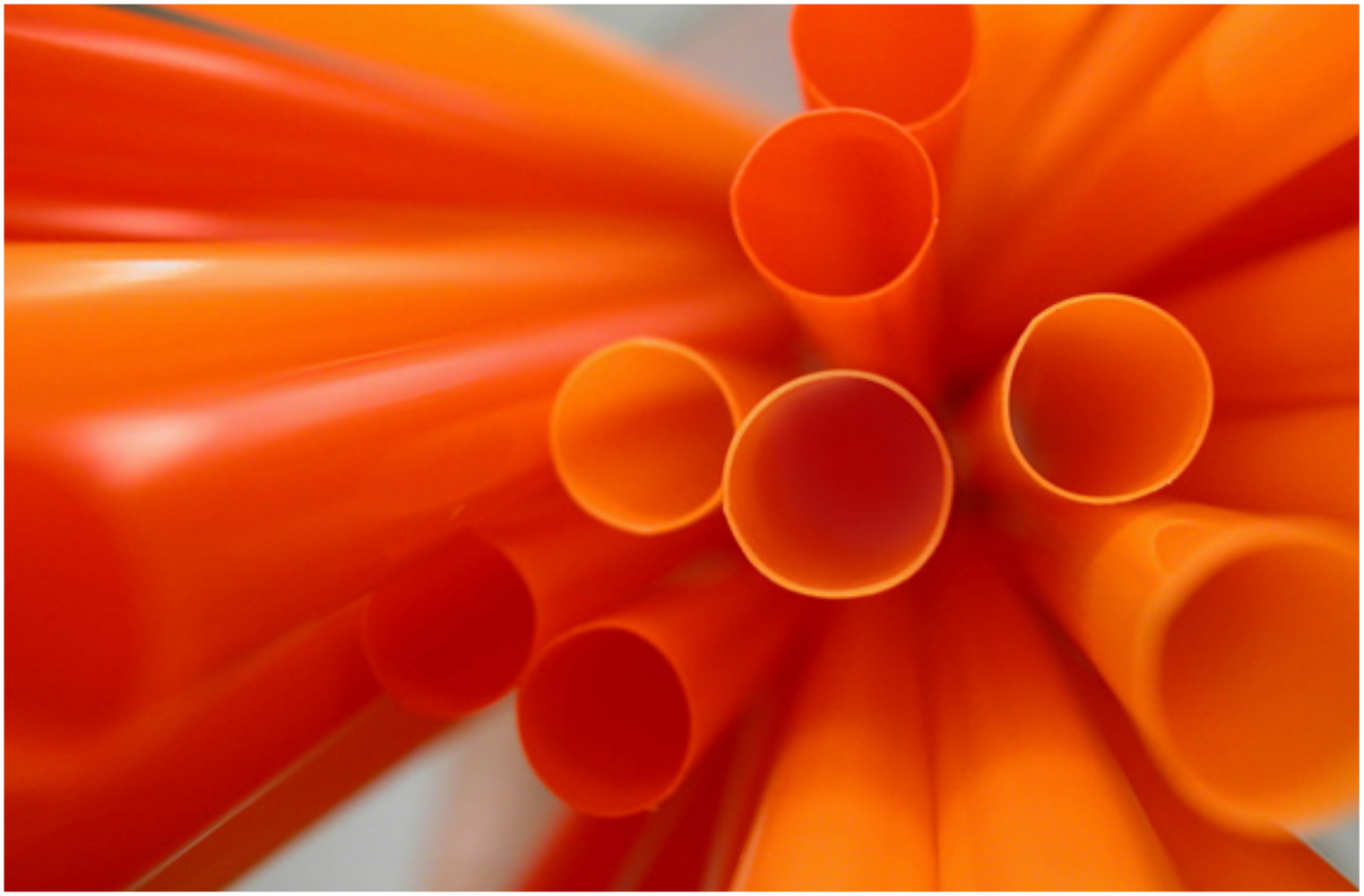

Pipe Dreams? Prospects for **next generation broadband** deployment **in the UK**

BSG
Broadband
Stakeholder
Group

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Pipe Dreams?

i/ Foreword

As broadband becomes ever more important for businesses and consumers, as well as a growing array of commercial stakeholders across the broadband value chain, interest is growing in the long-term evolution of the UK's broadband infrastructure. With investment in next generation broadband access networks gathering pace in a number of countries around the world, this report sets out to look at the prospects for similar investment to take place here in the UK.

The specific issue the report addresses is that while the underlying demand for greater bandwidth is likely to continue to grow rapidly, a variety of factors – notably the current business models associated with broadband and the balance of risk and reward associated with investment in advanced infrastructure – mean that it is not clear that this demand will be served. At a time when other countries are investing in higher speed broadband infrastructures, this may have damaging implications for the UK's competitiveness.

The objectives of the report are threefold:

- to raise awareness of the issues related to the deployment of next generation access networks with government, the regulator and industry
- to provoke discussion and inform policy development
- to suggest a number actions that can move this debate onto the next stage.

We have specifically investigated and reported on the potential demand for high bandwidth broadband; the factors likely to affect market development and network requirements; the likely developments in capability and capacity of access networks; the constraints to investment in next generation networks, content and services; the transition from current to future models; and the role of public sector intervention.

The report was written by the BSG Secretariat, and approved by the BSG Executive Committee and myself. The research and writing took place between spring 2006 and spring 2007, and has comprised desk research, one-to-one meetings with stakeholders and a series of round table meetings and seminars with key players, which took place under Chatham House rules. A list of the stakeholders who have taken part in the review process can be found in the Annex. Although comments given in interviews are not attributed, references have been given wherever possible.

This is the start of a new phase of debate and action on this subject, which is of great importance to UK consumers and businesses, as well as the UK's position in the world economy.

Kip Meek, Chairman
Broadband Stakeholder Group

ii/ Executive Summary

The UK's next generation broadband challenge

1 Broadband has been the key enabling infrastructure of the global knowledge economy in the twenty first century, and is now an integral and everyday part of many people's lives in the UK.

2 However, this success has bred a new dilemma. Rapid take-up, a fiercely competitive market place and the arrival of new bandwidth-intensive products and services, has led to a huge growth in internet traffic, which shows little sign of slowing down. The question now being asked by policy makers and industry stakeholders is whether the UK's current and planned broadband network infrastructure will remain capable of sustaining the UK's position at the forefront of the global knowledge economy.

3 In a number of countries next generation broadband services are now being deployed that are capable of delivering much higher upstream and downstream peak rate access speeds to end users than are currently available in the UK. In some cases, governments and regulators have chosen to incentivise these investments because they believe they will be critical to their national competitiveness.

4 Currently, there seems to be little prospect for the widespread deployment of next generation broadband access networks in the UK, as commercial incentives are particularly weak. High costs, unproven business models and intense competition for revenues from value added services make it extremely difficult for UK operators to justify large-scale investments in new access networks. This means that we cannot assume that the broadband value chain, as currently structured and regulated in the UK, will deliver the ever greater bandwidth that both upstream service providers and users increasingly expect.

5 If the UK was significantly to lag behind its international competitors in bandwidths available to citizens and consumers, the pace of innovation in the economy could slip behind that of those competitors. There is, therefore, growing agreement that the move towards next generation broadband services presents a difficult and serious challenge and that the implications for the wider UK economy could be significant.

6 For next generation broadband to move from pipe dream to reality in the UK, steps need to be taken now. The issues are complex and there are few clear or obvious solutions at this stage. However, there is a limited window of opportunity between now and April 2009 to get this right. A concerted and innovative approach to regulation and policy making will be required to achieve the right balance of investment incentives and competition that will enable a market-led transition to next generation networks.

'Next generation broadband is defined as broadband access services that are capable of delivering sustained bandwidths significantly in excess of those currently widely available using existing local access infrastructures and technologies.'

The potential importance of next generation broadband for the UK

7 It is too early to assess definitively whether our global competitors' investments in next generation infrastructures will deliver the commercial and socio-economic gains that are hoped for. However, the move to a globally connected world has clearly brought economic benefits. There is a strong possibility that expanding the range of services capable of being provided, as well improving the speeds with which they can be accessed and delivered, will further increase productivity and efficiency.

8 These factors are particularly important for the UK, as it seeks to become a leader in the knowledge economy and to capitalise on its end-to-end strengths in the high-tech, creative and new media sectors. The social impact of broadband has also been significant. It has raised standards of living by increasing choice and lowering prices, promoted efficient and effective public services, and allowed greater inclusion in civic society.

9 While evidence is emerging of the impact of first generation broadband, there is not much evidence yet about the additional benefit of next generation broadband, mainly because these networks are still new and the impacts have not yet started to work through the system.

10 This raises a dilemma: there is a strong probability that higher speed broadband will be crucial to maintain competitiveness. However, there is, as yet, no clear commercial model for widespread next generation access deployment. The policy instinct where there is a lack of evidence will be to do nothing. However, if significant efficiency gains are derived from next generation broadband then it is possible that nations that opt for accelerated deployment will gain sustained competitive advantage over nations that do not. Given the very long lead times involved in deploying next generation broadband, the risk of action must be weighed against the risk of inaction.

Likely evolution of the UK broadband market versus potential demand

11 In 2001 the UK sat in twenty-first place in the OECD countries in terms of broadband penetration[1]. Six years later there are more than 13 million broadband subscribers (representing more than 50 per cent of the UK's 24.4 million households[2]), and the UK now leads the G7 in terms of the availability of first generation broadband, with 99.6 per cent availability. Local loop unbundling (LLU) and the wide availability of wholesale DSL products, has lead to strong retail and wholesale competition, which in turn has resulted in falling prices and stimulated high levels of take-up. The 'virtuous circle', which the BSG has always argued is crucial, where industry innovation drives user adoption and market growth, is now a reality.

12 Operators will continue to invest in and deploy new broadband infrastructure over the next five years. Primarily this will involve the deployment of ADSL2+ by BT and other LLU operators and, potentially DOCSIS 3.0 by Virgin Media. BT will also start to deploy fibre to the home (FTTH) in a limited number of green field sites from 2008.

13 However, because the performance of ADSL2+ decreases over distance, this investment will, at best, result in a patchwork of broadband availability where, for the vast proportion of consumers, practical broadband speeds will vary massively between 1 and 24 Mbps (downstream). It is likely that a significant minority of users will see no real improvement in their broadband access speeds during this time. Only a small number of users on new developments will be able to access very

high-speed symmetrical FTTH services equivalent to those being deployed in the US, Japan and France today. Although perhaps sufficient in the short-term, for many consumers and businesses this may not be a tolerable outcome in the long-term.

14 This patchwork market, where speeds will be limited and variable, has the potential to become a significant issue when considering possible future demands for bandwidth. The BSG published a 'Green Paper' in March 2006 suggesting that by 2012 the most bandwidth intensive households will demand capacity that is beyond the capability of existing access infrastructures (downstream, 23 Mbps, upstream, 14 Mbps).

15 There were a large number of sensitivities in these conclusions, some which would reduce the potential demand for bandwidth, such as a lower than expected demand for HD content, and some which would increase it, such as the continued increase in peer-to-peer services. Moreover, consumer propensity to pay a premium for such services was not taken into account. However, even bearing these sensitivities in mind, if these predictions are correct, it would mean that a significant investment in next generation access infrastructures would be needed soon to make such services available ubiquitously across the UK in time to meet demand.

Technology options for next generation broadband and their implications

16 There is a range of technologies capable of delivering next generation broadband. Although wireless technologies will play a part, the move to next generation broadband will require the deployment of optical fibre deeper into the local access network, either to the street cabinet or directly to the customer premises. This will require a huge capital investment. The cost of providing fibre to the home to 90 per cent of UK households has been estimated to be €14bn[3].

The commercial case for investing in next generation broadband is uncertain

17 The commercial challenge is not simply about the scale of the capital costs involved. Digital convergence is transforming the telecommunications sector and the traditional business models that have supported telecoms investment are under challenge from new and diverse competition. Meanwhile, broadband operators are also facing rising operating costs as a result of the rapid growth of network traffic. As a result, there is considerable uncertainty about whether broadband operators can recoup sufficient revenue from the provision of new services to fund their deployment. This situation is exacerbated in the UK where the high penetration of digital TV makes the market for new IPTV services much more challenging.

18 Broadband operators face a challenge in moving customers away from simple flat fee pricing plans, which are in part driving traffic growth. However, they are seeking to innovate around new pricing models tiered around peak rate access speeds, traffic volume and quality. In addition, broadband operators are looking to generate additional revenues through new value added services. While many operators are seeking to do this through vertical integration, they may also seek to negotiate commercial agreements with content owners or content aggregators to provide guaranteed quality of service. Prospects for these business models are also uncertain, however.

19 In order for network operators to invest in the infrastructure needed for new services, business models will need to align the interests of the operators with the upstream content providers by enabling monetisation of usage that imposes costs on providers.

A gap between public and private value of next generation broadband

20 While the public value of next generation broadband for society and the economy as a whole is potentially high, the large scale of investment combined with the significant number of uncertainties surrounding the prospects for recouping that investment, mean that the potential private value available to investors is comparatively weak. This gap between public and private value becomes important when also considering that the current infrastructure, and planned investment in that infrastructure, seem unlikely to be able to support the probable (if not certain) demand for bandwidth in the medium- to long-term. If the UK wishes to be in a position to capitalise on the potential benefits of next generation broadband, and retain its position as a global knowledge economy leader, proactive steps that address this imbalance, and encourage investment, will need to be taken.

21 The evidence base needed to assist in this decision-making process is limited at present. However, over the next two years, the picture is likely to become clearer, as international deployments of next generation broadband accelerate and as demand for high bandwidth becomes more evident as a new wave of bandwidth intensive services come to market. For this reason we believe that there is a limited window of opportunity over the next 12-24 months in which to develop and implement a concerted and innovative approach to policy making and regulation to create the a balance of investment incentives and competition to enable a market led transition to next generation broadband.

Next generation broadband needs a tailored regulatory approach

22 Any new regulatory framework will need to strike the right balance between incentivising efficient investment and ensuring sustainable competition. Given the high capital cost and the high degree of commercial uncertainty and risk, simply extending the current regulatory framework to next generation broadband access would not achieve this balance.

23 Ofcom must ensure that potential efficient investment is not undermined by regulatory uncertainty. While enduring economic bottlenecks may emerge in the long term, we should not assume that any next generation broadband operator will quickly achieve a position of Significant Market Power (SMP). In a converged market, there may be many other partial competitors able to exert influence over the actions of a next generation operator. Market definitions should therefore not be set too narrowly.

24 Given that competition between value added service providers is likely to be intense, there may be commercial incentives that will encourage NGA operators to look for wholesale as well as retail revenues. Even if SMP is identified in some geographic markets, we should be very cautious about whether rate of return regulation should be imposed. Any such obligations could be self-fulfilling as they tend to have a negative indirect effect on the business models of other operators. Behavioural remedies based on functional separation are likely to be more benign.

25 If NGA networks are broadly deployed, the provision of wholesale access should be encouraged, and if necessary required, from all those operating at scale or with the benefit of public sector contributions. If wholesale products are available, then retail markets should not need regulation, especially where innovation in new products and applications which exploit increased bandwidth is to be encouraged from multiple parties.

26 Meanwhile, open access to alternative wayleaves and passive network elements can mitigate a significant amount of the total capital cost of NGA deployment. These should form the basis of any public sector interventions that might be considered appropriate in time.

Government must ensure that the UK is ready to take advantage of the next broadband opportunity

27 Given the critical importance of broadband as the key enabling infrastructure of the knowledge economy, a failure of broadband supply to meet demand could stifle the pace of innovation in the UK economy compared to our global competitors. This risk should be recognised and addressed by government.

28 To a large extent, the potential risk/benefit to the UK economy depends upon how investments in next generation broadband are made and utilised in other countries and the extent to which economic benefits start to emerge from these networks. Government should, therefore, begin to monitor the deployment, use and exploitation of next generation broadband in key leading economies. The evolution of the UK's own communications infrastructure can then be benchmarked against our global competitors.

29 In cooperation with stakeholders, the government should establish a target to ensure that by 2012 the UK remains in the upper quartile of OECD nations in terms of the range of broadband-delivered services to which its people have ready access (*Quality*) and the proportion of the population served by broadband (*Reach*). 'Quality' and 'Reach' should be defined through a basket of metrics, similar to the approach used to define the competitiveness and extensiveness targets set in 2001.

30 There are a number of justifications that can be made for public sector intervention, including the need to address market failure, the need to ensure the equitable distribution of welfare gains and the need to ensure regional competitiveness. However, there is a real risk that poorly targeted interventions could pre-empt the market, distort competition and actually deter or duplicate private investment that might otherwise be made at a later date.

31 Because the UK market for next generation broadband is at a very embryonic stage it is difficult to predict where market failure may emerge. The public sector should therefore forbear from making large-scale interventions to promote NGA deployment at this stage. However, it is likely that public sector interventions will eventually be required to support deployment in low-density areas. Working together with operators and regulators, public sector bodies should explore potential models for targeted, effective and well-timed interventions, which may be more widely applicable in due course.

32 It is also important to address those non-sector specific policy or regulatory issues that can inhibit investment because of their impact on construction and/or operational costs. The issues that have previously been identified by the BSG as inhibitors are non-domestic rating costs, planning rules and provisions related to access to highways, as well as issues such as security, payment systems and consumer trust and confidence.

33 As broadband penetration continues to increase, it is also becoming appropriate to review the definition and funding mechanisms for universal service/ universal access.

Recommendations for next steps

Recommendation 1
– Define the public value of broadband networks

It will take years for a complete evidence base to emerge to assess the full economic and social value of broadband. However, it should be possible now to define a framework to assess the potential public value of broadband, i.e., to identify the factors that should be taken into account when assessing broadband's impact on society and the economy. Once such an approach is agreed, evidence can be added in as it emerges and a more accurate model developed for assessing the public value of broadband. This should be a collaborative initiative involving industry, academics, the DTI and Treasury.

Recommendation 2
– Monitor demand for bandwidth

As a new wave of bandwidth intensive services come online over the next 12-24 months, close attention should be paid to the actual growth in demand for bandwidth by households and businesses both in the UK and internationally. Various approaches could be used to develop data in this area. However, this information should be made publicly available to help inform decision making by stakeholders across the value chain. This should be coordinated by Ofcom.

Recommendation 3
– Set a benchmarked target for 2012

The UK must have a communications infrastructure that enables it to compete and prosper in the global knowledge economy. The government and Ofcom should, therefore, benchmark the UK's communications infrastructure with our global competitors.

Government should establish a target to ensure that by 2012 the UK remains in the upper quartile of OECD nations in terms of the range of broadband delivered services to which its people have ready access (*Quality*) and the proportion of the population served by broadband (*Reach*)[4]. These two aspects of quality and reach should be defined through a basket of metrics, similar to the approach used to define the competitiveness and extensiveness targets in 2001. This work should be undertaken by government, in collaboration with stakeholders, and updates should be published bi-annually.

Recommendation 4
– Explore alternative commercial models to support network investment

Further work should be undertaken by stakeholders to debate and explore alternative commercial models to support network investment. Good solutions need to be found that align the interests of operators with upstream content and service providers and end consumers whilst mitigating concerns about blocking or degrading third party applications and services.

Recommendation 5
– Develop a regulatory framework for next generation broadband

Discussion on the regulatory challenges posed by next generation access (NGA) networks has only just begun in the UK. Ofcom opened up the debate with its discussion document published in November 2006. This document raised a broad range of complex issues, which need to be explored in more detail. Further informal discussions should be undertaken in advance of a full public consultation by Ofcom. However, Ofcom needs to set out the principles of its regulatory approach to NGA within a 12 month time period, if the inhibiting effects of regulatory uncertainty on investment are to be avoided.

Recommendation 6
– Explore options for access to passive infrastructure

As an input into Ofcom's NGA pre-consultation, a more detailed review should be undertaken into the options for access to alternative passive infrastructure in the UK. This work should be taken forward by stakeholders.

Recommendation 7
– Identify models for efficient public sector intervention

While the BSG recommends that the public sector should forbear from intervening to promote NGA deployment at this stage, it is highly likely that public sector support will be required in areas where persistent market failure is most likely. Building on the Best Practice Guide published by the DTI and Ofcom in February 2007, further work should be undertaken to identify and experiment in the development of efficient and effective models for public sector interventions in collaboration with commercial stakeholders, government and the regulator.

Recommendation 8
– Remove non-sector specific regulatory barriers

The deployment of next generation access infrastructure will inevitably require new civil infrastructure and will involve significant new street works across the country. DTI should work together with relevant departments and public sector bodies and the industry to develop streamlined approaches to NGA related street works and planning issues to minimise both the disruption caused and the cost to operators of these works. The government should also review the non-domestic rating applied to optical fibre. The current approach provides a strong financial disincentive to the use of deployed fibre.

Recommendation 9
– Review universal service/universal access

The current universal service directive refers only to functional internet access. However, as the adoption of broadband continues to accelerate, this definition is starting to look outdated. Ofcom's consultation on universal services should address both the definition of universal service and future approaches to funding universal service/ universal access.

1. Introduction

1.1 The UK's burgeoning knowledge economy faces an investment challenge. The rapid diffusion of residential broadband and continued innovation in new online services and applications is driving the consumption of bandwidth and generating staggering growth in internet traffic. If these trends continue many upstream service providers[5], businesses and end users may find, in time, that broadband peak rate access speeds are insufficient to meet their needs. Given the critical importance of broadband as the key enabling infrastructure of the knowledge economy, a failure of broadband supply to meet demand could stifle the pace of innovation in the UK economy compared to our global competitors.

1.2 There is a real concern that the incentives for broadband operators to invest in next generation broadband technologies in the UK are weak, compared to some of our key global competitors. High costs, unproven business models and intense competition for revenues from value added services make it extremely difficult for operators to justify large-scale investments in new access networks. Having let the genie of broadband-enabled disruptive change out of the bottle, we can not simply assume that the broadband value chain, as currently structured and regulated, will deliver the ever greater bandwidth that both upstream service providers and users increasingly expect. The broadband nirvana of fibre to the home currently looks like a pipe dream for all but the few in the UK. At very best, further investment in faster broadband services is likely to lead to a patchwork of availability across the country, with broadband speeds varying significantly depending on location. For many citizens and businesses, this is unlikely to be regarded as a tolerable outcome in the long-term.

1.3 There is much that remains uncertain and unproven about this hypothesis – markets and technologies move quickly. However, following extensive discussions with stakeholders from across the broadband value chain, we believe there is a growing consensus that the provision of next generation broadband presents a difficult and serious challenge and that the implications for the wider UK economy could be significant. This is a critical issue for the UK – one that government must play close attention to.

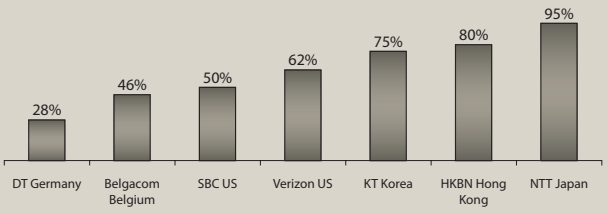
1.4 This is not special pleading on behalf of broadband providers, but a call to policy-makers and regulators, as well as to the commercial participants in the industry, to put significant effort into understanding the dynamics of the market and how their use will bear on UK competitiveness. Although there are no clear or obvious solutions at this stage, there is still time to get this right and we recommend some actions that need to be taken now. A concerted and innovative approach to regulation and policy making will be required to achieve the right balance of investment incentives and competition that will enable a market-led transition to next generation networks.

1.5 We have structured this report as follows: the next three chapters look at the current situation – what is going on worldwide, the evidence already available on the economic and social significance of broadband and the position of broadband in the UK. The following two chapters look into the future – what may happen to demand and supply, and what may happen in terms of technology developments. The final three chapters, prior to the conclusions and recommendations, articulate the challenges for broadband stakeholders: respectively, the commercial players, the regulator and the government.

2. Next Generation Broadband

2.1 Next generation broadband services are now being deployed in a number of countries around the world, including Japan, South Korea, Hong Kong, China, Singapore, Canada, the United States, the Netherlands, Belgium, France, Italy and Germany. In the US ultra-high-speed fibre-based services are now available to more than 6 million residential customers. These new services are capable of delivering much higher upstream and downstream peak rate access speeds to end-users than are currently available in the UK. They can be delivered by a range of technologies but require significant infrastructure upgrades to local access networks. Wide-scale deployment can take many years.

Targets Announced by Select Operators, (% Homes to be Passed with Fibre[a])



Target Year	2007	2006	2007	2008	2010	2008	2010
Target Homes (million)	11	2	16	20	12	1.8	47
Investment Planned	€3bn	€300mn	€3.4bn	€6.7–8bn	N/A	€100mn[b]	€37bn
Technology	FTTN	FTTN	FTTN	FTTH	FTTH	FTTH	FTTH

Figure 1: Planned next generation broadband deployments.
Source: Capgemini

2.2 These large-scale multi-billion dollar investments are being made in anticipation of a new wave of IP-based video-rich services and applications that are expected to drive demand for bandwidth from residential customers. In the most advanced markets, competition between telecoms companies and cable operators to deliver new TV-like entertainment services over these networks is driving investment[6]. However, in most cases, given the high capital costs involved and uncertainty about the underlying commercial business models, significant public sector support and/or policy and regulatory incentives have played a role in accelerating deployment (see Chapter 8).

2.3 In all of the countries listed above, it is argued that the availability of next generation broadband will deliver wider benefits to the economy, by encouraging innovation in new services and applications across the private and public sectors. Evidence of the existence of what economists would call positive externalities has yet to emerge, largely because these networks are only just being built. However, it should be noted that these services are primarily being deployed in high-density areas, with little expectation that they will be made universally available in the immediate future. If wider economic benefits do emerge they may not be distributed equally between urban and rural areas.

2.4 The implications of these international developments for the UK are uncertain. But they suggest that the debate about the need for next generation access is no longer hypothetical. Where operators can find a business case, based on commercial opportunity, commercial threat or policy or regulatory incentives (or a combination of all three) they are building next generation broadband access networks. Governments and regulators are looking to incentivise investments because they believe that next generation broadband will be critical to their competitiveness. However, both the long-term commercial case and the wider economic benefits remain largely unproven, suggesting that for both operators and governments the decision to support next generation broadband deployment involves a leap of faith.

‘This debate is no longer hypothetical. Where operators can find a business case, based on commercial opportunity, commercial threat, or policy and regulatory incentives, they are building next generation broadband access networks.’

3. Why Broadband Matters

'The last twenty-five years in technology have been the warm up act. Now we are going to the main event, by which I mean an era in which technology will literally transform every aspect of business, every aspect of life and every aspect of society.'

Carly Fiorina, quoted in The World is Flat, Thomas L. Friedman[7].

3.1 Broadband is a key underlying infrastructure that enables the global knowledge economy to function. Since the start of this decade, it has accelerated technology diffusion into both residential and business markets and stimulated a huge amount of innovation across the public, private and third sectors. It has transformed the way people live their lives. The following chapter provides a brief overview of some of the social and economic impacts of broadband, in order to demonstrate why the debate around next generation is of crucial importance to the UK.

3.2 This chapter unavoidably leaves one crucial question unanswered – how important, economically, socially, culturally, are the increments in speed of communications associated with next generation broadband? The underlying assumption in this document is that just as progressing from narrowband to broadband has substantial economic and other benefits, the progression to next generation broadband will have equal, if not even greater, economic implications. This assumption needs to be tested and its nuances articulated and this need underpins the recommendations at the end of the report, which address the requirement to build an evidence base.

3.3 The policy instinct where there is a lack of evidence will be to do nothing. However, if significant efficiency gains are derived from next generation broadband then it is possible that nations that opt for accelerated deployment will gain sustained competitive advantage of nations that do not. Given the very long lead times involved in deploying next generation broadband[8], the risk of action must be weighed against the risk of inaction.

Early forecasts about the economic and social impact of broadband

3.4 A number of reports have been published forecasting the potential social and economic benefits likely to arise from the mass adoption of broadband.

- In 2002 the Momentum Group and Brookings Institution forecast that 'business and government efficiencies from broadband had the potential to produce US$500 billion in savings in the US by 2010'. [9]
- In August 2002 Dataquest forecast that 'true broadband (greater than 10 Mbps) could incrementally increase US GDP by up to US$500 billion for each of the next 10 years.' [10]
- A 2006 MIT study concluded that 'communities in which mass-market broadband was available experienced more rapid growth in (1) employment, (2) the number of businesses overall, and (3) businesses in IT-intensive sectors'.[11]
- A 2007 report for the Scottish Executive concluded that the annual Gross Value Added (GVA) of Scotland's market sector in 2015 would be in the order of £2 billion to £6 billion higher due to business take-up of broadband than it would have been otherwise (at 2000 prices).[12]

Broadband and innovation, competitiveness and globalisation

3.5 Innovation in information and communications technologies has been at the heart of globalisation over the last 15 years.

'Hardware, software and networks were responsible for the economic boom that started in the United States and now reverberates throughout China, India and the rest of what was formerly known as the third world.'

Reed Hunt, former Chairman of the US Federal Communications Commission (FCC) and now a senior advisor at McKinsey & Company[13]

3.6 Broadband has been a key factor in globalisation, enabling knowledge and information to be shared rapidly and at low cost around the globe, changing the way people trade goods and services. Increasing public availability of information has enabled more effective competition and price convergence for traded goods and services. It has also driven the integration of world markets enabling specialisation and fragmentation. The internationalisation of production processes is increasingly feasible and cost effective, for example, enabling a small software company based in Cornwall to exploit international market opportunities and compete globally.[14]

3.7 Broadband is also an accelerator of wider ICT adoption. In a global economy (where there are increasing rewards to innovation), the importance of technology diffusion should not be underestimated. In its 2006 analysis of the long-term opportunities and challenges for the UK, HM Treasury identified rapid innovation and technological diffusion as one of the five key long-term opportunities and challenges facing the UK over the next decade.[15] It is, therefore, important that the public value of broadband networks is fully understood and that close attention is paid to the long-term evolution of the UK's communications infrastructure.

Innovation in ICT intensive sectors

3.8 Broadband makes the internet work more effectively and means that the processing power and storage in PCs can be put to more productive use. That, in turn, means that innovation moves more quickly. Broadband doesn't just speed up video downloads, it speeds up the pace of change across the global economy. It is a catalyst for innovation.

3.9 The pace of innovation in lead sectors such as media and entertainment has increased dramatically over the last five years with the global growth of broadband. We are now seeing an intense wave of innovation that is creating new business models and transforming old ones. Digital convergence across the telecoms, media and technology (TMT) sector is predicted to lead to a trillion dollar shift in value by 2010[16]. Across Europe the ICT sector continues to grow faster than Europe's overall economy, according to the i2010 second annual report. ICT contributed nearly 50% of EU productivity growth between 2000 and 2004, with software and IT services currently the most dynamic growth area (5.9 per cent for 2006-2007)[17].

3.10 Given the UK's end-to-end strengths in the high-tech sector, creative industries and new media, this disruption represents a major economic opportunity for the UK economy. As Intellect, the UK high tech trade association has argued, the UK has an opportunity to capitalise on convergence and become a net global producer of convergence products, services and applications rather than a net consumer[18].

Broadband impact on firm level productivity

3.11 Since its deployment, small- and medium-sized enterprises (SMEs) have been reporting strong benefits associated with broadband adoption. According to Ofcom in 2005 more than 73 per cent of SMEs were using broadband to connect to the internet[19] with 84 per cent believing that broadband offered good value for money.

3.12 According to an Institute of Directors (IoD) survey of its members in 2004, 84 per cent said they had seen improvements in productivity since installing broadband and 61 per cent said it had delivered cost savings. In all, 64 per cent reported a link between broadband and increased profits. According to the IoD:

'Broadband has established itself as an indispensable part of our business infrastructure. It is difficult to think of a comparable recent development in business equipment or techniques that has been so widely identified as a positive factor in terms of business performance.'[20]

3.13 This study was backed up by similar surveys by the British Chamber of Commerce[21] and Intellect[22]. A 2005 MIT study also found support for the conclusion that broadband positively affects economic activity in ways that are consistent with these qualitative surveys. MIT researchers found that communities where mass-market broadband was available experienced more rapid growth in (1) employment, (2) the number of businesses overall and (3) businesses in IT-intensive sectors. In addition it also found higher market rates for rental housing in broadband enabled areas.[23]

3.14 The broader impact of infrastructure is of course conditional on how efficiently it is used[24]. Productivity benefits are derived from process transformation, but technology is the underlying enabler and broadband is one of the most important change agents.

3.15 A study on the impact of broadband on UK firms prepared for the OECD supports this argument. This study showed a strong correlation between broadband adoption, automated business links and an increase in productivity:[25]

- '...average productivity of firms with multiple [automated business] links is higher than for firms without any links. ...firms with one automated business link and broadband are 31 per cent more productive than their counterparts without broadband, and firms with five or more multiple links and broadband are 22 per cent more productive than similar firms without broadband.'
- '...early adopters were indeed more productive by 22 per cent and early adoption strengthened this advantage. Broadband used in conjunction with multiple automated business links also has a favourable impact on labour productivity.'
- '...a 10 per cent increase in broadband-internet enabled workforce raises productivity by up to 12 per cent in IT intensive sectors.'

3.16 Overall, these findings suggest that broadband makes good companies better.

Broadband impact on GDP

3.17 A number of studies examine the impact of broadband at the macro-level, most specifically focusing on GDP and employment effects. In finding that broadband has a positive effect on GDP, these studies support the view that the widespread use of broadband can increase the output of GDP by improving the ability of enterprises and individuals to network, collaborate and innovate together.

3.18 The productive impact also depends upon its integration into an existing set of infrastructures, i.e. how it improves the network[26]. In the case of broadband access, it enables greater exploitation of both the capacity and capability of the computer equipment in the consumer/business premises (storage and processing power) on the one side and the core network and internet servers, and so on, on the other. In other words, it significantly improves the whole network and indicates that the scale of the potential benefit that can be derived may well be larger than for other infrastructure investments.

3.19 An Indepen case study[27] looking at the consumer surplus associated with broadband penetration found that consumer benefit of broadband for the EU-15 where there was 70 per cent household penetration would create a net present value of €966 billion, equivalent to one per cent of annual contribution to GDP for the EU 15. However, this increased to €1,648 billion, equivalent to 1.6 per cent GDP, with a penetration rate of 90 per cent, suggesting that the consumer surplus increases with penetration on more than a proportional basis due to strong network effects. The extent to which these benefits are triggered by the forms of broadband access currently provided and the extent to which they represent further gains dependent on faster rates of access is currently unclear.

Inward investment and greater dispersion of economic activity

3.20 Regions with abundant infrastructure can be more attractive to inward investment, thereby enhancing their competitiveness. Attractiveness is a factor, irrespective of whether the infrastructure leads to clear productivity gains. There are also examples, particularly in the US, of higher property prices being well served by broadband.

Efficient and effective public services

3.21 Across the world, governments are seeking to exploit the full potential of broadband-enabled ICT to improve the quality of their public services while also driving down the cost of delivery. This will enable them to either plough the savings back into the public sector to deliver even better outcomes in terms of health and education, for example, or to reduce the tax base to increase the competitiveness of their economies. As noted above, there are many examples of private sector companies transforming their competitiveness through the full exploitation of ICT. There is no fundamental reason why governments cannot do the same.

3.22 One example of the potential positive impact of broadband on public sector services is telehealth. In 2004 a PriceWaterhouseCoopers study looked at differences in costs of providing outpatient pulmonary care to a rural population. The study compared the costs of patient referral to a specialist clinic; telemedicine where patients connected via teleconference with the specialist clinic; and the use of onsite care at a local physician. Over a single year, the study found that telemedicine was the most cost effective option ($335 per patient) compared with patient referral ($585 per patient) and on-site care ($1166 per patient).[28]

‘Broadband is a key underlying infrastructure that enables the global knowledge economy to function… It has transformed the way people live their lives.’

'Given the very long lead times involved in deploying next generation broadband, the risk of action must be weighed against the risk of inaction.'

Social capital

3.23 The value of infrastructure as a contributor to higher living standards and quality of life is likely to be very high given that households and private individuals are heavy users of communications services. Consumers should benefit from more choice and lower prices. New media and communications services will bring the potential for social as well as consumer value. Networks generate inclusion and social capital[29].

3.24 Technology influences how people live their lives and lifestyles. In a 2003 study, Intellect found that 98 per cent of SMEs reported that broadband had a beneficial effect on staff satisfaction, 'giving staff the tools to do their job properly'. It also allowed employees to work remotely and enabled them to achieve a better work-life balance[30].

Conclusions

3.25 At the start of the decade, many predictions were made about the potential social and economic impact of broadband. Following the widespread and rapid adoption of broadband worldwide, there is a now growing body of evidence that supports many of these claims.

3.26 There is evidence that broadband has been a driver of globalisation and widespread innovation at many levels of the economy. Broadband has been shown to have a measurable impact on firm-level productivity and on GDP. The widespread diffusion of broadband, if harnessed effectively, can be a key enabler for the transformation of public services and can generate inclusion and social capital.

3.27 Electronic communications networks have become an essential input into business and society. It is difficult to imagine how the economy would function without them. As users exploit these networks to innovate on an almost constant basis, it is clear that businesses, public services, consumers and citizens are becoming ever more dependent upon these networks on a daily basis.

3.28 The importance of broadband was summed up by Thomas Friedman in The *World is Flat: the Globalized World in the Twenty-First Century*:

'Broadband and information technologies are important…because they are critical to advancing productivity and innovation in every sector of the economy. The more you connect an educated population to the flat-world platform, in an easy and affordable way, the more things they can automate, and therefore the more time and energy they have to innovate. The more they innovate, the more they produce things that improve the platform. It is a virtuous cycle, one that you always want to encourage to the greatest degree possible.'

3.29 This is why Friedman argues, 'the smartest countries and cities in the world are offering their residents not just the fastest broadband, but at the lowest prices to the widest areas.'[31]

3.30 Taking a similar line, Reed Hunt argues that governments have a responsibility to ensure that their citizens do not come off worst in the competitive battle between countries, and that government and regulators have an important role to help create an environment that supports and enables efficient investment in the creation of high-quality, modern and efficient broadband networks.[32]

3.31 If significant efficiency gains are derived from next generation broadband then it is possible that nations that opt for accelerated deployment will gain sustained competitive advantage over nations that do not. Given the very long lead times involved in deploying next generation broadband, the risk of action must be weighed against the risk of inaction.

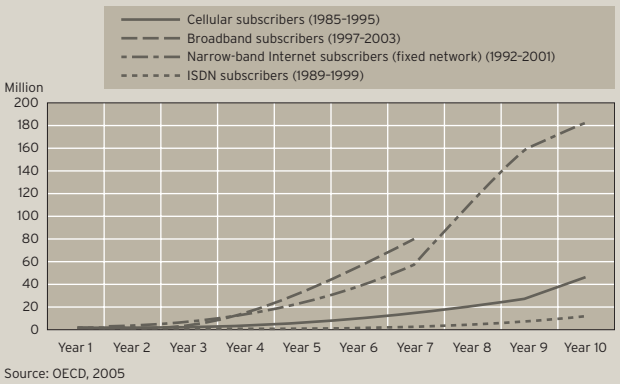
4. The UK Broadband Market 2001 to 2006

4.1 After a slow start, the UK broadband market has exceeded even the most bullish predictions. Since 2001, broadband adoption has grown from a few thousand subscribers to more than 13 million. This represents around 50 per cent of UK's 24.4 million households, and it is estimated that 30 million people now have access to broadband from home[33].

4.2 The UK leads the G7 in terms of the availability of first generation broadband with 99.6 per cent of homes connected to an ADSL-enabled exchange[34]. BT had achieved 10 million wholesale broadband lines by the end of 2006 (beating its own growth estimates) and Virgin Media had reached over 3 million (with a footprint covering about 50 per cent of UK homes). In addition, alternative network providers (altnets) are now offering a wide range of competing broadband services based on wholesale products provided by BT Openreach, including 1.5 million connections based on Local Loop Unbundling (LLU).

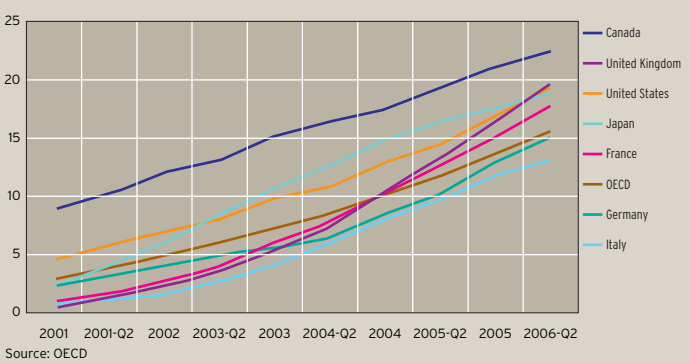
4.3 Worldwide, the pace of broadband adoption has been phenomenal: broadband take up has continued to outstrip other communications services and the trend is expected to continue[35]. See Figure 2 (below)

4.4 In terms of broadband penetration, the UK is currently ranked tenth in the OECD and second in the G7. The UK has experienced one of the highest sustained growth rates in broadband adoption in the G7 since 2004[36]. See Figure 3 (below)



Source: OECD, 2005

Figure 2: Broadband take-up compared with other communications services.
Source: OECD



Source: OECD

Figure 3: G7 Broadband adoption, June 2006.
Source: OECD

4.5 Falling prices, driven by strong retail and wholesale competition, have helped to stimulate high levels of take up with some service providers bundling broadband access for free together with other telephony or television packages (the implications of which are discussed in Chapter 7). See Figure 4 (below)

4.6 Generally, customers currently report a high level of satisfaction with the cost, value for money, speed and reliability of their internet services. See Figure 5 (below)

4.7 In its first report in 2001, the BSG argued that broadband deployment would stimulate a 'virtuous circle', where industry innovation drives user adoption and market growth. The virtuous circle is evident in the scope and scale of investments now being made in new and innovative broadband enabled online services and applications. See Figure 6 (below)

4.8 This virtuous circle has led to a massive increase in internet traffic over the last few years. According to the London Internet Exchange (LINX) the volume of internet traffic is now growing 50 per cent year-over-year. Today, LINX handles more than 116 gigabits of traffic per second. This growth is likely to continue to increase as new video rich entertainment services come online over the next 12-18 months. See Figure 7 (below)

4.9 However, while total traffic growth is growing rapidly, the vast majority of users still do not use the headline bandwidth that they have available. Average use is still quite low (e.g. around 10-15 per cent of the headline rate), although this is expected to increase over the next 18 months as new video rich services are launched (see Chapter 7). These new services are likely to generate very short and intense bursts of demand for bandwidth, making the peak access rate more important.

Planned evolution

4.10 As demand for bandwidth continues to increase, driven by the availability of new innovative content, services and applications, broadband operators will continue to invest in the current generation of broadband access technologies.

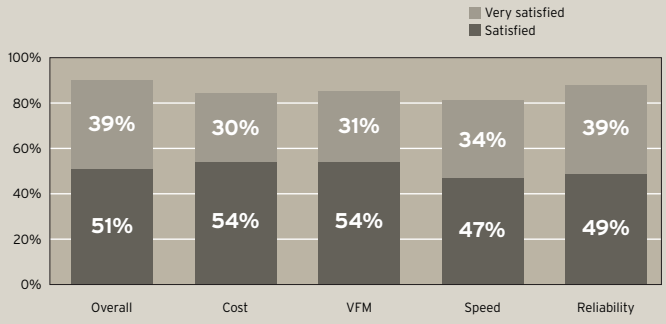
4.11 Several LLU operators are already deploying ADSL2+ technology in local exchanges and will be able to deliver peak rate access speeds of up to 24 Mbps downstream and 1 Mbps upstream to residential customers. BT has also announced that it will start nationwide deployment of ADSL2+ in 2008 and will complete deployment in 2011.

4.12 However, ADSL2+ performance diminishes over distance, meaning that only a small number of customers living very close to their telephone exchange will be able to access these headline speeds. BT estimates that 50 per cent of users will be able to get 8 Mbps or more, with the majority receiving between 8-12 Mbps downstream. See FIgure 8 (below)

ISP	Coverage	Conditions	Contract	Downstream line rate (up to)	Usage cap	Standard monthly rental (incl. VAT)
BSkyB	LLU areas Non LLU areas	Must be an existing BSkyB customer (from £15/month)	12 months	2 Mbit/s 8 Mbit/s 16 Mbit/s 8 Mbit/s	2Gb 40Gb - 40Gb	Free £5.00 £10.00 £17.00
CPW	LLU areas Non LLU areas	Must also take calls and line rental (£19.99/month)	18 months	8 Mbit/s 8 Mbit/s	40Gb 40Gb	Free £10.00
Orange	National	18 month mobile contract >£30	18 months	8 Mbit/s	2Gb	Free
		None	12 months	1 Mbit/s 8 Mbit/s 8 Mbit/s	2Gb 2Gb -	£14.99 £17.99 £27.99
Tiscali	National	None	12 months	2 Mbit/s 8 Mbit/s	- -	£14.99 £17.99
Virgin.net	National	None	None	1 Mbit/s 8 Mbit/s 8 Mbit/s	3Gb 6Gb -	£14.99 £17.99 £24.99
Pipex	National	None	12 months	8 Mbit/s	15Gb -	£19.99 £24.99
AOL	National	None	12 months	1 Mbit/s 2 Mbit/s 8 Mbit/s	- - -	£14.99 £24.99 £29.99
BT	National	None	12 months	8 Mbit/s	6Gb 40GB	£22.99 £26.99
NTL	50% UK homes	None	12 months	2 Mbit/s 4 Mbit/s 10 Mbit/s	- - -	£17.99 £24.99 £34.99

[Source: Enders Analysis based on company websites]

Figure 4: Residential broadband offers from major players ranked by price, October 2006. Source: Enders Analysis



Source: Ofcom research, Q1 2006

Figure 5: Customer satisfaction with aspects of the internet. Source: Ofcom

4.13 BT has also announced that it will start to deploy FTTH, capable of delivering 100 Mbps+ in a limited number of green field housing developments in 2008[38]. Virgin Media is also trialling 20-50 Mbps+ services using DOCSIS 2 technology on its Hybrid Fibre Coax (HFC) network. It is also looking at the potential of deploying DOCSIS 3.0 in the future. However, it has not yet made any public commitments to deploy these technologies on a wide scale or to extend the reach of its fibre based network reach beyond the current footprint.

4.14 Further investment over the next five years in faster broadband services is unlikely to change this patchwork of availability across the UK. Unless BT accelerates the deployment of fibre or Virgin Media accelerates the deployment of DOCSIS 3.0, broadband speeds available to most residential consumers will vary between 1 and 24 Mbps, depending on location, and these will be predominantly asymmetric. Only a very small minority of users on new housing developments will be able to access very high-speed symmetrical services (100 Mbps +).

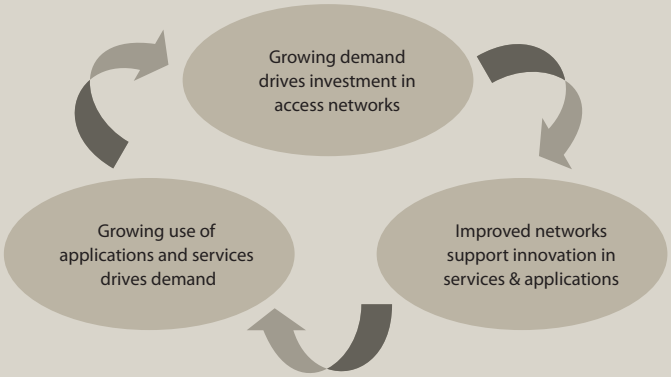


Figure 6: The broadband 'virtuous circle'.
Source: Broadband Stakeholder Group

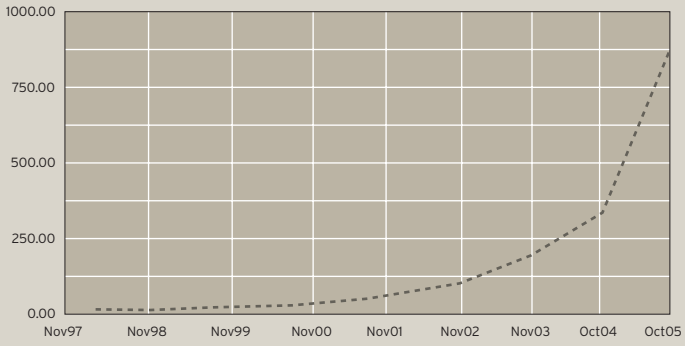


Figure 7: Aggregated traffic volume on the AMS-IX platform doubled in 10 months between November 2004 and September 2005. AMS-IX Annual Report 2005[37]

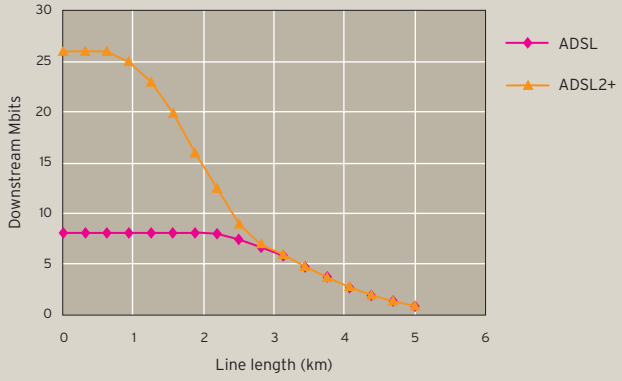


Figure 8: Maximum downstream speed of ADSL and ADSL 2+ by line length.
Source: Analysys

5. Predicting Demand for Next Generation Broadband

5.1 Making predictions about the demand and uptake for any new technology is fraught with difficulty and predicting demand for bandwidth is particularly challenging. Future demand will be dependent upon a range of variables, some of which we know and can predict, others that we know but cannot predict, and some that we simply do not know. As a result, views vary about the level of bandwidth that customers will require in the future.

5.2 Prior to the start of this review, the BSG undertook its own analysis of potential demand and published a 'Green Paper' in March 2006[39] which considered eleven different household types and their possible consumption of bandwidth in both 2008 and 2012, assuming an unconstrained availability of bandwidth at affordable cost[40]. The analysis did not attempt to make a commercial case for deploying such services or estimate the value to the UK economy of such services being available.

5.3 The headline results, shown in the figure below, were that:

- By 2008, the bandwidth demand for the most bandwidth intensive households could reach 18 Mbps downstream and 3 Mbps upstream.
- By 2012, the bandwidth demand for the most bandwidth intensive households could reach 23 Mbps downstream and 14 Mbps upstream.

5.4 These conclusions are significant, because they suggest a level of demand by 2012 from the most bandwidth intensive households for both upstream and downstream capacity that is beyond the capability of existing access infrastructures. It would require significant investment in next generation access to make such services available ubiquitously across the UK.

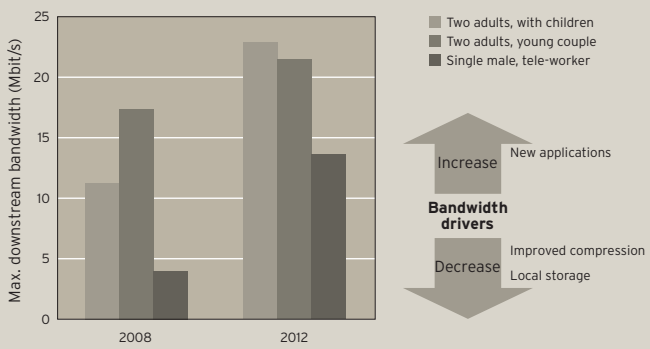


Figure 9: Maximum downstream requirements (three most bandwidth intensive households)
Source: BSG/Analysys

Key sensitivities

5.5 Since future bandwidth demand will be dominated by applications and services built on video flows and large file transfers, these findings are particularly sensitive to the assumptions made about the introduction of high definition (HD) video and consumer tolerance of delay in download times. There are a number of mitigating factors that could significantly reduce the bandwidth required to deliver these applications and services, such as:

- Non-time critical applications could be delivered more slowly, which could significantly reduce upstream bandwidth requirements.
- Advances in compression technology could lower the video bandwidth requirements.
- Improved streaming technologies and content distribution networks may emerge that enable more efficient content distribution.
- The use of HD video flows might develop more slowly than was assumed.
- The development of hybrid solutions exploiting local storage and intelligent personal video recorders (PVRs) could temper the downstream time critical peak bandwidth requirements of some entertainment services.
- There may be lower than expected demand for HD content.

5.6 However, there are a number of other factors that could further increase bandwidth requirements:

- Innovation is likely to lead to the emergence of new unforeseen services that could increase the requirement for concurrent flows.
- The development of user-generated content and peer-to-peer services and distributed business applications is likely to increase demand for upstream as well as downstream bandwidth.

Consultation on the Green Paper

5.7 The analysis presented in the Green Paper was widely discussed with stakeholders during the consultation on this report. While recognising the difficulties in predicting both consumer behaviour and the course of technological innovation, many respondents thought that the conclusions reached in the Green Paper appeared realistic, at least for the most demanding of households in the short- to medium-term.

5.8 In summary, we believe that demand for bandwidth will continue to increase as suggested in the Green Paper, driven by the development of new innovative content, services and applications and the much more extensive, and sometimes simultaneous, use of these of the services by households. We believe there is likely to be significant demand, from many households across the UK, for broadband services in excess of 20 Mbps downstream in the medium-term.

5.9 This does not mean that all households will immediately take up such services, nor does it mean that households will be willing to pay a significant price premium for next generation broadband. But, before NGA investment to meet such demands can be justified, operators need to know how many households will form the most bandwidth-intensive sector, and how many of those would be willing to pay a price premium for fast access. These are at present unknowns, making it difficult for operators to determine how extensive a network may be required, or to construct a business case for that deployment.

Recent developments in IPTV

5.10 There is currently a huge amount of investment taking place in new broadband enabled IPTV services. Many players from across the telecoms, media and technology (TMT) value chain are looking to bring new IPTV services direct to the consumer's PC and/or TV. Companies investing in this space include content owners, content aggregators, network operators and device manufactures, as well as a plethora of software developers and online retailers. Competition for value added upstream services, such as IPTV, is therefore likely to be intense.

5.11 Network traffic over the internet is already dominated by video traffic, with most of it (estimates suggest up to 80 per cent) being driven by pirated content being exchanged over peer-to-peer sites.

5.12 The availability of HD content has the potential to dramatically increase these traffic volumes. There are reports that encryption on HD-DVD and Blue Ray formats has already been broken and 20 GB video files are starting to appear on the internet. HD content that was previously unavailable can now be copied and sent around the world on the internet for free. The IP Development Network has estimated that the cost for an ISP to deliver two hours of 1080p HD content would be £2.10[41]. High volumes of pirated HD content being exchanged over peer-to-peer networks could impose unsustainable costs on ISPs.

5.13 All of the large UK broadcasters are experimenting with the development of new IPTV platforms, and services such as YouTube are looking to move from video clips to full format content. Many of these IPTV services, including the BBC's iPlayer, Joost and Babelgum, will exploit peer-to-peer architectures for distribution. This will put increasing pressure on the upstream capability of access networks.

5.14 Currently, many investors developing upstream services and applications simply assume that the market will deliver sufficient capacity in the access network to support their services. To a large degree, they are unaware of the commercial and regulatory issues further down the value chain that could hold back the deployment of next generation broadband access in the UK.

6. Next Generation Broadband Technologies

Definitions

6.1 Defining broadband has always been difficult. In 2001, the BSG agreed a 'dynamic' definition of broadband that was technology neutral and focused on the service characteristics required to utilise innovative forms of content, services and applications rather than specific peak rate access speeds:

'Always on access, at work, at home, or on the move provided by a range of fixed line, wireless and satellite technologies to progressively higher bandwidths capable of supporting genuinely new and innovative interactive content, applications and services and the delivery of enhanced public services[42].'

6.2 For the purpose of its Next Generation Access discussion document, Ofcom took a similar approach to developing a general definition of next generation broadband:

'Broadband access services that are capable of delivering sustained bandwidths significantly in excess of those currently widely available using existing local access infrastructures and technologies.' [43]

6.3 We agree that this general definition is probably most appropriate in order to progress the discussion on next generation broadband at this stage. In practice this general definition currently suggests services that are capable of providing in excess of 20 Mbps downstream (which would be sufficient to support services such as multiple HDTV feeds using MPEG4, broadband internet and voice services) as well as faster upstream access capable of supporting an increasing range of peer-to-peer applications and interactive and user generated services.

Technology evolution

6.4 There is a range of technologies capable of delivering next generation broadband. Some are effectively evolutions of existing access infrastructures that have already been deployed (copper and cable), while others would involve the deployment of entirely new physical infrastructures.

Cable (Hybrid Fibre Coax – HFC)

6.5 The cable network owned and operated by Virgin Media, which is available to just over 50% of UK households, is effectively a next generation access network. However, Virgin Media does not yet offer services above 10 Mbps (although it is currently trialling a 50 Mbps service). In the cable network, fibre is deployed to the street cabinet (typically serving around 500 customer premises) and combined coaxial cable and copper pairs are deployed over the last few hundred metres from the cabinet to the customer premises to provide DTV, broadband and fixed telephony services. Cable uses DOCSIS-based technology, the latest version of which (DOCSIS 2.0) is capable of providing 20-50Mbps downstream and potentially up to 30 Mbps upstream. However, the next generation of DOCSIS (version 3.0, which is expected to be commercially available from late in 2008) could offer 220 Mbps downstream and 120 Mbps upstream. Cable services are contended at the street cabinet (i.e. a number of customers will simultaneously share capacity at each cabinet). This will reduce the average peak access rate available to any single customer.

6.6 In order to deploy DOCSIS 3.0, Virgin Media would have to invest in new head-end equipment and upgrade the customer premises equipment (CPE) (customer cable modem/set top box). Although actual costs are not yet clear and are likely to decrease over time, an assumed CPE upgrade cost of between £150-£200 per customer, would involve an investment of around £600 million in CPE costs alone.

6.7 Given that most customers are less than 500 metres from the street cabinet, Virgin Media could also deploy VDSL (see below) from the street cabinet to the customer premises on the copper pair portion of the HFC cable, which could offer 20-50 Mbps symmetrically, and possibly more. As mentioned, above the impact of contention will lower these headline peak access rates in practice.

6.8 While Virgin Media is exploring options to extend its geographic reach, commentators argue that it is more likely to pursue an off net strategy using wholesale products provided by other operators rather than invest in further extending its HFC network. Off net options have the advantage of requiring significantly lower capital investment. However, no announcements have been made in this regard.

Asymmetric Digital Subscriber Line (ADSL and ADSL 2+)

6.9 Most broadband connections in the UK are currently provided using Asymmetric Digital Subscriber Line (ADSL) technology over copper telephone wires. ADSL services are available to 99.6 per cent of UK households, offering a minimum of 512Kbps and a maximum of 8 Mbps depending on copper line length and other factors (see below). ADSL services are asymmetric, meaning that upstream speeds are significantly lower than download speeds.

6.10 Several LLU operators, including Sky (Easynet), Carphone Warehouse and O2 (Be)44 have deployed or are deploying ADSL2+ technology in some exchanges. ADSL2+ can provide up to 24 Mbps subject to line length and other factors. Sky has announced that it is currently deploying LLU in 771 exchanges and is aiming for 70 per centcoverage of the UK by the end of June 2007. Carphone Warehouse, with the recent acquisition of AOL Broadband, is targeting unbundling at 1000 exchanges by May 2007. BT will start to deploy ADSL2+ in 2008 with the service being available to half of UK homes from launch[45], with national deployment to be completed by the end of 2011.

6.11 International experience suggests that, in practice, the maximum line speed achieved over ADSL2+ seems to be about 18-20 Mbps downstream and 800 Kbps upstream. However, only a minority of users will be able to access even these headline speeds as performance on any given copper line depends upon the signal to noise ratio at the end of that line.

6.12 The signal to noise ratio on any given copper line in the access network can vary for a number of reasons:

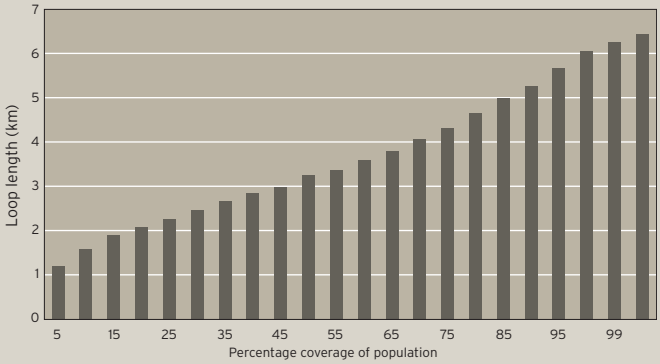
- the length, quality and dimensions of the copper cable
- the amount of crosstalk (directly related to 'cable fill', the proportion of pairs in the cables carrying DSL)
- noise from sources in the home or premises (including home wiring)
- noise picked up from the environment, eg radio frequency interference
- any faults that might be present.

Geographic coverage achieved at a given headline speed also depends on:

- the topology of the access network
- the statistical distribution of line lengths.

6.13 Although it is difficult to predict the other factors that affect the signal to noise ratio, it is possible to estimate broadband performance by line length. According to telecoms consultants, Point Topic, only 5 per cent of end users have local loops of 1200 metres or less, 45 per cent have 3km or less, and 85 per cent are within 5km. The median line length in the UK is estimated to be 3.25 km.

6.14 Drawing from data provided by Point Topic and others[46] it is possible to approximate the percentage of users that will have access to different service levels (bandwidths) from ADSL and ADSL2+.



Source: Point Topic, after BT

Figure 10: Distribution of telephone line (local loop) length in the UK.
Source: Point Topic

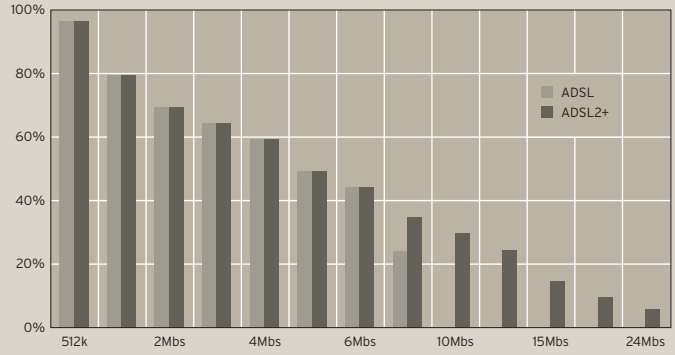


Figure 11: Peak rate access speeds of ADSL and ADSL 2+ available to UK households

6.15 This data suggests that 40 per cent of households will benefit from higher broadband download speeds through the deployment of ADSL2+ (8 Mbps and above). However, only 10 per cent of households would achieve 20 Mbps+. These estimates are close to BT's own estimate that 50 per cent of UK households will be able to access 8 Mbps or more[47].

6.16 As a consequence of the above, there will be an enduring patchwork of performance and availability, subject to line lengths and user density.

6.17 However, ADSL2+, when used in combination with a terrestrial or satellite Digital Television (DTV) receiver and a PVR-type local storage device, does provide an effective solution for providing time-shifted, on-demand, interactive DTV services at a relatively low cost, making it an attractive option for companies wanting to offer new interactive TV-like entertainment services.

6.18 ADSL2+ is still an asymmetric service and, therefore, has limited capability to support high-speed peer-to-peer services and other business applications that require higher upstream performance. None of the manufacturers we have spoken to envisage any further technological innovation that would increase the speed of DSL services over long line lengths.

Fibre to the cabinet (FTTC) and VDSL

6.19 The natural evolution from the existing copper-based local access infrastructure would involve the extension of fibre from the local exchange to the street cabinet and the use of VDSL to connect from there to the customer premises.

6.20 VDSL can provide a significant improvement in bandwidth over short distances. According to the DSL Forum the peak access rate/distance relationship for VDSL is:

- 12 Mbps up to 1500 metres
- 26 Mbps up to 1000 metres
- 52 Mbps up to 300 metres

6.21 DSL achieves these high bit rates by using more effective modulation techniques and better frequency spectrum usage. Further evolutions of the VDSL standard will be able provide even higher speeds over short distances[48]. However, performance drops over longer loop lengths, meaning that the access nodes need to be located in street cabinets or in-building i.e., closer to the customers' premises rather than at the local telephone exchange.

6.22 The deployment of VDSL therefore requires both the deeper deployment of fibre and the provision of new street cabinets that will need to be powered and secure. While FTTC/ VDSL does allow the possibility of competition through sub loop unbundling, the proliferation of street furniture may not be seen as desirable and access to limited space within street cabinets is likely to prove a practical inhibitor to sub loop unbundling.

FTTC and wireless

6.23 An alternative scenario could see an extension of fibre deeper into the access network and then the use of wireless solutions such as Wi-Max (IEEE 802.16) and/or local/municipal Wi-Fi 802.11g or e, rather than copper, to provide the final customer connection. However, this would be dependent upon the availability of appropriate spectrum. For more on wireless, see below.

Fibre to the Home (FTTH)

6.24 The deployment of fibre to the home is regarded as the ultimate next generation broadband solution. FTTH would be a one-off investment that could be exploited for many decades to come. Continued innovation in fibre optic technology means that once an end-to-end fibre connection is in place, the local access layer would no longer be a constraint in the network.

6.25 FTTH is regarded as more secure than other options as it does not require active street cabinets and the long-term operating costs would be lower than for other technology solutions. However, the up front capital costs of deploying fibre would be very significant.

6.26 In its report, 'Very High Speed Broadband: A Case For Intervention', published in January 2007, Enders Analysis[49] estimated that, in comparison to the incremental costs per household of €60 (£45) for ADSL2+, those costs could be around €300 (£250) for FTTC and €1000 (£800) for FTTH. They estimate the cost of deploying FTTH to 90% of UK households to be €14bn. In large part this is due to the extensive civil infrastructure required for its deployment (estimated to be up to 70 per cent of the overall costs). These estimates do not include the additional backhaul or core network costs that would be associated with such investment. This estimate seems reasonable or possibly low given that given the UK cable industry spent over £12bn to deploy the existing HFC networks across 50 per cent the country.

Technology	Incremental cost per household in UK (€)	Cost to deploy to 90% households in UK (€)
ADSL2+	€60	
FTTC	€300	
FTTH	€1000	€14 bn

Figure 12: Predicted deployment costs.
Source: Enders Analysis

6.27 Under current commercial and regulatory conditions and in the face of demand uncertainty, FTTH is therefore probably only commercially justified for new build and very high-density areas at this stage. However, this could change.

FTTH network options

6.28 A number of different network options can be used to deploy FTTH. Current options include: passive optical networks (PONs), Ethernet-based point to multi-point PONS and, ultimately, point-to-point fibre. These options each have advantages and disadvantages for operators but can also have important implications on the options for wholesale and service competition.

PON (Passive Optical Network)

6.29 A passive optical network (PON) is a system that brings optical fibre all or most of the way to the end user. It is a point to multi-point topology typically involving a single strand of fibre from the local exchange to a passive optical splitter in street furniture where its signal is split to, for example, 32 different lines to customers.

6.30 Currently, different PON-based systems are evolving. For example, North America is using Broadband PON (BPON) and GigabitPON (GPON) and, in Japan, an Ethernet-based approach (EPON) is emerging. Typically, GPON can provide significant upstream and downstream bandwidth around 2.5 Gbps for localised sharing providing up to 80 Mbps per user[50].

Ethernet PON

6.31 The Ethernet PON is still a point-to-multipoint architecture, which uses an aggregation Ethernet router located in the street cabinet, compared to PON, which uses a passive splitter at this aggregation point. The final drop can still use copper.

6.32 PONs are often seen as commercially attractive because they require less fibre and no active equipment in outside plant. However, there is still a degree of risk of

contention in future due to the sharing of the single fibre depending on the use by customers beyond the optical splitter.

Point-to-point

6.33 A point-to-point architecture involves a single connection to every customer's premises and is often regarded as representing the most future-proof solution as it can provide virtually unlimited bitrates to users. It also would enable fibre unbundling, which could ultimately be an attractive option for wholesale competition.

Wireless

6.34 There is a great deal of interest in the potential for new wireless technologies to provide alternative solutions for end-to-end next generation broadband access. New broadband wireless access technologies such as WiMax and WiBro are being deployed in a number of different ways to provide higher bandwidth services. However, it is unlikely that these solutions will replicate the performance of the other next generation technologies described above[51]. Much of the commercial interest lies in their potential to provide mobile broadband in high-density urban areas using, for example, the 802.16e standard, rather than as a direct substitute for fixed next generation broadband access.

6.35 Wireless technologies can also be used to provide broadband wireless access in rural areas. They can and are used to provide backhaul solutions, fixed link components in the access network, or wireless access connections to the end user. If WiMax or other solutions are adopted on an international scale, equipment costs will fall, making them more affordable as local access solutions.

6.36 However, there remains considerable uncertainty about whether sufficient appropriate spectrum will be available to support such services. There are a number of factors that could inhibit the availability and/or use of suitable spectrum:

- the timing of the release of spectrum from other uses
- the volume of spectrum needed to provide very high bandwidth data rates in local areas, or even for backhaul where fixed network capacity might not be available
- the suitability of the frequency band for access solutions (depending upon radio propagation characteristics)
- the impact of regulation applied to the spectrum, which could make it unsuitable for some high-value content types.

Mobile

6.37 Mobile networks will also deliver faster peak rate access speeds. 3G using WCDMA will be able to offer 2-2.4 Mbps (although this could average out at 400-500Kbps due to contention between users on the network at any time). Beyond this, 3G using HSDPA will offer 4-14 Mbps but average out at 1-2 Mbps and 3.5G and Super 3G will offer up to 100 Mbps but average out at 20 Mbps.

6.38 Manufacturers and operators are currently working on the Long Term Evolution (LTE) for mobile, which could lead to the development of much faster mobile services. However, these are not expected to reach the market before the middle of the next decade, at the earliest. To deliver higher bandwidths using LTE would require additional spectrum (for example, 100 Mbps would require 2x20MHz compared to 2x5MHz for WCDMA today). LTE is not, therefore, expected to compete as a complete substitute for fixed next generation broadband.

6.39 However, the long-term evolution of mobile services could increase the mobile operators' needs for fixed infrastructure deeper into local areas. Mobile operators could therefore benefit from the availability of wholesale next generation access products, if they were available, to provide base station backhaul.

Satellite

6.40 Although satellite is used primarily as a platform for delivery of broadcast services (e.g. from BSkyB), which can be used in conjunction with a terrestrial return path to provide interactivity, satellite providers, such as Astra, also provide two-way products that allow broadband services to be provided to individual users. These are of particular relevance where first generation terrestrial ADSL or cable services are unavailable. However, current products tend to be relatively narrow band[52].

6.41 Satellite services have relatively high latency (a delay in signal transmission) compared with other terrestrial solutions, which can be problematic for some applications. They are also likely to remain relatively expensive compared to the existing terrestrial current generation broadband alternatives above. Satellite is, therefore, likely to remain an important in-fill solution for locations that terrestrial solutions cannot serve and is unlikely to provide an end-to-end solution for next generation broadband.

Other technology solutions

6.42 In parallel with the development of the above access network options, network operators and service providers are using other solutions to improve performance and manage bandwidth demands, such as localised caching and traffic load management including bandwidth caps. Such technologies could mitigate the need for network upgrades in the short-to medium-term. (The implications of this are discussed in chapter 5).

Practical barriers

6.43 All access networks require some degree of passive/civil infrastructure. This is the most significant element of capital investment and the least replicable part of an access network. There may be various ways of reducing this barrier, by:

- making better use of existing passive infrastructures wherever practicable, recognising the difficulties associated with duct sharing, although these will vary on a case-by-case basis and are being actively addressed in other countries, such as France.
- considering whether new passive infrastructures should/could be provided on a 'multiple-user' basis so that infrastructure competition can be provided without replicating all network elements.
- considering funding options for such infrastructures, for example whether public sector funds could be directed towards this area (in the form of public/private partnerships) rather than towards complete networks, although each case should also be considered on its merits.
- considering whether alternative ducting approaches could reduce costs. For example, could the £100,000/km cost which has been quoted to us as a typical figure be reduced to, say, £30,000/km with micro-ducting approach.
- considering how other issues, such as transport and non-domestic rating regulations, could be eased to limit the cost of provision of these infrastructures.

Conclusions

6.44 As demand for bandwidth continues to increase, driven by the availability of new innovative content, services and applications, broadband operators will continue to invest in new broadband access technologies. Several LLU operators are already deploying ADSL2+ technology in local exchanges and will be able to deliver peak rate access speeds up to 24 Mbps downstream and 1 Mbps upstream to residential customers. BT has also announced that it will start nationwide deployment of ADSL2+ in 2008 and will complete deployment in 2011. However, ADSL2+ performance decreases over distance, only a small number of customers living very close to their telephone exchange will be able to access these headline speeds. BT estimates that 50 per cent of users will be able to get 8 Mbps or more, with the majority receiving between 8-12Mbps downstream.

6.45 BT has also announced that it will start to deploy FTTH, capable of delivering 100 Mbps+ in a limited number of green field housing developments in 2008. Virgin Media is also trialling a number of upgrade technologies, including DOCSIS 2 which could deliver 20-50 Mbps+. However, it has not yet made any commitments to deploy these technologies.

6.46 Despite continued innovation and investment in new fixed and mobile wireless technologies, they are not expected to provide end-to-end substitutes for 'last mile' next generation broadband due to spectrum constraints. However, new wireless technologies may be incorporated into mixed technology solutions where the final connection is provided wirelessly to the end-user over a very short distance.

6.47 Further planned investment over the next five years in faster broadband services is therefore likely to lead to a patchwork of availability across the UK. Unless BT or another operator accelerates the deployment of fibre or Virgin Media accelerates the deployment of DOCSIS 3.0, broadband speeds available to most residential consumers will vary between 1 and 24 Mbps, depending on location. It is likely that only a very small minority of users, on new developments will be able to access very high speed symmetrical services (100 Mbps+).

6.48 There is a range of technologies capable of delivering next generation broadband. Although wireless technologies will play a part, next generation broadband will require the deployment of optical fibre deeper into the local access network, either to the street cabinet or directly to the customer premises. This will require a huge capital investment. The cost of providing fibre to the home to 90 per cent of UK households has been estimated to be some €14bn.

'Further planned investment over the next five years in faster broadband services is therefore likely to lead to a patchwork of availability across the UK.'

7. Commercial Challenges

7.1 While the move to next generation broadband may, in some ways, appear a natural evolution of the fixed broadband market, it is in fact a much more complex and challenging transition dependent upon a broad range of commercial factors, market conditions and regulatory decisions.

7.2 The traditional business models that have sustained telecommunications services (voice minutes) and commercial free-to-air television (advertising) are coming under increasing pressure as broadband enables new competitors to launch innovative services, such as voice and TV over the internet. The telecoms, media and technology (TMT) sector is converging around a similar set of services and applications. This means that an increasing range of companies are now competing for revenue, including established broadband operators, altnets, mobile operators, broadcasters, virtual network operators, new media companies, online retailers, and new wireless entrants. The business case for next generation access therefore depends upon the structure and conditions in all of these related sectors.

The broadband incentive problem

7.3 Increased competition is not the only problem that broadband operators face. A 2005 White Paper[53] published by the MIT Communications Futures Programme argued that broadband faces a crisis. Today's prevailing business models, they argued, give wired and wireless broadband operators little incentive to invest in the new network upgrades necessary to support new innovative high-bandwidth uses of the internet.

User behaviour is changing

7.4 While popular flat fee pricing models have encouraged penetration, they have also led innovative users to adopt bandwidth-intensive behaviours that impose additional costs on network operators. As broadband diffuses in the market place, a growing number of users can be expected to exploit the capabilities offered by high peak rates. Some do this occasionally but others are now doing it routinely[54].

7.5 These structural and behavioural changes suggest that broadband traffic is different from narrowband traffic in several ways:

- The dispersion among users will be greater as penetration increases and the customer base comes to reflect the diversity of the general population.
- Convenience of always-on and the availability of usage intensive applications causes average traffic per user to increase.

7.6 These changes are more than hypothetical. In the most mature broadband markets, the mean traffic per user is rising rapidly and aggregate network traffic continues to increase, even when subscriber growth slows as the market moves toward saturation point.

Increasing broadband traffic raises operators' costs

7.7 The cost of increased usage can take the form of operational or capital expenses. Additional capital expenses are required when design limits are reached in the network components that the access provider owns, such as in the internal access and aggregation network.

7.8 Operational expenses arise when access providers lease capacity from others, such as for the communication links for backhaul transit. Increased usage can also raise operation expenses under other forms of operator interconnection. The rapid adoption of new applications that change the balance of the traffic flow, such as peer-to-peer video applications, can create operational expenses where none were expected.

Current broadband revenue models

7.9 All broadband operators derive revenues directly from the provision of network access to customers (although these charges are sometimes bundled into a wider package of services). Some also derive revenues in other ways, including directly from the customer for other value-added services, or indirectly from other players in the value chain.

Access-based revenues

7.10 Flat fee pricing is currently the dominant industry model. Customers are given a choice of different recurring fees. Prices are usually differentiated on the basis of the peak access bit rate, overall monthly traffic volume or both. However, volume-based price tiers are not common. Where they do exist they are nominal and actual enforcement can be quite variable[55].

Non-access-based revenues

7.11 Non-access-based revenues come in many forms, although there are two that are seen as critical to the broadband incentive problem: vertical integration into value-added services (VAS) and payments from third party affiliates.

- Value added services could include Voice over IP, additional security and support services or IPTV type entertainment services.
- Third party affiliate payments can take various forms, including revenue share in return for promotion of an upstream service or application or where operators offer content providers different levels of quality of service to deliver their applications to consumers.

Challenges for current revenue models

7.12 The simplicity and predictability of flat fee pricing makes it very appealing to customers, which is particularly important at the early stage of market development when penetration levels are increasing rapidly. However, this 'all you can eat' model is likely to prove problematic in the long term, as a small minority of bandwidth intensive users can cause aggregate usage to keep rising even as penetration rates and corresponding revenues flatten out. As bandwidth intensive behaviours and applications diffuse further into the customer base, this problem will get worse. If broadband operators are not able to move away from flat rate pricing, they are likely to be motivated to limit rather than encourage many innovative uses of the network through traffic shaping techniques.

Can broadband operators move away from flat rate pricing?

7.13 As the broadband user base becomes more diverse, one-size-fits-all pricing may become less desirable and more difficult to sustain. Broadband providers are increasingly using price to shape user behaviour as a solution to the problem of rising usage costs. Applied correctly, these more sophisticated pricing approaches should allow willing users to pay more for traffic that costs more, thus generating revenues needed for ongoing operator investments in network capacity. There are a number of possible pricing structures.

Pricing tiered by peak rates:

- Where next generation broadband services have been deployed around the world alongside first generation broadband services, there is not much evidence to suggest that operators have been able to achieve a significant price premium for the higher peak rate services[56].
- Peak rate tiers are not actually a very good proxy for the costs imposed by user traffic. In particular they do not protect broadband operators from high volume users. This problem will become worse as broadband speeds increase. Peak rate tiering exposes operators to risk from heavy users since, as capacity expands, such users are capable of sending ever larger volumes of traffic. This increased risk creates a disincentive for providers to make their access networks capable of much higher peak rates.

Pricing tiered by traffic volume:

- Access pricing schemes that differentiate price tiers based on the monthly volume of traffic are becoming more common. Since the volume of traffic is more closely related to the providers' costs, volume tiered pricing has the potential to better align user and provider incentives. However, the number of bytes sent and received by a digital communications application is largely invisible to, and beyond the control, of users. Fees based on actual usage could therefore create a disincentive for users to use and explore new innovative services.

Pricing tiered by quality:

- Operators may also be able to price their products on the basis of quality differentiators other than speed. However, possible differentiators, such as contention ratios, tend to be highly technical and are not currently easily understood by consumers.

7.14 However, despite the existence of these pricing structures, consumers still find the simplicity and predictability of flat rate very attractive and intense competition between broadband service providers makes it difficult for operators to unilaterally move away from this approach.

Recovering usage costs from non-access-based revenues

7.15 The two sources of non-access-based revenues most commonly cited are vertical integration and payments from third-party affiliates.

Vertical Integration

7.16 Operators hope to be able to capture additional revenues by vertically integrating into the provision of value added services and to use these revenues to offset any additional costs imposed by growing broadband traffic.

7.17 Vertical integration can bring a number of benefits to operators, including economies of scope, where retailing costs are shared across a number of products and services. Vertical integration can also help broadband operators expand their market reach and differentiate themselves. There is evidence in the mobile and pay TV markets of companies successfully raising ARPU through vertical integration. Service bundling can also help to reduce customer churn. However, successful vertical integration also requires significant investment in content acquisition and brand development, suggesting that scale will be critical to any vertical integration strategy.

7.18 In addition, vertically integrated operators will face significant market competition for value added services. Broadband operators have to compete with other providers of 'over the top' broadband-enabled value added services, such as third party VOIP providers, broadcasters and content aggregators, as well as other platforms such as free-to-air terrestrial and satellite DTV services. 77 per cent of UK homes have some form of digital television. 3 million digital cable, 7.9 million satellite, 8.5 million Freeview[57]. This competition will constrain the broadband operators' ability to price their VAS and limit the potential revenues available to offset bandwidth costs.

Payments from third party affiliates

7.18 Broadband operators may seek to negotiate commercial agreements with content owners or content aggregators to provide guaranteed quality of service. Concerns about the implications of traffic prioritisation have led to calls for regulatory intervention in the US to ensure so called 'net neutrality'. Revenues from third party affiliates may be limited by actual or threatened legal or regulatory interventions if it is evident that operators have rational incentives to block or degrade third party applications or services[58].

7.19 However, the very different market conditions in the UK mean that the debate about these issues has been much less polarised. Many commercial players across the value chain recognise that traffic prioritisation could enable the delivery of differentiated higher quality services to end consumers. If such agreements are offered on open, non-discriminatory terms, transparent to consumers and if effective service migration (switching) agreements are in place to protect consumers, it may be that many of the perceived concerns about traffic prioritisation could be mitigated. Whatever the sector specific regulation, operators are likely to find themselves constrained to some extent by competition law in this regard.

7.20 Another potential disadvantage is that many bandwidth intensive applications currently have no revenue generating potential. Peer-to-peer applications that are bandwidth intensive, such as BitTorrent or podcasting, have no potential for cost recovery by the broadband operator. With no way to recover the costs imposed by bandwidth-intensive applications of this sort, providers will have every incentive to block the development and use of such applications, despite their obvious value to users and innovators upstream[59].

Engineering solutions to reduce traffic costs

7.21 Economies of scale and price reductions over time resulting from technical innovation, will reduce the cost of delivering individual bits of traffic. However, evidence suggests that the rate of decline in costs is likely to be outstripped by the rise in traffic volumes.

7.22 Local caching and mirroring techniques can also be employed to use existing network capacity more efficiently by moving 'commonly accessed' content closer to the user. However, trends towards increased personalisation and customisation, such as ad-insertion and videoconferencing, may limit the potential of technical solutions to offset the overall impact of non-revenue generating traffic growth. Cutting costs is likely to be part of the solution to the incentive problem, but is unlikely to be enough in itself.

Conclusion

7.23 The 'all you can eat' pricing models that are common today create incentives for providers to limit broadband usage growth rather than invest to support it. These incentives, while rational for broadband operators, are likely to be damaging for users and other upstream value-chain participants, as they will break the broadband virtuous circle.

7.24 In order for operators to have more confidence in their ability to recoup investment, business models need to align interests across the value chain by enabling monetization of usage that imposes costs on providers. Solutions that achieve this alignment will produce the revenues necessary to support ongoing operator investments, enabling innovation and growth to continue in all parts of the value chain.

7.25 While the public value of next generation broadband for society and the economy as a whole is potentially high, the large scale of investment combined with the significant number of uncertainties surrounding the prospects for recouping that investment, mean that the potential private value available to investors is comparatively low.

7.26 This gap between public and private value is important given that the current infrastructure, and planned investment in that infrastructure, seem unlikely to be able to support the probable demand for bandwidth in the medium- to long-term. If the UK wishes to be in the position to be able to capitalise on the potential benefits of next generation broadband, and retain its position as a global knowledge economy leader, steps will need to be taken to address this imbalance which accelerate private investment.

7.27 The evidence base needed to assist in this decision-making process is limited at present. However, over the next two years, the picture is likely to become clearer, as international deployments of next generation broadband accelerate and as demand for high bandwidth becomes more evident as a new wave of bandwidth intensive services come to market. For this reason, we believe that there is a limited window of opportunity over the next 12-24 months in which to develop and implement a concerted and innovative approach to regulation and policy making to create the right balance of investment incentives and competition that will enable a market led transition to next generation broadband.

8. Regulatory Challenges

8.1 It is not yet clear how next generation broadband services should be regulated. A number of initial regulatory approaches have been taken to enable the deployment of next generation broadband access networks across the world, which have sought to strike a balance between incentivising efficient investment and ensuring effective competition.

Deregulation

8.2 The most developed next generation broadband markets tend to be those where, as a result of legacy regulation and investment, there is a high degree of competition for high speed broadband access from cable. In several such markets, recognising the need to incentivise investment, regulators have decided that the existence of platform competition enables them to take a laissez-faire approach to the regulation of new access networks, thus increasing the incentive for incumbent operators to invest in NGA deployment. Examples of countries taking a deregulatory approach include the US, Canada and Hong Kong.

8.3 In the US, investments in local access fibre infrastructures are completely exempt from regulation and obligations requiring incumbents to grant competitors access to existing copper infrastructure have been largely reduced. This decision by the FCC was justified by the existence of extensive competition from cable; a belief that the negative consequences of regulation would outweigh the negative consequences of dominance; and an assumption that market forces and technology would reduce the market power of dominant players over time.

8.4 In Canada, a Regulatory Review Panel was set up to explore regulatory approaches to infrastructure provision. Again, with extensive competition from cable the panel recommended that the regulatory framework should focus on encouraging facilities-based competition and move away from unbundling (based on the ladder of investment principle), because, it was argued, it could undermine the achievement of facilities-based competition.

8.5 In Hong Kong, the regulator has scaled back the more prescriptive ex-ante regulation and is progressively replacing it with ex-post competition law where possible. Unbundling obligations on FTTx are being phased out on the grounds that new network investments will only be made if operators are allowed to achieve returns commensurate with the risks involved. Once again, strong cable competition was critical in allowing the regulator to take such a laissez-faire approach.

8.6 In all three cases, this deregulatory approach has had the desired effect of accelerating NGA investment decisions. A 2006 study by the LSE concluded that incumbents' investments in deregulated markets in the USA and Canada exceed investments in the EU's more regulated environment[60].

8.7 In the Netherlands, with its high population densities and strong infrastructure competition between KPN, the incumbent operator, and cable (involving operators such as UPC and @Home (previously known as Essent, which has also recently merged with Casema and MultiKabel)), numerous next generation broadband projects are underway, including some municipal projects. These investments have not required significant regulatory incentives, although it is still unclear to what extent OPTA, the regulator, will impose wholesale obligations on both platforms.

8.8 In Belgium, regional cable companies have been deploying next generation broadband services based on EuroDOCSIS 2. In the face of such competition, Belgacom has begun upgrading its network to provide VDSL. Once again the national regulator has taken a laissez-faire approach, for similar reasons to the FCC, and has not, so far, imposed any regulatory obligations on Belgacom to offer wholesale access to this upgraded network. However, it is understood that the Belgian regulator is currently considering whether to impose access obligations upon Belgacom.

8.9 The German government has also taken the view that stronger incentives are required to enable the deployment of next generation broadband services (in this case VDSL). However, their decision to provide a regulatory holiday for Deutsche Telekom, through time limited forbearance of unbundling obligations on any new FTTx/VDSL services, is considerably more controversial due to the absence of any significant high speed broadband platform competition from cable[61]. The German approach is currently being challenged by the European Commission on the grounds that it contravenes the current EU Telecommunications Framework.

Regulated competition – the ladder of investment

8.10 Deregulation clearly works as a way of increasing the regulatory incentives to bring forward NGA investment. However, as the German example shows, it is much more difficult for regulators to take this approach in markets where there is limited competition from another fixed access platform (cable), as it risks undoing the benefits delivered by the legacy approach of ex ante regulation, and effectively handing back monopoly power to the incumbent.

8.11 A more sophisticated and nuanced regulatory approach is, therefore, required in markets with limited infrastructure competition. The approach taken in Europe has been based on the ladder of investment concept. This was introduced as the theoretical basis to argue that alternative operators would move up the infrastructure ladder on the basis of five regulated forms of competition, including DSL resale, Bitstream, shared access, LLU, and naked DSL. This concept foresaw that the five options would offer scope for service differentiation giving altnets an incentive to move up the next rung of the ladder and finally roll out their own infrastructure. So far, the only example of an altnet moving up to the deployment of fibre is Iliad in France, which announced its intention to deploy FTTH in Paris in 2006.

8.12 Already a successful LLU operator, Iliad decided it could achieve sustainable first mover advantage in the triple-play (HDTV, broadband, telephony) market in the Paris region by being the first operator to deploy fibre to the home. Critical to this decision was the fact that DTV take-up in France is comparatively low (35 per cent) and the ability of Iliad to secure alternative wayleave access via the sewage network, which significantly reduced the capital cost of network rollout. Following Illiad's announcement Neuf Cegetel has also announced FTTH deployments in Paris and other major metropolitan areas.

8.13 However, this is the only country where altnets are climbing the ladder of investment to NGA deployment, and in the vast majority of cases across Europe alternative operators are designing their businesses around one of the existing five options and have expressed little interest in moving higher up the ladder. The consequence of this is that competition predominantly takes place on the existing infrastructure platform. Many observers argue that the ladder of investment will only encourage altnets to deploy NGA in a very limited number of situations where other market factors and incentives are particularly strong, as in the case in Iliad's announcement.

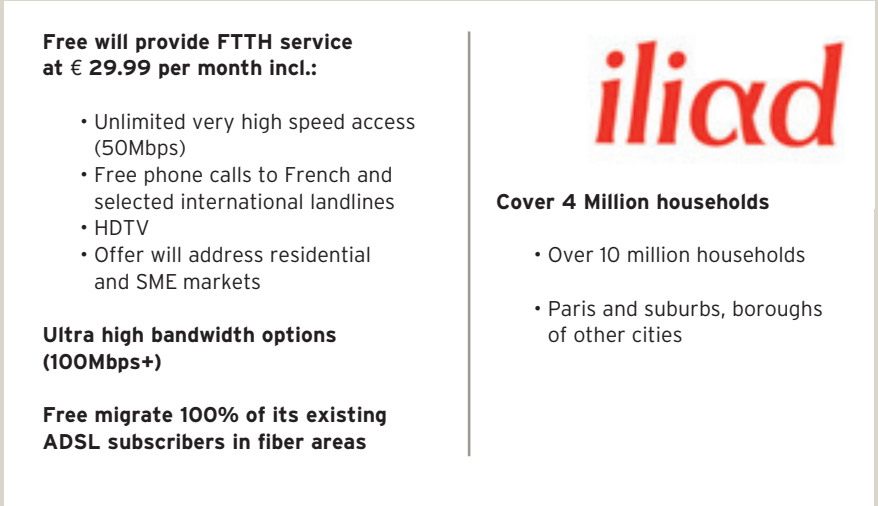


Figure 13: FTTH deployment announcement by Iliad in France.
Source: Iliad

Ofcom's discussion document – key regulatory issues to be addressed

8.14 Any new regulatory framework will need to strike the right balance between incentivising efficient investment and ensuring sustainable competition. As Ofcom's recent discussion document on the 'regulatory challenges posed by next generation networks' highlighted, there are many complex issues to be addressed. The following section provides some initial responses to the questions posed by Ofcom.

What is the potential for widescale competition in NGA deployment?

8.15 Currently, no UK operators have indicated an intention to deploy a national NGA network. Given the high capital costs involved and the substantial commercial risk in deploying a NGA network, it is likely that, even in more densely populated areas, there will only be a limited number of scale operators providing these services. However, if Virgin Media and BT were to emerge as competitive NGA operators it would mean that competitive facilities-based services would be available to half of the UK market. Nevertheless, it is clear that in some low-density areas, there may be only one facilities-based provider of next generation access services. This suggests that there may be a case for geographically-differentiated regulation.

8.16 New broadband wireless access technologies are being developed and deployed in a number of different ways to enable access to higher bandwidth services. However, it is unlikely that these solutions will replicate the performance of the other next generation technologies. Nevertheless, wireless technologies will form an important part of the technology mix and priority should be given to the availability of sufficient appropriate spectrum to support these services. Some of these wireless technologies may seek to exploit next generation broadband access for backhaul.

How should the market for NGA be defined?

8.17 In addition to access, the business case for NGA will depend upon the market for a wide range of value added services. While there may be a limited number of direct competitors providing end-to-end NGA services, there may be other partial competitors, making large scale interventions, capable of exerting significant influence on the behaviour of the NGA operator.

8.18 A NGA business case may depend upon an operator's ability to:

- gain a price premium for next generation broadband access service (versus current generation products)
- gain a price premium for next generation access (versus current broadband access)
- provide new Value Added Services
- increase market share at wholesale or retail level
- gain revenue for carriage from application or content providers.

This suggests that the market should not be defined too narrowly. More market players will need to be taken into account when assessing the level of prospective competition and dominance findings on any relevant next generation market. In determining a regulatory framework for NGA, Ofcom needs to take account of the impact of its approach on these business case drivers. Working together with operators and regulators, public sector bodies should explore potential models for targeted, effective and well timed interventions, which may be more widely applicable in due course.

Will NGA constitute an enduring economic bottleneck?

8.19 Wireline networks have traditionally been viewed as enduring economic bottlenecks and have been regulated accordingly in order to enable competition in the delivery of services at retail and wholesale level. The extent to which this continues to be the case for next generation access has yet to be determined. However, because of the high cost of the civil works required it seems likely that NGA infrastructure could become a non-replicable asset in the long-term.

8.20 While next generation access networks may have the potential to become an enduring economic bottleneck, initial NGA deployment is likely to be small scale and experimental, and national NGA deployment will take time. In the short term, if an NGA network co-exists with current generation access networks, it may not necessarily constitute a bottleneck. Regulators could take a relatively relaxed view on wholesale access obligations and retail pricing while operators are exploring options and testing possibilities. We should not assume the existence of enduring economic bottlenecks prematurely.

8.21 In some countries, overhead distribution or alternative wayleaves (such as canals, sewers and other utilities) have lowered the civil works part of the overall capital costs. This suggests that enduring economic bottlenecks may not be the network as a whole but may actually be a component of the network, i.e., the civil component. However, such options seem limited in the UK (see below) and so the underground duct network is likely to remain a non-replicable asset.

8.22 Nevertheless, any determination of Significant Market Power (SMP) will ultimately depend upon the market definition employed. As described above, narrowly defined market definitions will make a finding of SMP more likely.

What are the prospects for alternative wayleaves or infrastructure deployment reducing the bottleneck?

8.20 Civil works can constitute up to 70 per cent of the capital cost of deploying next generation networks. Any opportunity to mitigate these costs will have a significant impact on the business case for NGA, as the Iliad example demonstrates. Operators are likely to explore all options for alternative wayleaves, duct sharing and new ducting technologies on a case-by-case basis.

8.21 As outlined above, achieving infrastructure competition may not require replication of every element. If open access civil infrastructure was more readily available to new entrants, it is possible that more alternative access infrastructure would be provided. However, given the condition of the existing UK duct network, it is not clear that regulated solutions, such as obligations imposing duct sharing being considered in France would be practicable, as much of the existing duct infrastructure is old, congested and, in many cases, poorly mapped.

8.22 The BSG has previously explored the potential for new civil infrastructure utilities to emerge that would provide open access for operators to deploy their own 'active' network[62]. This remains a compelling concept and various companies are known to have explored potential business models in this area. However, as yet few have been able to develop a business case that does not depend, to some extent, on an element of public sector support. Nevertheless, this is a concept that should be reviewed in the course of Ofcom's work on NGA.

Can ex ante regulation create sufficient incentives to enable efficient investment?

8.23 This situation presents a challenge for Ofcom. Simply extending the current regulatory framework to next generation access would fail to take full account of the commercial uncertainty and risk currently associated with NGA and could kill the business case for any investment altogether. However, failure to impose any access obligations in the long-term could mean a return to a situation where an NGA operator could impose monopoly rents for both access and carriage. Competition at retail and wholesale level has been critical to the success of the broadband market and there is little appetite for a return to monopoly provision of communications services. Ofcom's challenge is to balance the need to provide sufficient incentive to enable efficient investment in new services with the need to ensure effective competition.

8.24 Given the commercial challenges involved, it is clear that there are significant commercial risks for any entity contemplating any NGA investment, which would have to be taken into account by the regulatory framework.

8.25 If NGA networks are broadly deployed, the provision of wholesale access should be encouraged, and if necessary required, from all those operating at scale or with the benefit of public sector contributions. If wholesale products are available, then retail markets should not need regulation, especially where innovation in new products and applications which exploit increased bandwidth is to be encouraged from multiple parties.

8.26 As explained above, there may be a commercial case for a cable operator to voluntarily provide wholesale products on normal non-discriminatory commercial terms, without the regulator having to intervene to set wholesale terms and conditions.

What should happen to legacy wholesale products following NGA deployment?

8.26 Existing LLU operators need clarity about how the regulatory framework will evolve following NGA deployment, and the implications for their businesses, given their dependence upon access to first generation assets. Given the length of time it will take to deploy any large-scale NGA networks, current generation services will be required to co-exist and compete with NGA for sometime to come. However, it would not be appropriate to expect them to be supported indefinitely. It should be possible for the regulator to signal to the market the likely time horizons for the termination of legacy network elements, without fettering its discretion, so that operators have a consistent approach that provides a reasonable level of regulatory certainty.

Implications of functional separation

8.27 In 2005 Ofcom agreed a new regulatory settlement with BT that led to a voluntary agreement to implement a functional separation of its wholesale and retail operations. BT agreed with Ofcom that it would establish in internal organisational structure called Openreach to guarantee operational separation and provision of equivalent (wholesale) products to itself and its wholesale customers in order to maintain an adequate level of competition. The decision to institutionalise regulatory obligations through an independent organisation within BT Group, with its own profit and loss account, has been seen as an innovative incentive-based regulatory approach to stimulating investment in current generation broadband in markets where there is relatively weak infrastructure competition, and the European Commission has advocated the potential benefits of similar approach in its discussions on the revision of the EU telecommunications framework.

8.28 In a speech at a recent ITU event in Hong Kong, Information Society Commissioner, Viviane Reding, said:

'The most significant factor enabling broadband growth is the existence of alternative infrastructures, in particular cable. However, the wider conclusion for public policy makers is that regulation still plays a very important role in the investment ladder, especially in Member States with no or weak infrastructural competition. In countries where there has been more effective implementation of the Framework, including enforcement of full or shared access rules, there has also been more progress up the investment ladder.'[63]

8.29 Functional separation is also finding support in the financial community. Bear Sterns argued in 2006 that functional separation was a positive development for telecoms operators:

'The separation of wireline incumbents' 'last mile' (e.g. BT's Openreach) is widely regarded as another regulatory burden. On the contrary, we believe it delivers significant benefits: first, it provides relief on retail asset regulation; second, it encourages the market to re-rate the 'last mile' assets to a higher utility multiple (for example 22% for BT); and third, it can produce a significant release of capital (we estimate as much as €123 billion across Europe)'[64].

8.30 As mentioned above, given the extent of competition for value added service revenues, such as IPTV in the UK market, it seems unlikely that an operator will be able to build a business case for NGA deployment solely on a vertically integrated business model. Both wholesale and retail revenues are, therefore, likely to be critical to any NGA business case. This suggests that there may be a commercial imperative for operators of NGAs to provide wholesale services, which could avoid the need to pursue premature wholesale ex-ante regulation. This should be encouraged.

Conclusion

8.31 Any new regulatory framework will need to strike the right balance between incentivising efficient investment and ensuring sustainable competition. Given the high capital cost and the high degree of commercial uncertainty and risk involved, simply extending the current regulatory framework to next generation broadband access would not achieve this balance.

8.32 We need to ensure that potential efficient investment is not undermined by regulatory uncertainty. While enduring economic bottlenecks may emerge in the long term, we should not assume that any NGA operator will quickly achieve a position of SMP. In a converged market, there may be many other partial competitors able to exert influence over the actions of an NGA operator. Market definitions should, therefore, not be set too narrowly.

8.33 Given that competition for upstream value added services is likely to be intense, there may be commercial incentives that will encourage NGA operators to look for wholesale as well as retail revenues. Even if SMP is determined in some geographic markets, we should be very cautious about whether rate of return regulation should be imposed. Any such obligations could be self-fulfilling, as they tend to have a negative indirect effect on the business models of other operators. Behavioural remedies based on functional separation are likely to be more benign.

8.34 Meanwhile, open access to alternative wayleaves and passive network elements can mitigate a significant amount of the total capital cost of NGA deployment. These should form the basis of any public sector interventions that might be considered appropriate in time.

9. Policy Challenges

9.1 Broadband is having a significant impact on the economy today. It has not been proven that next generation broadband will have an equal impact but there is a strong possibility that it could and the UK needs to be in a position to take advantage of this possibility. It seems highly prudent, therefore, for central government to play close attention to the evolution of the market and the prospects for next generation broadband deployment and be prepared to take proactive steps if necessary.

9.2 A first question to consider is whether the provision of ADSL2+ will be sufficient to meet the requirements of the economy as a whole. There are two issues. Firstly ADSL2+ will lead to a patchwork of availability across the UK, with broadband speeds varying considerably depending on location (between 1-20 Mbps) with only 40 per cent expected to get more than 8 Mbps. Some small businesses and consumers will benefit from higher speeds, which may well prove sufficient for their needs. However, others will only see a slight improvement in their peak access rates at best. Secondly, it is possible, although again as yet unproven, that demand for bandwidth will exceed even the headline capabilities of ADSL2+ in the medium term.

9.3 A second question is the impact on the UK economy of our global competitors moving to next generation broadband deployment ahead of the UK. In the Far East, North America and Europe, significant investments are now being made in the deployment of next generation broadband. Initially the main benefit of these services will be as alternative infrastructures for delivering TV and TV-like services. However, like the first generation of broadband, these faster services are likely to lead to a new wave of innovation by businesses, public services and consumers that could have an impact on national competitiveness.

9.4 A third question is the potential for long-term market failure in certain geographic areas and the requirement for some kind of minimum universal service. Although the UK leads the G7 in terms of the availability of first generation broadband, it is unlikely that commercial operators will be able to deploy next generation access technologies ubiquitously across the UK. Public sector support is likely to be required to deliver next generation access in low-density areas and a new form of universal service may need to be defined to ensure a minimum level of connectivity for inclusion in a modern knowledge economy.

9.5 Finally, the fourth question is the extent to which government needs to take additional measures to encourage infrastructure investment in order to meet the needs of the UK economy over the next twenty years.

What role for government?

9.6 In a situation where there is a probability, but not a certainty, that: a) next generation access may deliver significant economic benefits; b) demand for bandwidth may exceed the capabilities of current technologies; c) investment incentives for next generation broadband may remain weak; the policy instinct will be to leave the market to determine the outcome. However, this also carries a risk. If significant efficiency gains are derived from next generation broadband, then it is possible that nations that opt for accelerated deployment will gain competitive advantage over those that do not. So what should government do?

Recognise the significance of broadband for the UK economy

9.7 The evolution of the UK's communications infrastructure should be of primary concern to policy makers. In its recent report on 'long-term opportunities and challenges for the UK' HM Treasury, recognised that rapid innovation and technological diffusion was one of the five key opportunities and challenges facing the UK in the next decade. However, the importance of having a globally competitive communications infrastructure was not discussed in the Treasury report. Indeed there seems to be an assumption that the market will deliver all of the UK's communications needs over the next decade. Currently, this does not look like a safe assumption to make.

9.8 Given the critical importance of broadband as the key enabling infrastructure of the knowledge economy, a failure of broadband supply to meet demand could stifle the pace of innovation in the UK economy compared to our global competitors. This risk should be recognised and addressed.

Monitor international developments and benchmark progress

9.9 To a large extent, the potential risk/benefit to the UK economy depends upon how investments in next generation broadband are made and utilised in other countries and the extent to which economic benefits start to emerge from these networks. Government should, therefore, begin to regularly monitor the deployment, use and exploitation of next generation broadband in key leading economies. The evolution of the UK's own communications infrastructure can then be benchmarked against our global competitors.

9.10 Many countries around the world have set aspirational targets for next generation broadband deployment, including targets for FTTH adoption. Targets are valuable because they help to focus policy development and signal policy intent to stakeholders.

9.11 In cooperation with stakeholders, the government should establish a target to ensure that by 2012 the UK remains in the upper quartile of OECD nations in terms of the range of broadband delivered services to which its people have ready access (*Quality*) and the proportion of the population served by broadband (*Reach*). 'Quality' and 'Reach' should be defined through a basket of metrics, similar to the approach used to define the competitiveness and extensiveness targets set in 2001.

9.12 Regular published assessments of the UK's performance, benchmarked against our competitors, will enable to government, Ofcom and the industry to assess whether further proactive steps are required to ensure that the UK is on course to meet the 2012 target and does not fall dangerously behind its international competitors.

Do no harm – avoid premature interventions that could distort the market

9.13 A number of public sector organisations, including RDAs, devolved administrations, and local authorities, are currently considering whether or not to intervene to ensure the accelerated delivery of next generation broadband services.

9.14 There are a number of justifications that can be made for such interventions, including the need to address market failure, the need to ensure the equitable distribution of welfare gains and the need to ensure regional competitiveness. However, there is a real risk that public sector interventions could pre-empt the market, distort competition and actually deter or duplicate private investment that might otherwise be made at a later date.

9.15 This is not to say that public sector funding will have no role in the widespread provision on next generation broadband. On the contrary, there will almost certainly be areas that will be non-commercial in the long-term and public sector interventions will need to be carefully targeted at areas where persistent market failure is most likely. The problem is that, at this stage, when the commercial case for next generation access is so uncertain, it is difficult to determine where the line should be drawn.

9.16 The timing of any public sector intervention can have a significant impact. If interventions are made too early, they risk distorting the market. If made too late, they could lead to the development of distributional inequalities and the emergence of new urban/ rural divides. However, public sector intervention to promote next generation broadband deployment that is ahead of any commercial deployments (even in the most commercially attractive areas) and ahead of the establishment of a new regulatory framework is likely to be premature. We therefore believe that the public sector should forbear from making large scale interventions to promote next generation broadband deployment at this stage.

9.17 However, public sector bodies need to be fully engaged in the debate with operators and regulators about the prospects for and likely limitations of commercial next generation broadband investment so that they can scope the likely requirements for public sector support and agree best practice for possible solutions. It is essential that bodies responsible for the long-term economic development of regions of the UK have as much visibility as possible on the likely evolution of their communications infrastructures. Working together with operates and regulators, public sector bodies should explore potential models for targeted, effective and well-timed interventions, which may be more widely applicable in due course.

9.18 Where public sector interventions are made, they should focus on the provision of non-replicable 'passive' infrastructure that can then be made available to private sector investments to provide competition in services.

9.19 It is important that there are clear criteria for the use of public funds and the BSG welcomes the Best Practice Guide published by the DTI and Ofcom in February 2007[65].

Facilitate investment where possible

9.20 It is also important to address those non-sector specific policy or regulatory issues that can inhibit investment because of their impact on construction and/or operational costs. Typically, the issues that have previously been identified by the BSG as inhibitors are non-domestic rating costs, planning rules and provisions related to access to highways.

9.21 For both fixed and wireless operators, non-domestic property rating of cable/duct infrastructure represents a substantial proportion of their operating costs, which cannot help the viability of business cases. In addition, newer operators will also claim that inconsistent valuations create barriers to investment.

9.22 Interpretation of planning rules by local authorities is also cited as a cause of delay in construction, which will also impact business cases. In terms of access to highways, whilst the New Roads and Street Works Act 1991 provides a national framework for regulating street works, its provisions, too, present barriers because of advance notice requirements and charges for prolonged works or for occupation of the highway.

9.23 Each of these potential barriers to investment in new infrastructure seem as valid now as they did when the BSG flagged them as concerns three years ago. If the UK is serious about accelerating the provision of critical (next generation) access infrastructure, government should work together with industry to understand how investment and business cases are undermined by the above and to assess where improvements can be made to improve investment flow, by, for example, reducing rating costs and the costs associated with roadworks.

Evolution of Universal Service

9.24 There is a question about whether high-speed broadband networks should be part of a Universal Service Obligation. Currently only 'functional' internet access is included under the terms of the current USO Directive, which is due for review from this year. It seems clear that this will need to be revised, in order to determine the minimum level of connectivity needed to ensure inclusion.

9.25 In a 2006 paper, the OECD argued that current funding arrangements for USO may be unsuitable for broadband and that governments might want to consider funding a USO from general taxation revenue[66]. In the UK, it has been suggested that consideration should also be given to whether a portion of the BBC licence fee could be used to support the provision of minimum connectivity levels to those areas where the market is unlikely to deliver[67]. Another model could be Canada where there is a proposals for a programme known as UCAN (Ubiquitous Canadian Access Network) which has the objective of achieving near-universal broadband coverage by 2010 and involves targeted 'smart subsidies' – with least-cost auctions – to determine which service providers (telco, cable, wireless, satellite) can provide coverage at lowest cost.

9.26 Ofcom's consultation on universal access should address both the definition of universal service and the future approaches to funding. Future definitions of USO may also need to be more technology neutral as broadband services in very rural areas may be best delivered by wireless services rather than over fixed lines.

'The government should establish a target to ensure that by 2012 the UK remains in the upper quartile of OECD nations in terms of the range of broadband delivered services to which its people have ready access (Quality) and the proportion of the population served by broadband (Reach).'

10. Conclusions and Recommendations

10.1 Broadband matters because it has an impact on the UK's long-term competitiveness. To compete in a global knowledge economy, UK businesses and citizens need to have access to a world-class communications infrastructure.

10.2 The UK has been quick to embrace the potential of broadband. Adoption rates have outstripped many of our G7 competitors and across the economy people are exploiting broadband to innovate and do things differently. The UK has also been successful in ensuring that broadband access is available as widely as possible and leads the G7 in terms of broadband availability. This has been important to ensure social inclusion and the health of the rural economy. However, we should not assume that the UK will maintain this position.

10.3 Around the world, rapid broadband adoption and massive innovation in broadband enabled content, services and applications is driving huge growth in network traffic. This trend is expected to accelerate significantly in the next two years as a plethora of new video rich services, often based on peer-to-peer technologies, reach the market. Next generation broadband services are now being deployed in a growing number of countries around the world in anticipation of this new wave of bandwidth-intensive video-rich services. In most cases significant public sector support and policy and regulatory incentives have played an important role in accelerating the next generation broadband deployment. These interventions have been justified by the need to maintain national competitiveness.

10.4 Further investment is also expected in the UK. Primarily, this will involve the deployment of ADSL2+ by BT and other LLU operators and, possibly, DOCSIS 3.0 by Virgin Media. BT has also announced that it will begin deploying FTTH in green field locations from 2008. In practice, however, over the next five years, this will mean that a patchwork of broadband availability in the UK will continue to exist, where the broadband speeds available to the majority of consumers will vary depending upon location between 1 and 24 Mbps downstream and up to 1 Mbps upstream. Unless BT or another operator accelerates deployment of fibre or Virgin Media accelerates deployment of DOCSIS 3.0, it is likely that a significant minority of users will see no real improvement in their broadband access speeds during this time. Only a very small number of users on new developments will be able to access very high-speed symmetrical FTTH services.

10.5 Making predictions about demand for bandwidth is difficult, but there is a strong possibility that over the next five years demand for both upstream and downstream capacity will exceed the capabilities of existing and currently planned broadband infrastructure in the UK. In particular, the rapid development of peer-to-peer services is likely to increase demand for upstream speeds. There is a real risk that upstream service providers, businesses and consumers will find in time that broadband peak access speeds available to them are insufficient to meet their needs.

10.6 Our key concern is that incentives for operators to invest in next generation broadband networks in the UK remain weak due to the high capital costs involved, the erosion of traditional revenue streams, increased competition for broadband enabled value added services, and uncertainty about future commercial models. The strength of the UK DTV market is also a particular challenge, as this weakens the market opportunity for new broadband enabled IPTV services that have been critical to commercial deployments in other markets such as France. These challenges are compounded by increased operating costs resulting from the rapid growth in network traffic.

10.7 This suggests that a gap is opening open up between the 'public value' to society of next generation broadband and the 'private value' available to investors in these services. Evidence of the positive externalities resulting from next generation access has yet to emerge – largely because these networks are only just being built. However, over the next two years as international deployments of next generation broadband accelerate and a new wave of bandwidth intensive are taken up by the mass market, the requirement for next generation broadband in the UK is likely to become much more transparent.

10.8 For this reason, we believe that there is a limited window of opportunity over the next 12-24 months to develop and implement a concerted and innovative approach to regulation and policy making to create the right balance of investment incentives and competition that will enable a market led transition to next generation broadband.

10.9 The issues are complex and there are few obvious solutions at this stage. The lack of sufficient platform competition from cable means that deregulation or regulatory forbearance would not be appropriate in the UK. Ofcom will need to find an alternative approach that provides the right risk/reward balance to enable and, possibly, incentivise efficient investment. At the same time, government should monitor the UK market closely and benchmark progress against our international competitors. In the short term the public sector should forbear from making premature interventions in the market, but should be prepared to make carefully targeted interventions in the future in areas where persistent market failure is most likely.

'There is a limited window of opportunity over the next 12-24 months to create the right balance of investment incentives and competition that will enable a market-led transition to next generation broadband.'

Recommendations for next steps

Recommendation 1
– Define the public value of broadband networks

It will take years for a complete evidence base to emerge to assess the full economic and social value of broadband. However, it should be possible now to define a framework to assess the potential public value of broadband, i.e., to identify the factors that should be taken into account when assessing broadband's impact on society and the economy. Once such an approach is agreed, evidence can be added in as it emerges and a more accurate model developed for assessing the public value of broadband. This should be a collaborative initiative involving industry, academics, the DTI and Treasury.

Recommendation 2
– Monitor demand for bandwidth

As a new wave of bandwidth intensive services come online over the next 12-24 months, close attention should be paid to the actual growth in demand for bandwidth by households and businesses both in the UK and internationally. Various approaches could be used to develop data in this area. However, this information should be made publicly available to help inform decision making by stakeholders across the value chain. This should be coordinated by Ofcom.

Recommendation 3
– Set a benchmarked target for 2012

The UK must have a communications infrastructure that enables it to compete and prosper in the global knowledge economy. The government and Ofcom should, therefore, benchmark the UK's communications infrastructure with our global competitors.

Government should establish a target to ensure that by 2012 the UK remains in the upper quartile of OECD nations in terms of the range of broadband delivered services to which its people have ready access (*Quality*) and the proportion of the population served by broadband (*Reach*)[68]. These two aspects of quality and reach should be defined through a basket of metrics, similar to the approach used to define the competitiveness and extensiveness targets in 2001. This work should be undertaken by government, in collaboration with stakeholders, and updates should be published bi-annually.

Recommendation 4
– Explore alternative commercial models to support network investment

Further work should be undertaken by stakeholders to debate and explore alternative commercial models to support network investment. Good solutions need to be found that align the interests of operators with upstream content and service providers and end consumers whilst mitigating concerns about blocking or degrading third party applications and services.

Recommendation 5
– Develop a regulatory framework for next generation broadband

Discussion on the regulatory challenges posed by next generation access (NGA) networks has only just begun in the UK. Ofcom opened up the debate with its discussion document published in November 2006. This document raised a broad range of complex issues, which need to be explored in more detail. Further informal discussions should be undertaken in advance of a full public consultation by Ofcom. However, Ofcom needs to set out the principles of its regulatory approach to NGA within a 12 month time period, if the inhibiting effects of regulatory uncertainty on investment are to be avoided.

Recommendation 6
– Explore options for access to passive infrastructure

As an input into Ofcom's NGA pre-consultation, a more detailed review should be undertaken into the options for access to alternative passive infrastructure in the UK. This work should be taken forward by stakeholders.

Recommendation 7
– Identify models for efficient public sector intervention

While the BSG recommends that the public sector should forbear from intervening to promote NGA deployment at this stage, it is highly likely that public sector support will be required in areas where persistent market failure is most likely. Building on the Best Practice Guide published by the DTI and Ofcom in February 2007, further work should be undertaken to identify and experiment in the development of efficient and effective models for public sector interventions in collaboration with commercial stakeholders, government and the regulator.

Recommendation 8
– Remove non-sector specific regulatory barriers

The deployment of next generation access infrastructure will inevitably require new civil infrastructure and will involve significant new street works across the country. DTI should work together with relevant departments and public sector bodies and the industry to develop streamlined approaches to NGA related street works and planning issues to minimise both the disruption caused and the cost to operators of these works. The government should also review the non-domestic rating applied to optical fibre. The current approach provides a strong financial disincentive to the use of deployed fibre.

Recommendation 9
– Review universal service/universal access

The current universal service directive refers only to functional internet access. However, as the adoption of broadband continues to accelerate, this definition is starting to look outdated. Ofcom's consultation on universal services should address both the definition of universal service and future approaches to funding universal service/ universal access.

11. Glossary

ADSL
Asymmetric Digital Subscriber Line (ADSL), a form of DSL, a data communications technology used for providing broadband

ADSL2+
ADSL2+ extends the capability of basic ADSL

Altnets
Alternative network providers, ie not incumbent operators

Bitstream
A BT Group wholesale product

BT Openreach
A BT Group division created to guarantee operational separation and provision of equivalent (wholesale) products to itself and its wholesale customers in order to maintain an adequate level of competition, following Ofcom's Strategic Telcommunications Review in 2002

CPE
Customer Premises Equipment

DOCSIS
Data Over Cable Service Interface Specification (DOCSIS), an international standard employed by many cable operators

Downstream
Refers to the transfer speed by which data can be sent from the server to the client in an internet connection

DTV
Digital Television

Ethernet
Ethernet, a widely-installed local area network technology

FCC
The Federal Communications Commission, the US communications regulator

HFC
Hybrid fiber-coaxial, a network which incorporates optical fibre and coaxial cable to create a broadband network

FTTC
Fibre to the (street) cabinet

FTTH
Fibre to the home

FTTx
Fibre to the x, a generic term for any network architecture that uses optical fibre to replace all or part of the usual copper loop used for telecommunications

GDP
Gross Domestic Product

GVA
Gross Value Added

HD
High Definition

HDTV
High Definition Television, a technology that provides viewers with better quality, high-resolution pictures

HSDPA
High Speed Datalink Packet Access, an evolution of 3G mobile technology, often known as 3.5G, which offers higher data speeds

IP
Internet Protocol, the packet data protocol used for routing and carriage of messages across the Internet and similar networks

IPTV
Internet Protocol Television, a system where a digital television service is delivered using the Internet Protocol over a network infrastructure

ISP
Internet Service Provider, a company that provides access to the internet

Kbps
Kilobit per second

Knowledge Economy
An economy where the generation and use of knowledge has come to play the predominant role in the creation of national wealth, achieved by effective use and application of all types of knowledge and technology, in all manner of economic activity.

LLU
Local Loop Unbundling, a process where incumbent operators (in the UK, BT and Kingston Communications) make their local network (the lines that run from customers premises to the telephone exchange) available to other communications providers. The process requires the competitor to deploy its own equipment in the incumbent's local exchange and to establish a backhaul connection between this equipment and its core network

Mbps
Megabits per second

Naked DSL
A DSL broadband connection without a telephony service

NGA
Next Generation Access, referring to key architectural evolutions in the access part of the telecommunications network (from the exchange to the subscriber) allowing higher bandwidth and greater symmetry than is currently possible with today's most commonly deployed network architectures

NGN
Next Generation Network, referring to architectural evolution throughout the whole telecommunications network

OECD
Organisation for Economic Cooperation and Development

Ofcom
The UK communications regulator

PON
Passive Optical Network, a point-to-multipoint, fibre to the premises network architecture

PVR
Personal Video Recorder

SME
Small to Medium sized Enterprise, a company with fewer than 250 employees

SMP
Significant Market Power

Sub loop unbundling
Local loop unbundling taking place in the street cabinet

TMT sector
Telecommunications, Media and Technology sectors

Upstream services (providers)
Referring to services, and the providers of those services, which exist higher up the value chain than broadband access provision

Upstream
Refers to the speed at which data can be transferred from the client to the server (uploading).

VASs
Value Added Services, a telecommunications industry term for non-core services

VDSL
Very High Speed DSL, a DSL technology providing faster data transmission

VOIP
Voice over Internet Protocol, a technology that allows users to send calls using Internet Protocol, using either the public internet or private IP networks

WDMA
Wavelength Division Multiple Access

WiMAX
A wireless MAN (metropolitan area network) technology, based on the 802.16 standard. Available for both fixed and mobile data applications

12. Endnotes

1 See OECD Broadband Statistics www.oecd.org/sti/ict/broadband

2 30 million subscribers also includes business as well as residential customers

3 Very High Speed Broadband: A Case for Intervention, Enders Analysis, January 2007

http://endersanalysis.com/publications/publication.aspx?id=390

4 'Quality' and 'Reach' to be defined through a basket of metrics, similar to the approach used to define the competitiveness and extensiveness targets set in 2001.

5 Organisations dependent on the availability of broadband to deliver their services.

6 It is commonly argued that operators need a business case that can generate an ARPU of approximately €80 per month based on a combination of access and value added services (generally TV) in order to justify investment in NGA.

7 'The World is Flat' Thomas.L. Friedman, 2005, p. 233, (published by Farrar, Straus and Giroux)

8 Once a commercial decision to deploy next generation broadband is taken, wide-scale deployment is likely to take many years to complete.

9 'Net Impact Study: National Economic Benefit', Momentum Research Group, Brookings Institution and University of California-Berkeley, http://www.netimpactstudy.com/nis_2002.html

10 Gartner Dataquest November, 2002, http://www.gartner.com/5_about/press_releases/2002_11/pr20021113a.jsp

11 'Measuring broadband's economic impact', Lehr, Osorio, Gillet and Sirbu, MIT October 2005

12 Next Generation Broadband in Scotland, SQW Limited report for Scottish Executive, January 2007 http://www.scotland.gov.uk/Publications/2007/01/09153006/0

13 'Communications: the Next Decade', Ofcom, November 2006, p.197

14 T-Plan (www.T-Plan.co.uk) provides an excellent case study of the way in which an SME can harness broadband to drive innovation, productivity and growth. T-Plan is an SME providing test management solutions. The availability of broadband in Cornwall enabled T-Plan to relocate out of the South East to take advantage of the lower costs and improved lifestyle available in Cornwall and to create new high-value jobs in a rural location. T-Plan has a dozen virtual offices across the UK with all staff connected using broadband. T-Plan believes that broadband-enabled ICT makes the company more productive, allowing it to take on more business and grow. Broadband has enabled T-Plan to reduce its turn around time on projects from 5 to 1.5 days. It enables faster more effective research and easier competitor analysis. It is also being used to transform client training operations, eliminating the need to run expensive courses at physical locations. Broadband has become critical to T-Plan 'without it we'd have to review our entire operation...that's not really an option.' In 2004 T-Plan was recognised by Deloitte as one of the fastest growing technology companies in the South East and gained a place in Deloitte's Technology Fast 50. According to Deloitte 'The Fast 50 Programme has always been a reliable indicator of whether British innovation is leading to more growth and wealth creation. These companies have demonstrated how to survive and thrive in today's market by helping their customers reduce their costs and improve their performance.'

15 'Long-term opportunities and challenges for the UK: analysis for the 2007 Comprehensive Spending Review' HM Treasury, November 2006

16 'Show me the money; The Impact of Convergence on the Consumer Electronics Sector', Dave Tansley, Deloitte, Intellect Consumer Electronics Conference, July 2005

17 i2010 Annual Information Society Report, European Commission, 30 March 2007 http://ec.europa.eu/information_society/eeurope/i2010/annual_report/index_en.htm

18 'Capitalising on Convergence – Delivering value and driving growth in a digitally converged world', Intellect, 2005 http://www.intellectuk.org/policy/convergence/default.asp

19 'The Communications Market, 2006' Ofcom, 2006, p.180

20 'Broadband: its impact on British business', IoD Policy Paper, 2004

21 'The Benefits of Broadband to SMEs in the ICT Sector', Intellect, September 2003 http://www.broadbanduk.org/

22 'The Benefits of Broadband to SMEs in the ICT Sector', Intellect, September 2003, http://www.broadbanduk.org/

23 'Measuring broadband's economic impact', Lehr, Osorio, Gillet and Sirbu, MIT October 2005

24 'Infrastructure to 2030: Telecom, Land Transport, Water and Electricity', OECD, 2006, p.16 http://www.oecd.org

25 'Broadband availability, use and impact on returns to ICT in UK firms', Raffaella Sadun (CEP/LSE) and Shikeb Farooqui (ONS), OECD Working Paper, 5 April 2006 http://www.oecd.org

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27 http://www.indepen.co.uk/panda/docs/brt-appendices.pdf

28 'Technical assistance in bridging the digital divide: a cost benefit analysis for broadband connectivity in Europe', PriceWaterhouseCoopers, Ovum and Frontier Economics, October 2004

29 Social capital consists of the stock of active connections among people: the trust, mutual understanding, and shared values and behaviours that bind the members of human networks and communities and make cooperative action possible. (Cohen and Prusak 2001: 4)

30 'BSG Annual Report', BSG, January 2004 http://www.broadbanduk.org/

31 The World is Flat', Thomas.L. Friedman 2005, p.350 (published by Farrar, Straus and Giroux)

32 'Communications: the Next Decade', Ofcom, November 2006, p.11

33 This assumes an average of 2.4 persons per household, http://www.statistics.gov.uk

34 BT estimates that broadband is available over 99.6% of lines. This is based on three different forms of assessment: the proportion of lines where broadband was required but could not be provided; a directional estimate of the proportion of problem lines based on line length distribution, and a second estimate of problem lines based on data mining of line characteristics. These three different assessments yield a range of 0.15 – 0.45% non-availability. A Community Broadband Network survey in 2006 reported that there were 1200 broadband 'not spots' spread throughout the UK. The four main reasons for not being able to access ADSL services reported by their survey were: distance from the exchange, line quality, line sharing and the existence of fibre-optic cables in the local loop. http://www.broadband-uk.coop

35 OECD Broadband Statistics www.oecd.org/sti/ict/broadband

36 OECD Broadband Statistics www.oecd.org/sti/ict/broadband

37 AMS-IX Annual Report 2005 https://www.ams-ix.net/about/Jaarversl_2005%20def.pdf

38 http://www.landsecuritieslink.com/news.asp?PageID=8&MediaID=59&InitialView=False

39 'Predicting UK Future Residential Bandwidth Requirements', Green Paper, Broadband Stakeholder Group and Analysys, http://www.broadbanduk.org/component/option,com_docman/task,doc_details/gid,95/Itemid,9/

40 The analysis merely assumed the provision of services at affordable cost and made no estimate of the propensity of consumers to pay a premium for faster broadband services.

41 http://blog.ipdev.net/2007/03/part-2-cost-implications-of-video.html

42 BSG Report and Strategic Recommendations, November 2001 http://www.broadbanduk.org

43 Ofcom, Regulatory challenges posed by next generation access networks http://www.ofcom.org.uk/research/telecoms/reports/nga/nga.pdf

44 See BSkyB at Sky.com, http://phx.corporate-ir.net/phoenix, Carphone Warehouse at http://www.cpwplc.com/phoenix and O2 at http://o2.com/services

45 http://www.btplc.com/21CN/Theroadto21CN/UKRollout/UKrollout.htm

46 Including Analysys and IEEE data.

47 In a March 2006 BT Group Industry Analyst Briefing on broadband access speeds in the fixed network, BT reported that "Based on 25% cable fill and a DSL Max type of ranged product, we estimate that ADSL2+ will give about 50% of customers 8Mb/s downstream and give a few downstream speeds of more than 18Mbit/s. As with ADSL1, at least 50% of customers should get 0.5Mb/s upstream. These speeds will give good sustainable throughput suitable for applications involving video, for example."

http://www.btplc.com/Thegroup/Industryanalysts/Industryanalystspresentations/BBinthefixednetwork.pdf

48 In ideal conditions, VDSL 2 may be able to provide 100 Mbps over 500 metres of copper. However, there is not much practical data yet on the impact of the real world on what will be achievable with VDSL 2. Nodes may need to be closer to the customer than existing street cabinet positions and RFI and intermod issues are unclear.

49 'Very High Speed Broadband: A Case For Intervention?', Enders Analysis, January 2007, http://www.endersanalysis.com/publications

50 Source FTTx Mini Guide http://www.telecommagazine.com/2007/Research/FTTx/

51 Ofcom recently commissioned a report from Plextek to investigate the use of wireless technology as an alternative for the provision of the last mile communications to the home. Plextek concluded that wireless cannot realistically compete with fibre for the provision of next generation broadband over the whole of the last mile but that wireless would have application as a last mile feeder element, using Gb/s wireless as a fibre replacement and within the home, e.g. 802.11n. Wireless Last Mile Report, Plextek, November 2006.

http://www.ofcom.org.uk/research/technology/overview/ese/lastmile/lastmile1.pdf

52 For example, the Astra2Connect service offers broadband internet services with a capability 1024kbit/s (max) download and 128kbit/s (max) upload.

53 'The Broadband Incentive Problem', MIT Communications Futures Programme (CFP), September 2005. (http://cfp.mit.edu/groups/broadband/docs/2005/Incentive_Whitepaper_09-28-05.pdf)

54 "Consumers are now routinely uploading their own audio-visual content, watching IP-based TV and other forms of on-demand or streaming media, videoconferencing via Skype or participating in other peer-to-peer file sharing or distribution applications like BitTorrent, that are capable of transferring data at the peak rate of the access link on a more or less continual basis." The Broadband Incentive Problem, p. 5

55 Some providers will simply generate a letter after several months to subscribers who 'consistently' exceed their volume tier, while others claim they will charge additional usage-based fees in real time once customers exceed their volume thresholds.

56 See Exploiting the broadband opportunity: Lessons from South Korea and Japan, DTI Global Watch Mission Report , March 2006, p. 24 http://www.broadbanduk.org/content/view/182/7/1/1/

57 Ofcom Digital Progress Report, Digital TV, Q4 2006 http://www.ofcom.org.uk/media/news/2007/03/nr_20070314

58 In March 2005, the FCC ordered Madison River Communications, a small phone company in North Carolina to stop blocking the Vonage VOIP service on the basis that the internet should remain open to all types of traffic.

59 This is evident in the 3G market where operators are trying to keep content and services as closely integrated with their networks as possible and have not generally encouraged the kind of third party innovations that have been associated with fixed line broadband services.

60 'USA Broadband after 10 years of confusing and confused regulatory policy' May 25, 2006, Robert Crandall, London School of Economics

61 The current multi-level structure of cable networks in Germany, coupled with the upgrades required in the Kabel Deutschland networks, has seen competitive high speed offerings slower to emerge on a wide scale, although some newer city based networks are offering such services.

62 'The challenge of financing the deployment of next generation broadband networks in the United Kingdom and the Civil Infrastructure Utility concept', BSG Discussion Document, December 2003, http://www.broadbanduk.org/content/view/99/

63 'Connecting up the Global Village: a European View on Telecommunications Policy', Viviane Reding, European Commissioner for Information Society and Media, ITU 'Telecoms World 2006' conference, Hong Kong, 4 December 2006, http://ec.europa.eu/information_society/newsroom

64 Bear Sterns European Equity Research – "Telecommunications Services: Wholesale Salvation", 18 August 2006, http://www.bearsterns.com

65 'Public broadband schemes – A best practice guide', Ofcom and DTI, February 2007 http://www.ofcom.org.uk/media/mofaq/telecoms/pbs/dti_pbs.pdf

66 Infrastructure to 2030: Telecom, Land Transport, Water and Electricity, June 2006, http://www.oecd.org

67 In his recent independent review of the future of broadcasting for the DCMS, Robin Foster argued that "there could still be a powerful case for a shift in the aims of government intervention – changing the balance of funding so that less goes on creating new content, and more goes to securing universal access to the infrastructure and devices needed to take advantage of the new broadband world. The challenge for the future is to assess these different options in a rational and rigorous way." Future Broadcasting Regulation 2006, Robin Foster for DCMS available at http://www.culture.gov.uk P. 50

68 'Quality' and 'Reach' to be defined through a basket of metrics, similar to the approach used to define the competitiveness and extensiveness targets set in 2001.

13. Annex
(list of contributors)

The people listed have contributed to this report, through private discussions and attending the meetings below:

20 April 2006 – BSG Next Generation Access Review group meeting
25 May 2006 – BSG NGA Review group meeting
13 June 2006 – Workshop: Platforms for next generation networks
3 July 2006 – Colloquium 'Platforms to deliver next generation services' (run by BSAC and BSG)
17 November 2006 – Workshop: Platforms for next generation networks

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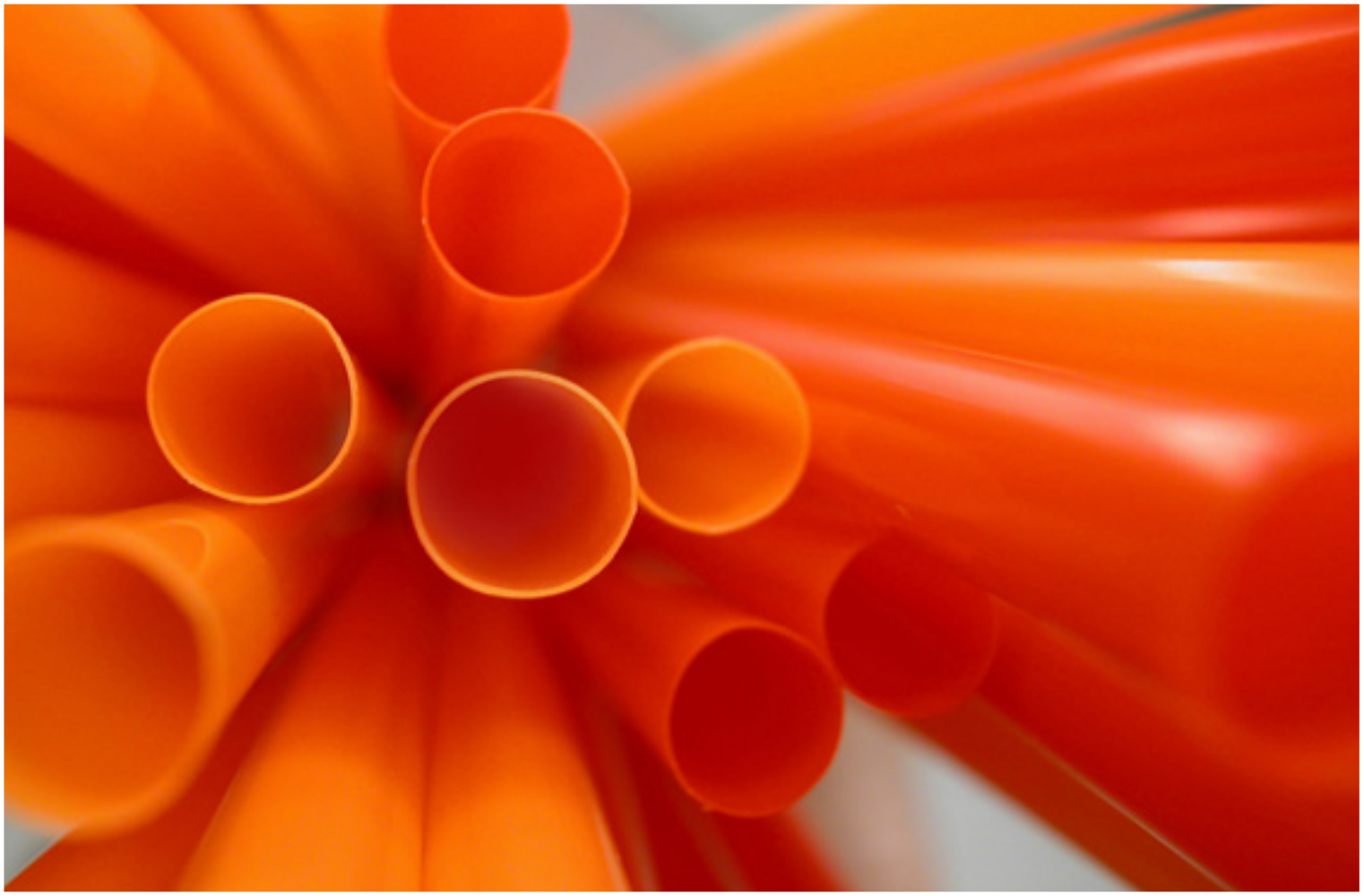

The BSG is the industry-government forum tackling strategic issues across the converging broadband value chain. It:

- provides a neutral forum for collaboration for organisations across the converging broadband value-chain to discuss and resolve the issues related to the development and exploitation of broadband that affect them all.

- aims to be a 'critical friend' of government and the regulator, and comprises companies from the telecoms and technology sectors through to content providers and rights holders. It also has direct representation from government departments and Ofcom.

- focuses on strategic, medium- to long-term challenges that affect the whole broadband-enabled value chain, with the ultimate aim of helping to create a strong and competitive UK knowledge economy.

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