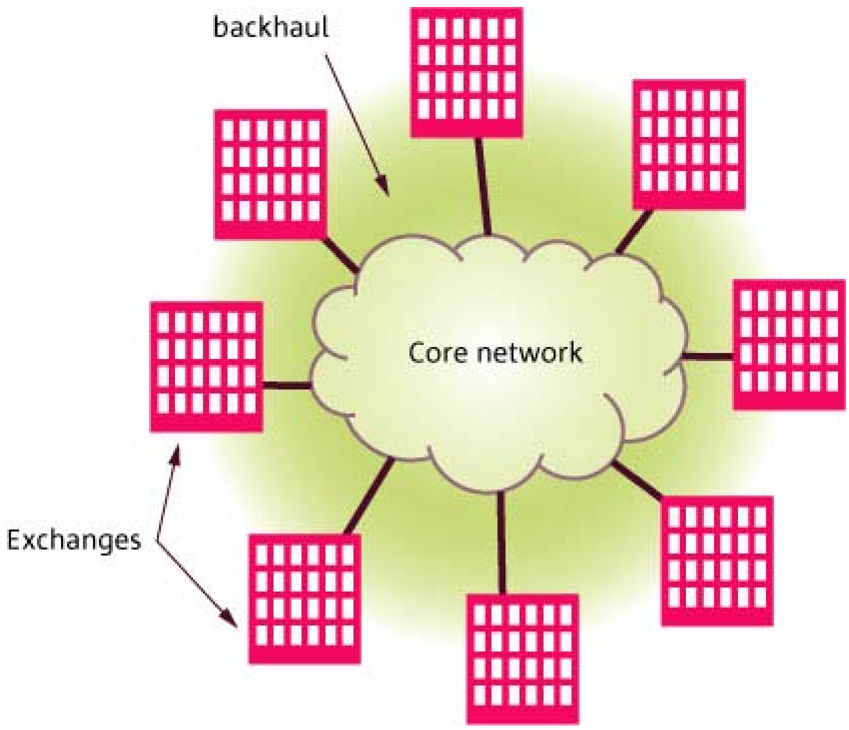
3GPP: Third Generation Partnership Project. The 3GPP was formed in December 1998 as a collaboration agreement bringing together a number of telecommunication standards bodies, referred to as Organizational Partners. The original aim of the 3GPP was to produce globally applicable technical specifications for third-generation mobile systems based on evolved GSM core networks and the radio access technology UTRA (Universal Terrestrial Radio Access).

Access network: Electronic Communications Network which connects end-users to a service provider; running from the end-user's premise to a Local Access Node and supporting the provision of access based services. It is sometimes referred to as the local loop or last mile.

ADSL (Asymmetric Digital Subscriber Line): ADSL is one of the family of DSL technologies. It is digital broadband technology that allows the use of a standard copper telephone line to provide high-speed data communications at the same time as providing a traditional analogue telephony service. ADSL and ADSL2+ both provide higher speeds in one direction (towards the end-user) than the other. The theoretical maximum download speed of ADSL is 8Mbps, whereas for ADSL 2+ it is 24Mbps.

ATM (Asynchronous Transfer Mode): ATM is a link layer transport technology, often used in current generation ISP networks to transport broadband IP traffic. ATM technology allows the network operator to specify different classes of service, and thereby prioritise traffic and manage congestion. As operators build NGNs, ATM tends to be replaced by Ethernet, which can provide higher bandwidth at a lower cost.

Backhaul: Backhaul connects the access network to the core network. It is generally distinguished from local access and core by the fact that it does not perform any switching or routing function. It simply takes traffic from a number of local access nodes, possibly aggregates this together, and transports it back to the core network. It is generally made up of very high capacity transport links, which are generally provided using Ethernet in NGNs.



Call Server: A call server is a device that sets up and manages calls within an IP-based voice network. Specifically, it controls call sessions, and amongst other things, will be determining bandwidth requirements for the call, controlling signalling, producing call records, and opening and closing firewall ports.

Communications Providers (CPs): Companies which provide electronic communications services to the general public, i.e. end-users.

Concentrator / Remote Concentrator Unit (RCU): A concentrator, or RCU, is the equipment to which an end-user's telephone line is most likely to connect (some connect directly to a DLE). As the name suggests, the concentrator aggregates the traffic from a number of analogue telephone lines, digitises it, and send it on to the DLE equipment at the local exchange.

Conveyance: conveyance refers to the transport of traffic, often voice traffic, across a network.

Copper line / copper pair: this refers to the telephone lines in the access network, which are most often made from copper. Each telephone line consists of a pair of copper wires which carry the electronic signals for voice and/or data services.

Core network: The core network represents the backbone of a communications network. It tends to cover a relatively large area, and carries traffic between geographically distant points. What tends to distinguish core from backhaul is that the core network contains routers and switches which can change the direction of the traffic, and ensure that it gets to the correct destination.

Core node: A core node is a place within the core network which contains switches or routers which can direct traffic to the correct onward path. It is where backhaul circuits generally connect to the core network.

CPS (Carrier Pre-Selection): CPS is a mechanism that allows end-users to select, in advance, alternative CPs to carry their voice calls without having to dial a prefix or install any special equipment at their premises. The end-user subscribes to the services of one or more CPS operators (CPSOs) and chooses the type of calls (e.g. all national calls) to be carried by them. The end-user may have a direct retail relationship with the CPSO, or may purchase the service via a CPS Reseller. The end-user is billed for these calls by the CPSO or CPS Reseller.

Delay: Used in the context of communications networking, delay is a measure of the time taken for a data packet, or voice call, to get from source location to destination. It may be measured in one direction, or as the round-trip-time for a return journey. Certain applications and equipment are sensitive to the amount of delay in a communications network. For example, delay in voice networks introduces a lag between the time one person speaks, and the time the speech is heard at the other end of the call. If this delay gets too large, intelligible conversation becomes very difficult.

Derived voice: derived voice tends to refer to voice services which are provided within a broadband data connection. As such, derived voice is usually based on VoIP. It is distinguished by the fact that a non-derived voice service will use an access connection which is separate from an end-user's broadband connection.

DLE (Digital Local Exchange): The DLE is a type of switch in BT's legacy voice network. It is generally the switch closest to the end-user, i.e. the first switch to which an end-user line connects. End-user copper access lines may connect directly to a DLE, or may connect via a concentrator. There are around 700 DLEs in BT's current voice network architecture.

DSL (Digital Subscriber Line): DSL, or xDSL, refers to a family of technologies which use the twisted copper phone lines that make up the access network in the current generation of fixed telephony networks, to create high bandwidth digital data connections. Some of the technologies coexist with analogue voice on the same line, whereas others require a dedicated line. These high bandwidth data connections are capable of supporting high speed Internet services, video on demand, and business connectivity services. ADSL, HDSL (high data rate digital subscriber line), SDSL and VDSL (very high data rate digital subscriber line) are all variants of xDSL. The different variants of DSL all have different characteristics, and provide different bandwidths. However, as a general rule, the maximum bandwidth on a copper line tends to be limited by the length and quality of the copper wires over which DSL is being used – shorter and better quality lines enable higher bandwidths.

DSLAM (DSL Access Multiplexer): A DSLAM is a device which is located in the access network, and allows the operator to create DSL connections to end users over the copper lines which connect to the DSLAM. It also then aggregates the traffic from all the connected lines to pass over to a single backhaul link.

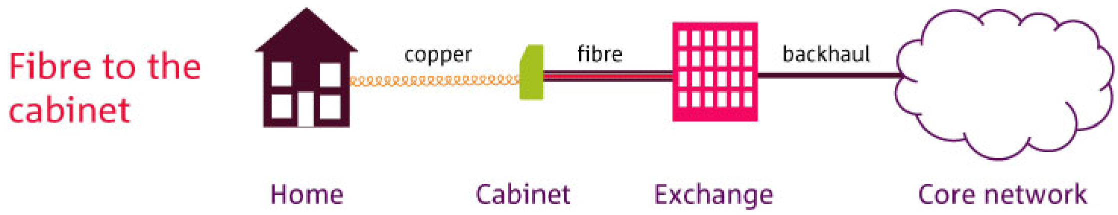
DWDM (Dense Wavelength Division Multiplexing): Wavelength Division Multiplexing ('WDM') is a general term for the technologies which use different wavelengths of light to send multiple signals along an optical fibre. Dense (DWDM) and Course (CWDM) are two different versions of WDM. DWDM offers more wavelengths, and therefore greater capacity, and is generally used in core networks. CWDM is more likely to be used in backhaul and metro networks.

EoI (Equivalence of Inputs): Equivalence of Inputs, or EoI, is a concept legally defined in section 2.1 of BT's Undertakings. See paragraph 3.7 above for a full definition.

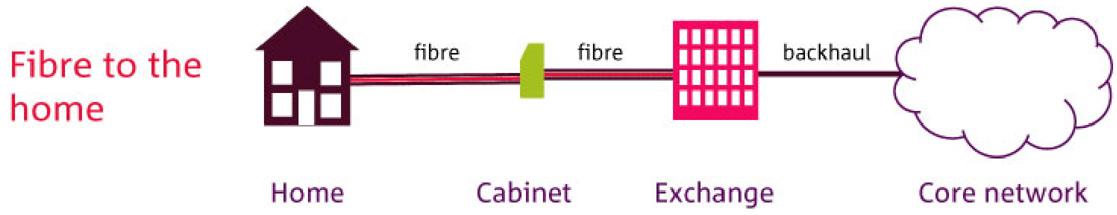
Ethernet: Ethernet is a link layer transport protocol, originally designed for linking computers on a Local Area Network (LAN). Its widespread use in computing means that it is familiar, and well tested technology, with relatively cheap interface components. These characteristics, along with its flexibility, have made Ethernet an attractive choice for data links in NGNs. Here they tend to replace ATM technology. Businesses have also started to adopt Ethernet for connections between offices, since it can be built as a natural extension of the Ethernet-based LANs within individual office buildings.

Firewall: A firewall is a sophisticated filter which forms part of a network, usually a computer-based network, designed to block unauthorised traffic, but to allow legitimate communications. Firewalls are usually put at the perimeter of a trusted region within a network, for example, at the edge of a home or office network before the connection to the Internet.

Fibre-to-the-cabinet (FTTC): An access network architecture in which optical fibre extends from the local exchange to a street cabinet. The street cabinet is usually located only a few hundred metres from the end-user premises. The remaining part of the access network from the cabinet to the end-user is usually copper wire but could use another technology, such as wireless. Where it is based on copper wire, a DSLAM will often be used in the street cabinet to enable a DSL-based service. Since the length of the copper line from the street cabinet to the end-user is much shorter than from the local exchange, much higher bandwidths can be provided over the line.



Fibre-to-the-home (FTTH): An access network structure in which the optical fibre runs from the local exchange to the end-user's home or office. Fibre based transport technologies allow for more reliable, greater bandwidths to be provided relative to copper-based access networks.



HSPA (High Speed Packet Access): 3G digital data services that jointly refer to downlink and uplink mobile broadband technologies.

IMS (IP Multimedia Subsystem): IMS is a network architecture, and a set of technical standards, that creates a common session layer on top of an IP network layer. It was originally created by the 3GPP to make it easier for operators to provide common applications and services between different access networks. The common session layer provides the means of delivering this service convergence.

Interconnection The linking of one Public Electronic Communications Network to another for the purpose of enabling the persons using one of them to be able (a) to communicate with users of the other one; (b) to make use of services provided by means of the other one (whether by the provider of that network or by another person).

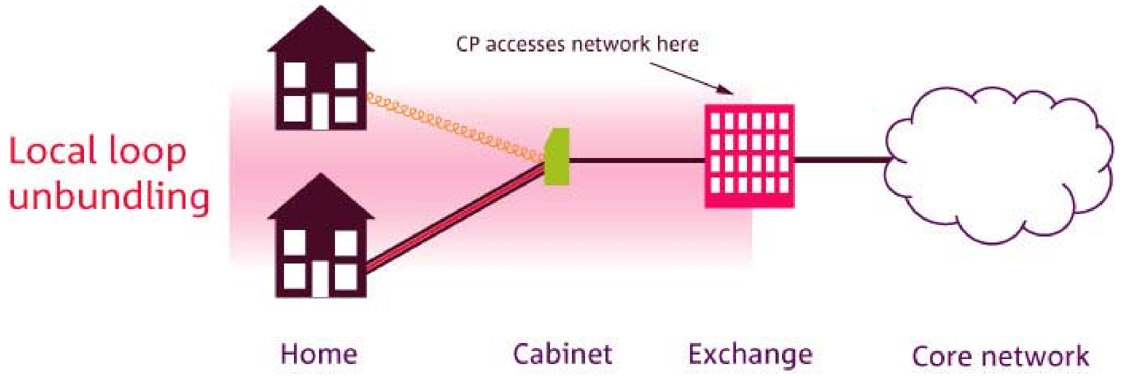
IP (Internet Protocol): IP is a protocol which is used to send data across the Internet, and now in many other networks. IP defines the addressing system on the Internet and allows different IP datagrams (packets) to be routed to the correct destination.

IPStream: IPStream is a wholesale broadband access service provide by BT Wholesale on the current generation network. It allows CPs to sell broadband services to end-users based on ADSL technology.

Integrated Services Digital Network (ISDN): ISDN is a digital technology used in telephony networks, which is provided over the PSTN, and can be used to provide both voice and data services on the same line.

Latency: Another word for delay.

Local Loop Unbundling: LLU refers to the process by which CPs can gain access to the copper local access network of an incumbent operator. It also allows these CPs to place equipment in the local exchange buildings in order to deliver services to end-users over their own network infrastructure.



Local Exchange / Exchange: The local exchange refers both to a building and the equipment within it. It is the location at which local access network lines (both copper and fibre) will end, and will be connected to the relevant equipment. Exchanges may house DLEs and concentrators for voice services; DSLAMs for broadband; or MSANs for both voice and broadband in an NGN. In the BT network there are around 5,500 exchange buildings across the UK.

LTE (Long Term Evolution): Part of the development of 4G mobile systems that started with 2G and 3G networks. Aims to achieve an upgraded version of 3G services having up to 100 Mbps downlink speeds and 50 Mbps uplink speeds.

MDF (Main Distribution Frame): The MDF is a physical frame located in every BT local exchange, which connects the copper local access wires to internal cables. These internal cables are then passed to the relevant pieces of equipment (which could be owned by BT or another CP via LLU).

Media gateway: A media gateway is a device that converts the transport protocols of the media (voice, data, video) between different types of telecommunications networks such as PSTN; NGN and mobile networks. For example, a VoIP media gateway performs the conversion between TDM voice and VoIP.

MNO (Mobile Network Operator): The label used to refer to mobile operators in the UK who own one of the five 2G or 3G spectrum licences. That is, 3, O2, Orange, t-Mobile, and Vodafone.

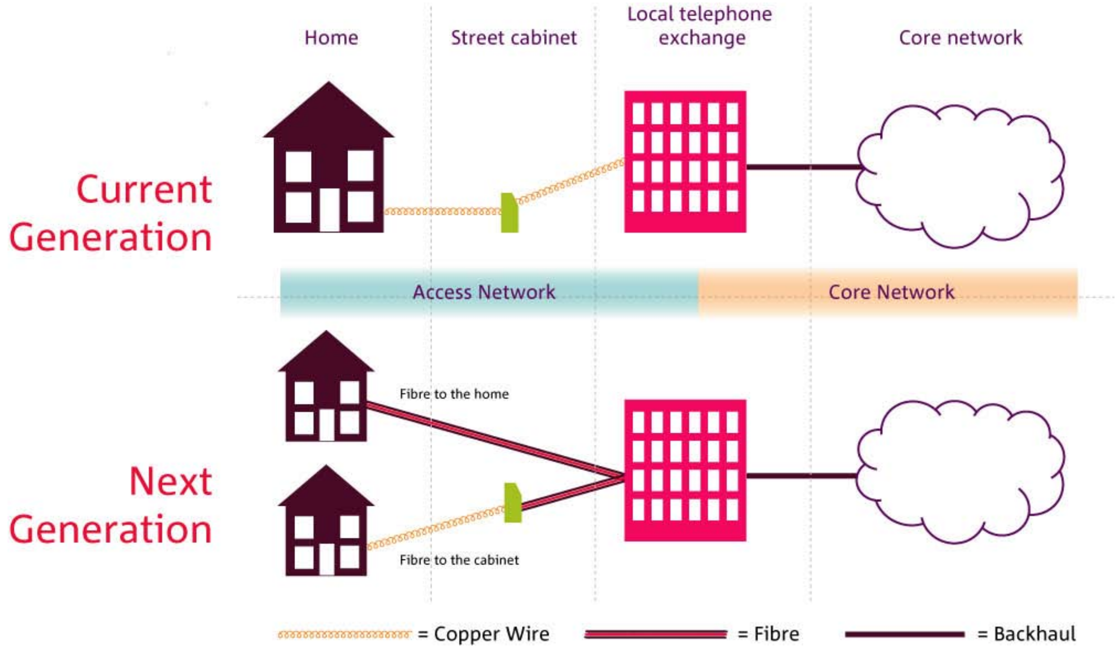
MPF (Metallic Path Facility): MPF is an LLU service provided by Openreach which allows other CPs, including BT's downstream divisions, to access the copper pairs which run from the local exchange building to the end-user premises.

MPLS (Multi-Protocol Label Switching): MPLS is a technology that allows a network operator to label specific IP packets, and then control the routing and forwarding of these packets according to the label. This allows the operator to create different classes of service, and to prioritise specific types of traffic, or specific services.

MSAN (Multiservice Access Node): In 21CN and in other NGN designs, an MSAN is a piece of equipment which allows a CP to provide both DSL based broadband and voice services over a single line. It therefore replaces performs the function of both a DSLAM and concentrator/DLE. It is usually located in the local exchange.

Network intelligence: this refers to an abstract layer within an NGN which provides the intelligence to control the network, and provide services and applications to end users. It performs functions such as allocating network resources to specific users or applications, and controlling access to either the network or specific content and applications.

Next Generation Access (NGA): New or upgraded access networks that will allow substantial improvements in broadband speeds and quality of service compared to today's services. NGAs can be based on a number of technologies including cable, fixed wireless and mobile. The phrase is most often used to refer to access networks using fibre optic technology, for example, FTTC and FTTP.



Next Generation Networks (NGN): A 'Next Generation Network' is generally understood to refer to an IP network capable of being used for both voice and data, and in which there is some control over quality of service. The key features of an NGN are that it is a packet-based, multi-service network, which has a clear separation of transport and control, and where the control functions may reside on a physically separate network.

NGNuk: NGNuk is an industry forum which was created to help the coordinate the transition to NGNs in the UK.

NGS (Next Generation Switch): The NGS is a type of switch used in the current generation BT voice network. It is not part of BT's NGN, 21CN.

Openreach: Openreach is the name of the division within BT that was created as a result of BT's Undertakings, the primary purpose of which is to look after the network assets which represent enduring economic bottlenecks.

Pathfinder: Pathfinder is an extensive trial of BT's 21CN being run in South Wales.

PATS (Publicly Available Telephony Service): A publicly available telephone service is a regulatory concept defined under both European and UK regulatory regimes. Publicly available services are generally distinguished from private networks. Generally, regulatory obligations (such as the obligation to offer 999 access) are imposed on providers of publicly available services but the same obligations may not apply to private networks.

POSI (Point of Service Interconnect): POSI is the name given to points of interconnection on 21CN. Both voice and data traffic could potentially be exchanged at a POSI.

PSTN (Public Switched Telephony Network): PSTN refers to the set of technologies that have been used to create the current generation of voice telephony networks. One of its key features is that it uses telephone numbers for addressing.

QoS (Quality of Service): In general, Quality of Service refers to a wide range of factors that may affect an end-user's perception of a communication service. However, in terms of communications networks, QoS usually refers to a system of prioritisation to ensure that certain traffic, or specific services, are delivered in a manner which will be acceptable to the end-user. QoS can relate to things like delay and bandwidth.

SDH (Synchronous Digital Hierarchy): SDH is a method of digital transmission. One of its key features is that its transmission streams are packed in such a way as to allow simple multiplexing and de-multiplexing, and the addition or removal of individual streams from larger assemblies. SDH is a TDM based technology that requires very accurate timing across the network.

SDSL (Symmetric DSL): One of the DSL family of technologies which provides the same data rate in either direction. It is not possible to run SDSL and a traditional analogue telephone service on the same line, as is the case with ADSL. It is often used by businesses.

Session border controller (SBC): A session border controller is a device that functions as a firewall on VoIP networks, filtering traffic as appropriate between private networks, or between different CPs.

Session Initiation Protocol (SIP): This is a signalling protocol often used for controlling multimedia communication sessions over IP. It is often used to control VoIP based voice applications.

SMP (Significant Market Power): SMP is the term used in the European Regulatory Framework to describe the position of a company, which either individually or jointly with others, enjoys a position equivalent to dominance, that is to say a position of economic strength affording it the power to behave to an appreciable extent independently of competitors, customers and ultimately consumers.

SMPF (Shared MPF): SMPF is an LLU service provided by Openreach which allows other CPs, including BT's downstream divisions, to access just the frequencies on the copper pairs which would allow the CP to provide broadband to the end user. The line is therefore ‘shared’ since the other frequencies are used to provide voice services.

TDM (Time Division Multiplexing): TDM refers to technologies and methods of putting multiple data streams in a single signal by separating each signal into many segments, each having a very short duration. Each individual data stream is re-assembled at the destination based on timing.

UMTS (Universal Mobile Telecommunications System): UMTS is the 3G mobile technology most commonly used in the UK and Europe.

Undertakings: The Undertakings refer to a set of legally binding commitments which BT proposed and Ofcom accepted which established a regulatory framework focusing on the enduring bottlenecks of competition. These Undertakings were provided in lieu of a market investigation reference to the Competition Commission under the Enterprise Act 2002, and accepted on 22nd September 2005.

VLAN (Virtual LAN): VLANs are used in Ethernet based networks, and represent a logical partition within a physical Ethernet network to create a Virtual LAN.

VoIP (Voice over IP): VoIP is a general term used to refer to any situation which involves the provision of voice communications over an IP network.

WBC (Wholesale Broadband Connect): A wholesale broadband access product provided by BT Wholesale over 21CN infrastructure. It uses ADSL2+ technology installed in MSANs. It is the 21CN equivalent to IPStream.

WBCC (Wholesale Broadband Converged Connect): A wholesale product proposed by BT to run over 21CN which was to allow a CP to provide both voice and ADLS2+ broadband services to end-users. This would allow a customer of WBCC to provide a retail bundle of telephony and broadband to end-users.

WDM (Wavelength Division Multiplexing): See DWDM.

WiMAX: A wireless technology, similar to WiFi, but with a longer range which can cover many kilometres. WiMAX has been considered as a wireless alternative to fixed access connections to provide high speed access links instead of using copper to properties.

WLR (Wholesale Line Rental): A service provided by Openreach that allows a CP to provide voice services to an end-user in conjunction with CPS or another wholesale calls product from BT.

WVC (Wholesale Voice Connect): A proposed 21CN wholesale service to allow CPs to provide NGN based telephony services to end-users. WVC would have allowed a CP to use its own call server to control BT’s MSAN, and therefore specify its own call feature set. Product development was discontinued following BT’s strategic review of 21CN.

xMPF: This is the name which has been adopted to refer to a proposed voice-only passive access product from Openreach. There are many different variants of xMPF, but it is perhaps best understood as the input which Openreach implicitly consumes in order to provide WLR in situations where an end-user also takes broadband.