NEXT GENERATION BROADBAND IN SCOTLAND

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Final Report

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Executive Summary

1. The UK broadband market is developing rapidly. Various suppliers are now offering or trialling 'Next Generation Broadband' (NGB) services considerably above 2Mbit/s. A service of up to 22Mbit/s has recently been launched at £30 per month by one operator in parts of Edinburgh and Glasgow, and one of the largest players has mooted the possibility of 50Mbit/s services by 2007.

2. As the NGB market develops, the Scottish Executive is concerned both to optimise the social and economic benefits of broadband for Scotland, and to avoid the emergence of an unacceptable new digital divide. SQW was commissioned to undertake a study to: assess the economic impact of broadband for Scotland; appraise the incremental benefits (social and economic) of NGB services and applications; forecast the likely future evolution of NGB coverage and take-up, in the absence of intervention; analyse whether there is a case for public sector intervention in the NGB market; and identify the optimum policy option(s) for the Scottish Executive to adopt.

Coverage and take-up

3. We have developed a definition of the various generations of broadband services using successive orders of magnitude of peak downstream bandwidth, with first generation broadband ("1B") being 10 times faster than dial-up internet access, second generation ("2B") being 100 times faster, and third generation ("3B") being 1,000 times faster.

4. The availability of 1B services in Scotland is now approaching 100% - making Scotland one of the most extensive broadband markets in the world. However, our study confirms that a new 'broadband divide' has already started to open up between urban and rural areas, in terms of the availability of 2B services (at least 5Mbit/s). Our expectation is that there will remain a significant proportion of Scotland's population (c. 26%) who will remain unable to access such services in the foreseeable future due to line lengths.

5. Furthermore, there is the prospect of a much more persistent divide emerging in 3B+ services (50Mbit/s +) from 2007 onwards. We anticipate that such services will start to become available through cable and VDSL2 platforms in urban areas. However, whereas the roll-out of 1B and 2B services in rural areas require upgrades in core transmission, backhaul capacity and exchange equipment (but uses the existing copper access infrastructure), the bandwidths associated with 3B+ services go beyond the capabilities of the legacy BT copper access infrastructure and necessitate the extension of fibre deep into the access network – to the cabinet, if not the home. There would be major costs associated with such a roll-out, and – in areas with no infrastructure level competition – relatively little incentive for BT or anyone else to risk such an investment, given that 3B+ services would be competing with 1B and 2B

services in these areas. Approximately 44% of Scotland's population will remain unable to access 3B+ services in 2015.

6. Nevertheless, take-up of broadband by consumers and businesses continues to grow rapidly. We estimate that c. 0.8 million broadband connections were in use in Scotland at the end of 2005, and that the total will rise to c. 1.8 million by 2015. By 2010, we anticipate that c. 36% of broadband connections will be at 1B bandwidths, 54% will be 2B, and 10% will be 3B+.

Economic and social impact

7. There is a growing body of evidence in the economic literature that Information and Communication Technology (ICT) – and the organisational and process innovations which it enables - has very significant positive impacts on productivity and economic output. Given that ICT investments being made by businesses are increasingly reliant on sites having broadband connectivity, we estimate that something in the order of a third to half of the productivity benefits associated with ICT-related innovation in the period 2001-2015 would not be realised if affordable broadband were not available.

8. Our model indicates that the annual Gross Value Added (GVA) of Scotland's market sector in 2015 will 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). Our central projection is that annual GVA of Scotland's market sector will be c. **£3.4 billion** higher in 2015 than it would have been otherwise (approximately 5% of annual market sector GVA).

9. Much of the economic benefit (45%) is expected to accrue to the J&K SIC grouping (financial services; real estate, renting and business activities). These are the industries that have adopted broadband most rapidly, and the sectors in which ICT has a disproportionately large effect, given the nature of their operations.

10. The bulk of the overall impact (77% in 2015) derives from the incremental benefits of 1B bandwidths vs dial-up. This is due to three factors: the roll-out and take-up of 2B and 3B+ broadband happens later than that of 1B; the incremental productivity benefits of 2B vs 1B and of 3B+ vs 2B are each assumed to be lower than the incremental benefits of 1B vs dial-up; and we have assumed a lag of four to six years before businesses upgrading to these bandwidths realise the full incremental productivity benefits associated with that upgrade.

11. In this context, the Scottish Executive's *Broadband for Scotland* intervention – to accelerate the roll-out of 1B services in Scotland – has had an important impact. We estimate that the 70% coverage point was brought forward by three months, 90% coverage by 17 months, and near-100% coverage by four years. Our model suggests that the economic impact of this intervention will peak in the year 2008, with the annual market sector GVA being approximately £150 million higher in that year than it would have been in the absence of intervention.

12. As well as bringing economic benefits, the availability and take-up of broadband has important social impacts. The advent of 2B and 3B+ services will facilitate new forms of video-related consumer entertainment – some of which will be in direct competition with

services delivered via other platforms. There is evidence that first generation broadband has accelerated the growth in teleworking, and we anticipate that the increased bandwidths associated with 2B and 3B+ broadband can only serve to make teleworking still more attractive; despite this, we are sceptical that the availability of broadband will, on balance, lead to any appreciable reduction in traffic levels and congestion.

13. In Scotland's health and education services, broadband is already bringing significant benefits. We foresee that these services could well have a much higher reliance on video-based (and large image file) applications than will be the case for a typical business. We therefore expect the higher bandwidths associated with affordable 2B and 3B+ services to bring substantial incremental benefits to the health and education sectors in Scotland – where they are available.

Policy implications

14. Analysing the case for further public sector intervention in Scotland's broadband market, we find that there remains an important market failure in the extent to which businesses are exploiting their broadband connectivity, and there is a further potential market failure in respect of unidentified clusters of underserved demand.

15. Notwithstanding our projection of a new 'broadband divide' between urban and rural areas in the availability of 2B and 3B+ services, it is not possible yet to say with absolute certainty which areas will remain persistently underserved by the market. Furthermore, it is too early to judge whether the future lack of 2B and 3B+ services in certain areas will represent an unacceptable inequity, given the availability of substitute entertainment services over other platforms, and the possibility of multiple (bonded) 1B lines being used by businesses.

16. Our recommended overall approach, therefore, is to refrain from major intervention in the 2B and 3B+ markets at this stage, but to minimise avoidable barriers to network investment and ensure that Scottish businesses are well informed regarding the opportunities presented by broadband-enabled ICT. The first step, however, is to ensure that ICT as a whole is given sufficient weight, at a policy-making level, as a driver of productivity growth in Scotland.

17. Our specific recommendations are as follows:

- Recommendation 1: Radically increase the profile of ICT within Scottish productivity policy (including the development of an overall ICT policy for Scotland, and the updating of the broadband strategy)
- Recommendation 2: Ensure that existing publicly-funded ICT support is '2B ready'
- Recommendation 3: Exploit the broadband-enabled web as a channel for stimulating ICT-related innovation by Scottish businesses
- Recommendation 4: Develop mechanisms for identifying and aggregating under-served demand for broadband

- Recommendation 5: Minimise avoidable barriers to private sector investment in 2B/3B+ networks
- Recommendation 6: Avoid market-distorting interventions in the 2B/3B+ markets
- Recommendation 7: Ensure that Scotland's planning system takes competitive broadband availability into account
- Recommendation 8: On completion of the 'Pathfinder' procurements, determine the optimum scale and scope for future public sector broadband demand aggregation initiatives

1 Introduction

1.1 It is widely recognised that the exploitation of Information and Communications Technology (ICT) – and broadband, in particular – can bring profound economic and social benefits to businesses and citizens.

1.2 As a result, public policy makers around the world have sought to ensure that broadband services are made as widely available as possible across their territories. The UK has been notably successful in this regard, with broadband coverage now approaching 100%.

1.3 Ubiquitous broadband coverage has been particularly challenging to achieve in Scotland, due to its dispersed population and mountainous terrain. Nevertheless, market developments - in conjunction with focused demand-side and supply-side initiatives by the public sector – succeeded in delivering broadband to every community in Scotland by the end of 2005. This is no mean achievement, considering that the Scottish Executive's Supply Side Intervention (SSI), alone, covers an area roughly the size of Switzerland.

1.4 However, the UK broadband market is evolving rapidly. A number of suppliers are now offering or trialling 'Next Generation Broadband' (NGB) services considerably above 2Mbit/s. A service of 'up to 22Mbit/s' for £30 per month has recently been launched by one operator in parts of Edinburgh and Glasgow, and one of the largest players has mooted the possibility of 50Mbit/s services by 2007. Such higher bandwidths will enable new applications to be used, and these could potentially bring important social and economic benefits to those households, businesses and public sector organisations that have access to them.

1.5 As the NGB market develops, the Scottish Executive is concerned both to optimise the social and economic benefits of broadband for Scotland, and to avoid the emergence of an unacceptable new digital divide. A report by KPMG in February 2005 (commissioned by Scottish Enterprise) provided information on the NGB market in seven countries and outlined Scotland's current relative position. SQW was commissioned to undertake a second phase of research, to:

- assess the economic impact of broadband for Scotland;
- appraise the incremental benefits (social and economic) of NGB services and applications;
- forecast the likely future evolution of NGB coverage and take-up over the next five years, in the absence of intervention;

- analyse whether there is a case for public sector intervention in the NGB market;
- identify the optimum policy option(s) for the Scottish Executive to adopt.

1.6 This document is the final report of our study, and is structured as follows:

- Section 2 outlines our methodology;
- Section 3 summarises our findings on future NGB coverage;
- Section 4 presents our estimates of future NGB take-up by households and businesses;
- Section 5 assesses the economic impact on Scotland of various broadband generations, including an analysis of the impact of the *Broadband for Scotland* intervention;
- Section 6 discusses the social impacts;
- Section 7 sets out the policy implications, analysing the rationale for intervention and discussing our recommendations on specific policy actions; and
- Section 8 is a summary of our policy recommendations.

1.7 There are five annexes:

- Annex A lists the people and organisations consulted in the course of our study;
- Annex B presents some illustrative comments from our consultees;
- Annex C summarises the approaches taken by four previous studies into the economic impact of broadband;
- Annex D includes some brief case studies, taken from published material, to provide qualitative illustrations of how broadband can help to improve business performance in a variety of industries;
- Annex E lists the documents referenced in the report.

2 Methodology

Definitions

2.1 The question that immediately arose at the start of this project was "what constitutes 'Next Generation' ?". The KPMG study proposed the following definition of NGB:

- *"Flexible bandwidth, available on demand, throughout Scotland for the net benefit of Scotland's competitiveness and its people".*

2.2 KPMG also noted that that there was no current consensus on the bandwidths associated with NGB, but that some stakeholders – including the Scottish Executive – considered that NGB services would have a downstream bandwidth of at least 20Mbit/s, and that these would be preceded by an 'intermediate' phase in which progressively higher bandwidths of up to 20Mbit/s would be offered.

2.3 However, the process of designing a model of the coverage and take-up of NGB services has necessitated the use of more clear-cut definitions. In discussion with the Scottish Executive, we observed that the phrase '*next* generation' was increasingly likely to be rendered a misnomer by rapid market developments, and we decided to use the concept of successive orders of magnitude of peak downstream bandwidth, relative to dial-up internet access, as illustrated in the table below.

Table 2-1 Definitions used in this study

Generation	Label	Description
Dial-up		Bandwidth in the order of 0.05Mbit/s
First generation broadband	1B	Downstream peak bandwidth of at least 0.5Mbit/s[1] (10 x dial-up), but less than 5Mbit/s, at a price affordable by households and SMEs
Second generation broadband	2B	Downstream peak bandwidth of at least 5Mbit/s (100 x dial-up), but less than 50Mbit/s, at a price affordable by households and SMEs
Third generation broadband	3B	Downstream peak bandwidth of at least 50Mbit/s (1000 x dial-up), but less than 500Mbit/s, at a price affordable by households and SMEs

2.4 This approach has the attractions of being rigorously technology neutral (and not, for example, determined by the current capabilities of ADSL, ADSL2+ or VDSL2 technology), and of being able to stand the test of time as successively higher bandwidth offerings become available. Furthermore, the large steps between the 'entry point' bandwidths mean that quite

[1] Note that this aligns with the definition of broadband adopted for the Scottish Executive's recent Supply Side Intervention, but differs from Ofcom's definition of broadband referring to higher speed always-on services, offering data rates of 128kbit/s and above.

different applications can be supported by the various broadband generations, leading to distinct user behaviours and impacts.

2.5 In practice, of course, there is relatively little perceptible difference between the capabilities of a 4Mbit/s (1B) service and a 5Mbit/s (2B) service, for example. For the purposes of this study, however, we have needed to distinguish between different generations of broadband, and this has led to a need to 'draw the line' somewhere.

2.6 Given that affordable Gigabit services are already being launched in some other countries, it is likely that '4B' services (of at least 500Mbit/s) will be made available in parts of Scotland well within our modelling period (which extends to 2015). In this study, however, we are not separately considering services of more than 500Mbit/s; rather, we use the term '3B+' to refer to third generation broadband bandwidths and above.

Consultations

2.7 Our analysis has been informed by an extensive consultation exercise with senior personnel in industry and public sector organisations, through a mixture of face-to-face and telephone interviews.

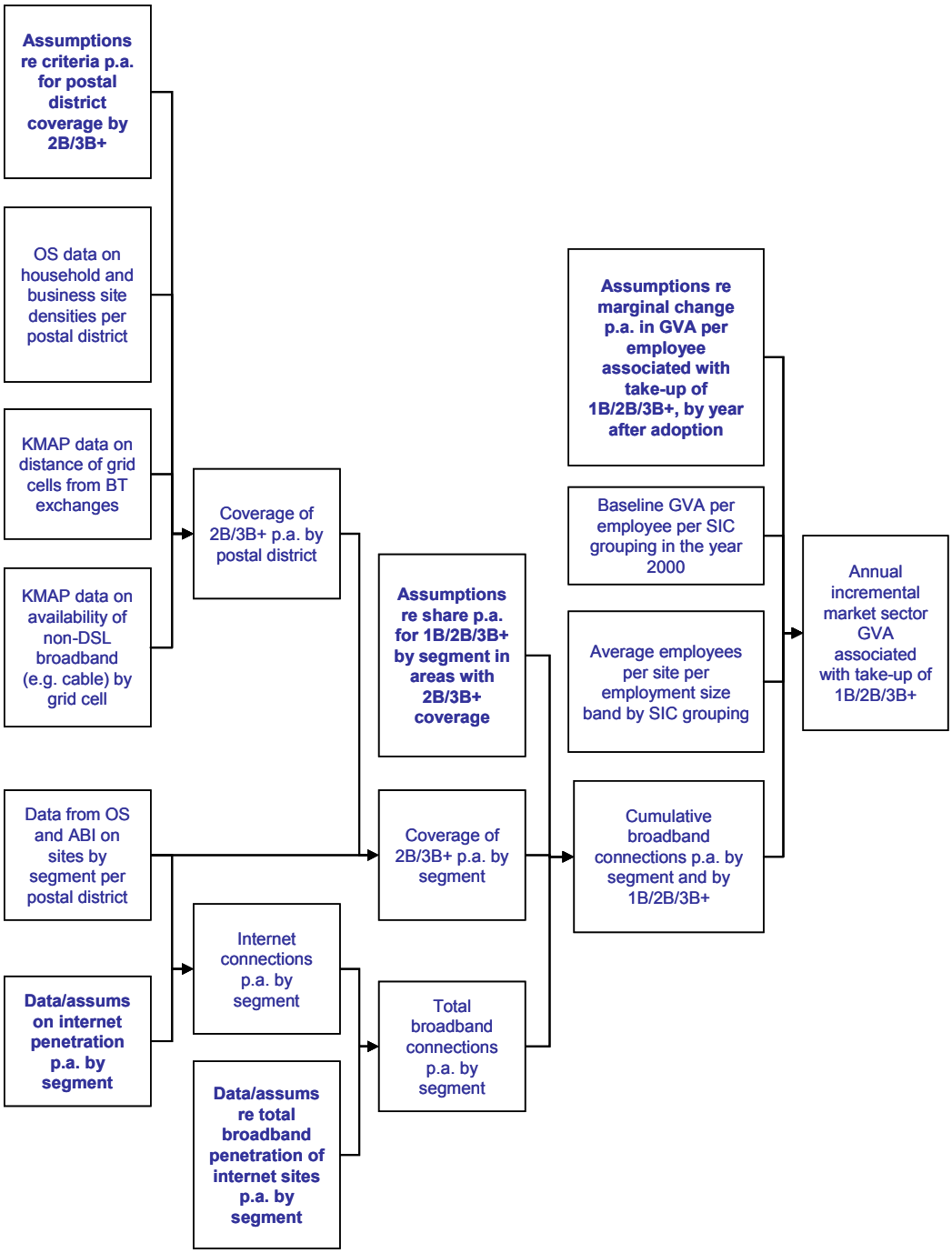
2.8 We have consulted with 65 people, from 50 different organisations, as listed in Annex A. These consultations have sought to test a variety of hypotheses regarding NGB coverage, take-up, impact and policy.

2.9 It should be stressed, however, that the views presented in this report are those of SQW, and do not necessarily reflect the views of the Scottish Executive or any individual consultee. Given the very high degrees of uncertainty in this market, we inevitably heard a wide spread of opinions as to the future shape of NGB in Scotland: there is no single consensus view. We have applied our own judgement, to derive our projections of a likely future.

Model structure

2.10 The flow chart below illustrates the overall structure of the model we have developed for our coverage, take-up and economic impact forecasts. The key assumptions that drive our projections have been highlighted in bold.

Figure 2-1 Overall structure of the model [source: SQW]



2.11 We can be entirely confident that our model's projections will **not** turn out to be absolutely correct – there are too many variables at work for anyone to be able to predict such a rapidly developing market with certainty. In putting our projections together, we have attempted to take the 'mid-line', around which the chances of the market developing more rapidly and more extensively than forecast are approximately equal to the chances of it developing less rapidly and less extensively than forecast.

2.12 The segments modelled are as follows:

- Households in Scotland
- Business sites in Scotland by broad SIC groupings, each of which is divided into four employment size bands (1-10 employees, 11-49 employees, 50-199 employees and 200+ employees):
  - A, B (Agriculture, hunting and forestry; Fishing)
  - C, D (Mining and quarrying; Manufacturing)
  - E, F, I (Electricity, gas and water supply; Construction; Transport, storage and communication)
  - G (Wholesale and retail trade; repair of motor vehicles, motorcycles and personal and household goods)
  - H (Hotels and restaurants)
  - J, K (Financial intermediation; Real estate, renting and business activities)
  - O (Other community, social and personal service activities)
  - L, M, N (Public administration and defence, compulsory social security; Education; Health and social work)

2.13 We have used a variety of data sources, including:

- Scottish Enterprise's KMAP database, which includes a division of Scotland's land mass into 500m x 500m grid cells, each which has an indication of the radial distance of the grid cell centroid to the nearest BT exchange, and an indication of whether non-DSL broadband services (such as cable) are available.
- Ordnance Survey Geographic Information System (GIS) data on the numbers of residential postal delivery points (as a proxy for households) per postcode, the numbers of non-residential delivery points (as a proxy for business sites) per postcode, and the geographic size of postal districts[2].
- ONS (2004) – the analysis of Regional Gross Value Added from the Office for National Statistics.
- The Annual Business Inquiry (ABI), which provides information on employees per SIC section, and on the numbers of 'data units' (as a proxy for business sites) in each postal district, broken down by Standard Industrial Classification section and employment size band.

[2] Postal district refers to the first part of the postcode. For example, the postcode EH2 4PH is in postal district EH2.

2.14 Our assumptions have been benchmarked through our literature review and industry consultations, combined with a variety of public domain sources of information, including:

- Ofcom reviews of the UK communications market;
- the Scottish Household Survey (which includes information on historic household internet penetration);
- UK operators' public statements on future plans and expectations;
- overseas' operators' public statements on future plans and expectations;
- industry press; and
- the Scottish E-Business Survey 2005 (SEBS 2005), from which we have extracted up-to-date information on the current levels of internet and broadband penetration in Scotland by SIC grouping at various employment size bands.

3 Coverage

3.1 With the extension of coverage through the Scottish Executive's Supply Side Intervention and the Connected Communities network in the Western Isles, we have taken first generation broadband (1B) coverage to be approaching 100% of Scotland's households and businesses by the end of 2005.

3.2 The following sub-sections discuss recent developments in the 2B and 3B+ markets, summarise key messages emerging from our consultations, and present our modelling assumptions and projections.

Market developments

3.3 Bandwidth is currently being used as a key competitive differentiator in the UK broadband market, and the 2B market is developing rapidly. Key recent developments include the following:

- In November 2004:
  - UK Online (Easynet) launched an unlimited 'up to 8Mbit/s' ADSL service over unbundled local loop, for £40 per month (reduced to £30 in April 2005).
- In March 2005:
  - BT announced the start of trials of an 'up to 8Mbit/s' ADSL service in Strathclyde and Greater London, and trials of ADSL2+ offering speeds up to 18Mbit/s.
- In June 2005:
  - Bulldog announced the launch of an 'up to 8Mbit/s' ADSL service over unbundled local loop, for £16 to £30 per month, depending on usage allowance.
- In August 2005:
  - Ofcom published Issue 3 of the Access Network Frequency Plan, which allows the use of ADSL2+ technology over BT's copper access network.
  - NTL announced plans to migrate its broadband customers to 10Mbit/s as standard by the end of 2006, starting with those customers currently taking their 3Mbit/s service. There are no plans to change monthly prices, but

different levels of service will have different monthly usage allowances. NTL also noted that broadband speeds of 30Mbit/s to 50Mbit/s are possible in the future using DOCSIS 3.0 (over their Hybrid Fibre-Coax network[3]) or ADSL2+ (over the twisted copper pairs currently used for end user telephony).

  - Telewest announced free-of-charge speed upgrades for its customers: the peak bandwidth of the entry level service is increased from 0.5Mbit/s to 2Mbit/s (£18 per month); the 1Mbit/s service is increased to 4Mbit/s (£25 per month); and the previous 2Mbit/s and 4Mbit/s options are replaced by a 10Mbit/s service (£35 per month). No usage allowances are applied to any of these options. Completion of the upgrades is planned for early 2006. Telewest also noted that cable services of up to 50Mbit/s could be possible by 2007, using DOCSIS 3.0 or Ethernet to the Home.

- In September 2005:
  - Be launched an 'up to 24Mbit/s' service for £24 per month at certain exchanges in London, using ADSL2+ technology over unbundled local loops.
  - Video Networks announced that it plans to move to ADSL2+ for the delivery of its triple play HomeChoice offering.
- In November 2005:
  - UKOnline (Easynet) launched an 'up to 22Mbit/s' service for £30 per month across its LLU exchange network – including 11 exchanges in Glasgow and Edinburgh (serving c. 170k households).
- In February 2006:
  - NTL announced that it will start field trials in March of a service offering up to 100Mbit/s, using a 'pre-DOCSIS 3.0' channel bonding solution from ARRIS.
- In March 2006:
  - BT Wholesale launched DSL Max products (offering up to 8Mbit/s) at over 5300 exchanges.
- In November 2006:

[3] DOCSIS 3.0 uses a technique known as 'channel bonding', which enables a user's data to be spread over multiple frequency channels, rather than the single channel used currently. This requires changes to the equipment at the customer's premises (the cable modem) and at the cable operator's local hubs (the Cable Modem Termination Systems), but operates over existing cables between the CMTS and the customer premises.

- NTL Telewest announced that it would be launching a commercial trial of a 50Mbit/s service to paying customers.

3.4 Overseas, there have been significant developments in the 3B+ market:

- In 2004, both Verizon and SBC announced major deep fibre roll-outs in the US; Verizon will extend fibre to about 10 million homes by 2010 (20% of their footprint), the first 3 million of which would cost c. $3 billion; SBC are not extending fibre as far as the home, but will invest c. $4 billion to serve 18 million homes (37% of their footprint) through Fibre-to-the-Node technology by 2008.

- In April 2005, Hong Kong Broadband Network launched a 1Gbit/s service for residential customers in Hong Kong (at c. £120 per month).

- In June 2005, Motorola announced that they are working on upgrading Starhub's network to DOCSIS 3.0, in order to offer speeds of up to 50Mbit/s to 100Mbit/s to StarHub's customers in Singapore.

- In September 2005, Deutsche Telekom announced that it would roll-out 50Mbit/s services (using fibre to the cabinet) to the top 50 cities in Germany by 2007, at a cost of c. EUR3 billion.

- In December 2005, Telefonica announced that it would start trials of VDSL in Spain in 2006, offering speeds up to 52Mbit/s. Mass deployment is expected to commence in 2007, with 60% of households in Spain having access by 2010.

- In January 2006, France Telecom announced that it would be piloting Fibre to the Home with thousands of households in six districts of Paris and six cities in the Haut-de-Seine.

- In January 2006, Danish incumbent operator TDC announced that it will roll-out a 'triple-play' offering of up to 50Mbit/s, covering more than 80% of households in Denmark over the next two years.

- In September 2006, French ISP Iliad announced that it would spend EUR1 billion to roll out a Fibre to the Home network past 4 million premises by 2012, starting in Paris.

Key messages from consultations

3.5 Our consultees provided valuable insights into the likely development of 2B and 3B+ coverage in Scotland. Key messages were as follows:

- The business cases for deployment of 2B and 3B+ services are typically predicated on the consumer (rather than business) market. Unless 2B and 3B+ bandwidths are commercially viable for ISPs to offer to households in a given area, they are unlikely to become widely available to SMEs.

- Cable companies would be likely to use their HFC infrastructure for 'on-net' services, and ADSL2+ over unbundled local loops elsewhere.

- Above 10Mbit/s, the pace is currently being set by the LLU operators, using ADSL2+ technology in cities. Consultees noted that 24Mbit/s would only be available on very short loops, and that 16Mbit/s to 18Mbit/s would be more typical. At the extremes of DSL's capabilities, services tend to be more prone to faults (a line's maximum capability could vary from day to day, depending on weather conditions, for example). Consultees anticipated that BT would have to launch ADSL2+ services, in order to compete with LLU operators, but that its roll-out to rural and remote parts of Scotland would be likely to follow the 21CN roll-out[4].

- VDSL2 would require fibre to the cabinet, and was generally perceived to be some way away for the UK. There may well be significant operational challenges in installing and operating DSLAMs in street cabinets. Most consultees expressed doubts as to whether this would extend to rural areas in the foreseeable future, although one noted that it may not be much more expensive to VDSL2-enable a cabinet serving 200 customers in a village than it would be to VDSL2-enable a cabinet serving 200 customers in a city.

- Mass market Fibre to the Home (FTTH) was generally not seen to be commercially viable in the UK in the near term, given the capabilities of DSL and cable technologies. It is quite possible that some operators will 'have a go' at FTTH in Scotland before 2015. However, in the medium term, deployment is likely to be restricted to new build housing developments (where the cost of installing fibre is close to the cost of installing new copper) and multi-occupancy buildings (where the costs can be shared across several customers).

- There was some scepticism regarding the prospects for WiMAX. A number of consultees noted that the technology has not, so far, lived up to its early promises in terms of performance. Although WiMAX services will start to appear in Glasgow and Edinburgh in 2006, most ISPs interviewed considered that WiMAX would find it difficult to compete in urban areas where DSL and cable technologies were already established and rapidly evolving, but that it may have a role in extending higher bandwidths to rural areas. It was also noted, however, that economics of density apply

[4] 21CN is a major upgrade to BT's core network – rationalising several different platforms, including the PSTN, onto a very high capacity IP network. This much increased core network capacity – including the backhaul out to exchanges – enables higher bandwidth services to be offered to customers; however, it should be noted that the access network is *not* within the scope of 21CN.

to wireless solutions as well as to wireline offerings (i.e. that WiMAX might not be economic to deploy in rural areas).

- Mobile broadband was seen to have an important role in enabling seamless working for business people, and offering entertainment and e-commerce for consumers on the move. It was generally seen to complement – rather than substitute for – fixed broadband. Given that mobile bandwidth is likely to retain a significant premium over fixed bandwidth (due to the relative scarcity of spectrum and the additional network intelligence associated with mobile broadband provision), and given the relatively small screen size of a mobile phone compared to that of a computer or TV, the bulk of broadband usage (in terms of data) is expected to remain on fixed networks.

Modelling assumptions

3.6 SQW's view is that 2B bandwidths (i.e. at least 5Mbit/s downstream peak) will rapidly become the standard broadband offering over the next year in areas where they are technically possible – i.e. in areas served by Telewest and NTL (now merged as NTL Incorporated), and sites within c. 1.5 km radial distance of a BT exchange which has been enabled for at least 'up to 8Mbit/s' ADSL service either by LLU operators or by BT Wholesale[5].

3.7 For simplicity, our model treats all cabled areas equally: i.e. it applies the same profile of 2B and 3B+ coverage growth in cabled areas, whether the area is served by NTL, Telewest or WightCable North (ex Omne Communications, which serves parts of Ayrshire). The only exception to this is our assumption that there was no 2B coverage in WightCable North areas as at the end of 2005, given that no upgrades have been announced as yet.

3.8 Given that 21CN needs to be rolled out to 100% of BT's exchanges, we anticipate that 'up to 8Mbit/s' services will eventually be made available to *all* BT's exchanges. This includes – probably towards the end of the 21CN roll-out, in c. 2010 - those currently served by the Exchange Activate service (through the Executive's Supply Side Intervention) and those 'untriggered' exchanges on the Western Isles (which were excluded from the Supply Side Intervention on the grounds that the Connected Communities wireless broadband initiative was already addressing those areas).

3.9 Regarding 3B+, we have assumed that the adoption of DOCSIS 3.0 or Ethernet to the Home will allow UK cable companies to offer peak bandwidths of 50Mbit/s and above – starting in 2007 and completing roll-out across their networks by the end of 2008.

[5] We estimate that c. 70% of households in Scotland are within 1.5 km radial distance from a BT exchange. This is broadly in line with BT's press release of 2nd March 2006, which indicated that it expects 78% of BT lines to be able to support 4Mbit/s, and 42% to be able to support 6Mbit/s.

3.10 We anticipate that BT will have to respond to this competitive threat by rolling out fibre to the cabinet and VDSL2 technology in urban areas – starting in the densest areas of population in 2008. It will, we believe, take a very long time for BT to extend such services to rural areas, however, given:

- the heavy costs of digging up roads to lay new ducts and fibre in the access network, and installing new street cabinets capable of housing DSLAMs (we estimate that SBC's 'Lightspeed' roll-out is costing c. £120 per household covered, and that DT's equivalent roll-out is costing c. £180 per household covered[6]);
- the lack of infrastructure-level competition in rural areas (leading to BT's existing 1B/2B wholesale revenues facing little competitive threat);
- the relatively small incremental benefit to consumers of 3B+ services versus 2B or 1B services, and the likelihood that the premium that BT Wholesale will be able to charge for 3B+ services (versus 1B or 2B services) would be insufficient to provide a reasonable return on the incremental investment required.

3.11 By 2015 we have assumed that 3B+ services will have been rolled out to areas with at least 80 'weighted DPs[7]' per square km. In all years, we have assumed that long digs to provide fibre to remote cabinets will be prohibitively expensive, and that, on average, only customers within c. 1.5 km of an enabled BT exchange will be able to access 3B+ services.

3.12 It is possible that wireless technologies could provide a lower cost solution for extending 3B+ services to rural areas. However, such services would be competing against established wireline 1B and 2B services from several different ISPs in relatively low density areas, and we are sceptical as to whether the incremental benefit to consumers of 3B+ bandwidths would allow wireless ISPs to achieve sufficient volumes – at sufficient premiums – to make a commercial return on the investment involved in constructing a wireless network at such capacities.

3.13 Similarly, we do not currently see an attractive commercial case for wireless operators to undertake mass roll-outs of 2B services in rural areas, given that they would be competing with established 1B broadband services, and given the recent national roll-out of fixed 2B services through BT's ADSL Max service.

3.14 We therefore consider it to be relatively low probability that widespread wireless networks at 2B or 3B+ bandwidths will be developed in rural areas of Scotland during our modelling

[6] These unit costs would imply that an investment in the order of £4 billion would be required for VDSL2 roll-out throughout the UK (c. £400 million for Scotland).

[7] We have used a notional measure of Weighted DPs (= residential postal delivery points plus 5 x non-residential postal delivery points) in order to reflect the higher total revenue potential associated with business sites. The factor of 5 was derived from an analysis of BT's average revenue per household and an estimate of their average revenue per business site.

period (through to 2015). Whilst some local community networks may well emerge – especially in 'not spots' beyond the reach of cable and the higher speed DSL services, we would expect these to be relatively small-scale, and our model has not assumed any incremental 2B or 3B+ coverage due to wireless networks in rural areas.

3.15 In recent years we have seen significant extensions to the reach of DSL technology. It is possible that further technology changes could increase the reach of the higher speed services beyond those assumed in our model. However, our consultations indicate that there is little remaining potential for further extending the length of line over which such services can operate, and that operational work-arounds, such as extending fibre to cabinets serving customers far from the exchange, are a more likely means of reach extension.

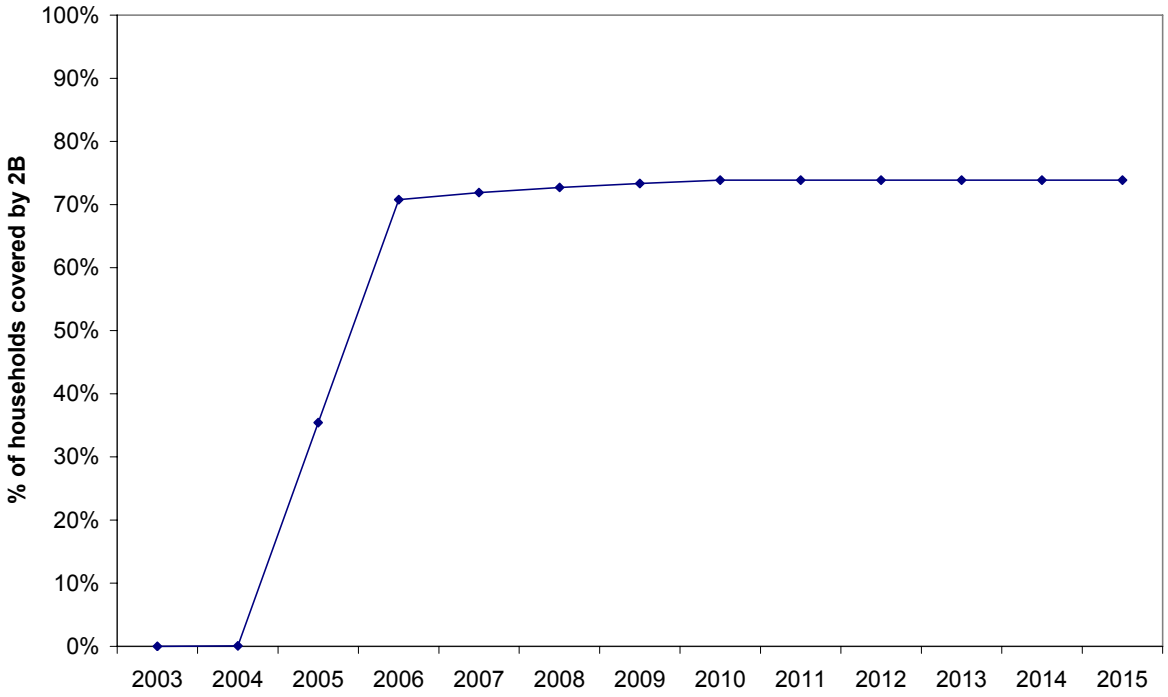
Coverage projections

Second generation broadband (2B)

3.16 As shown in the chart below, we estimate that 2B coverage in Scotland will rise from c. 35% of households at the end of 2005 to a saturation point, determined by the reach of 5Mbit/s ADSL, of c. 74% by the end of 2010 (61% in HIE area, 75% in SE area[8]).

3.17 The 2B coverage is driven initially by upgrades for cable customers, and then by BT's roll-out of its ADSL Max services.

Figure 3-1 Projected household coverage of 2B services in Scotland [source: SQW]



3.18 The maps below compare our indicative projections for 2005 and 2010 for the coverage, by postal district, of 2B services in Scotland.

[8] HIE = Highlands and Islands Enterprise; SE = Scottish Enterprise

Figure 3-2 Estimated 2B coverage of households by the end of 2005, by postal district [source: SQW]

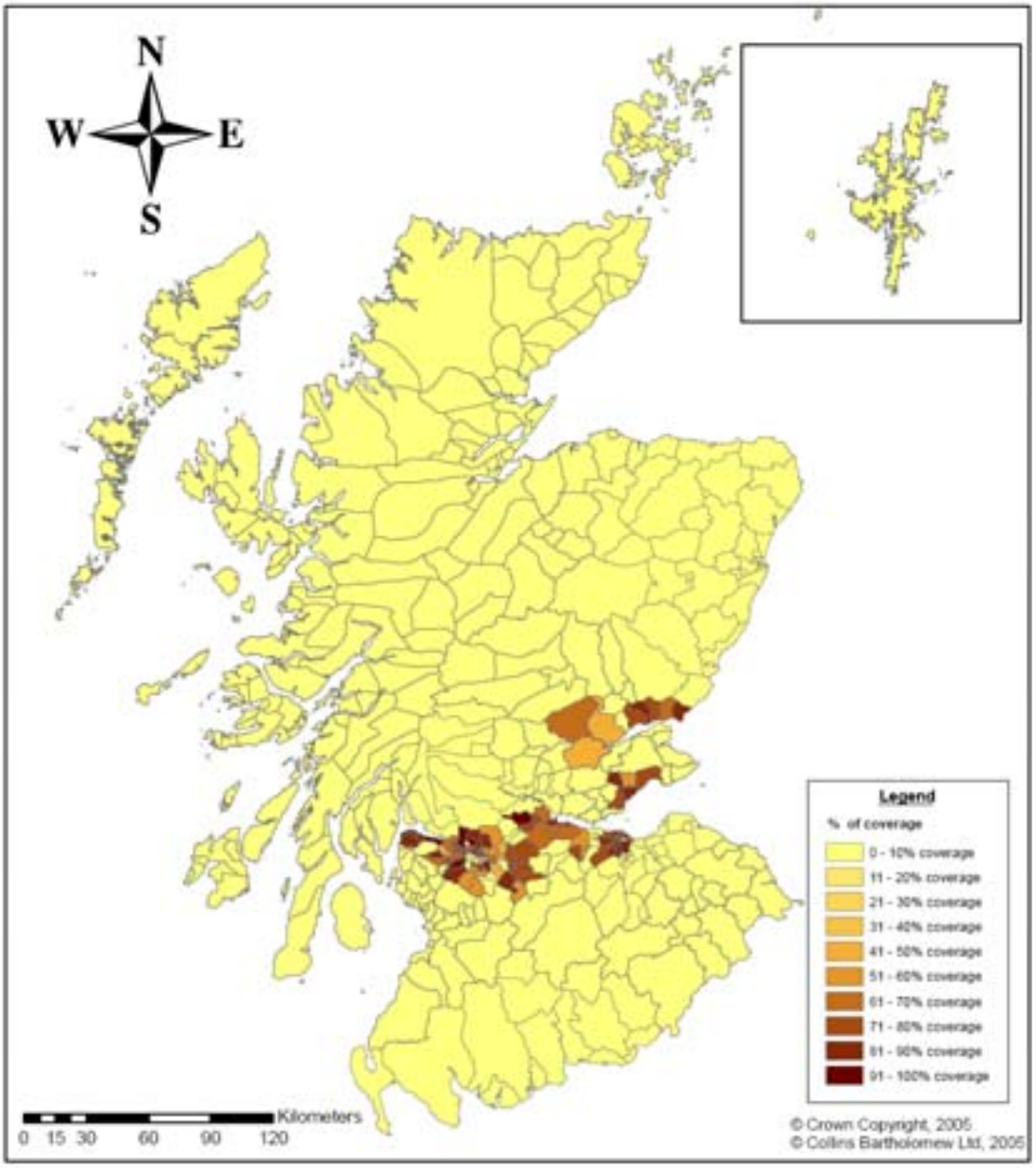
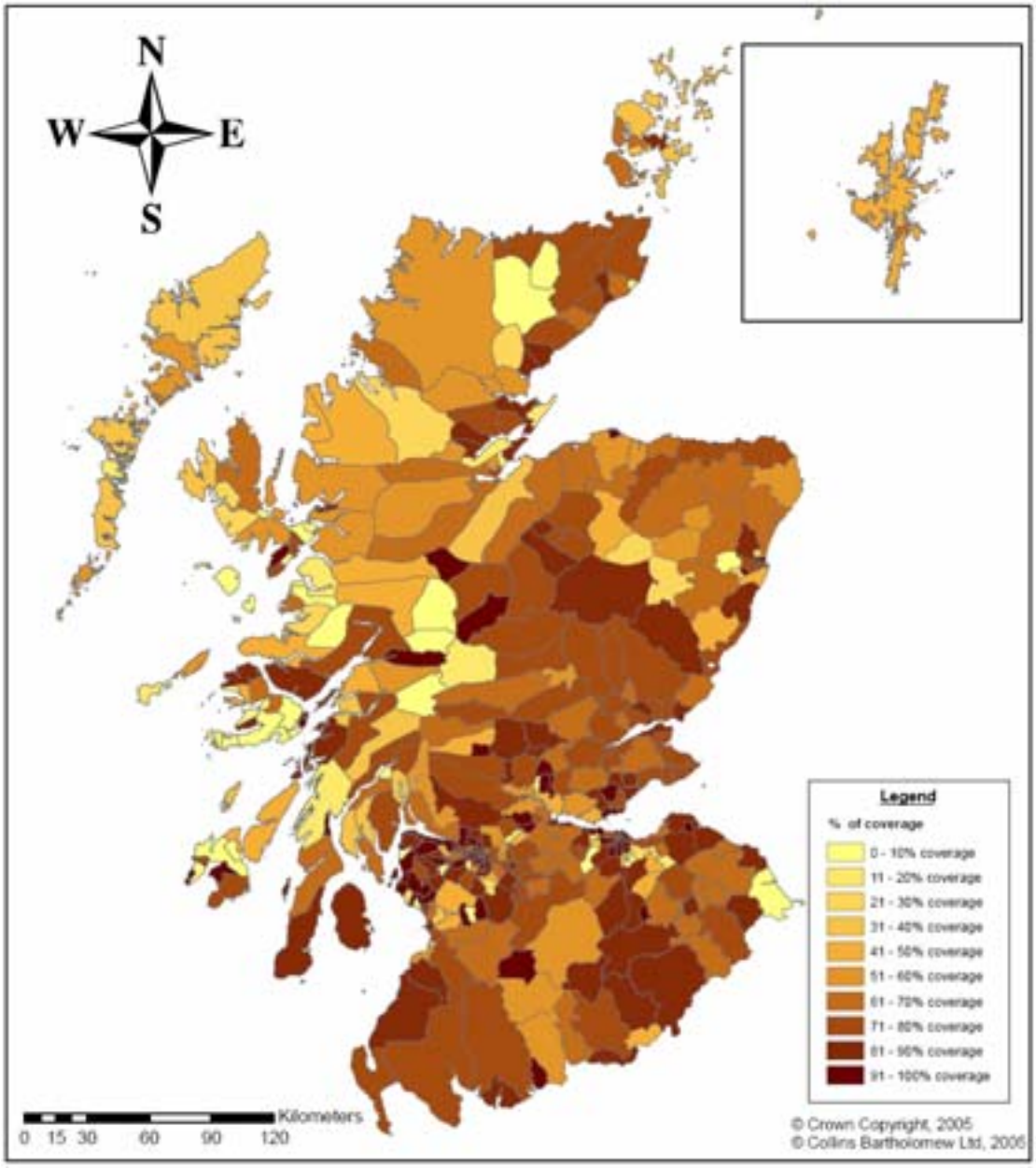


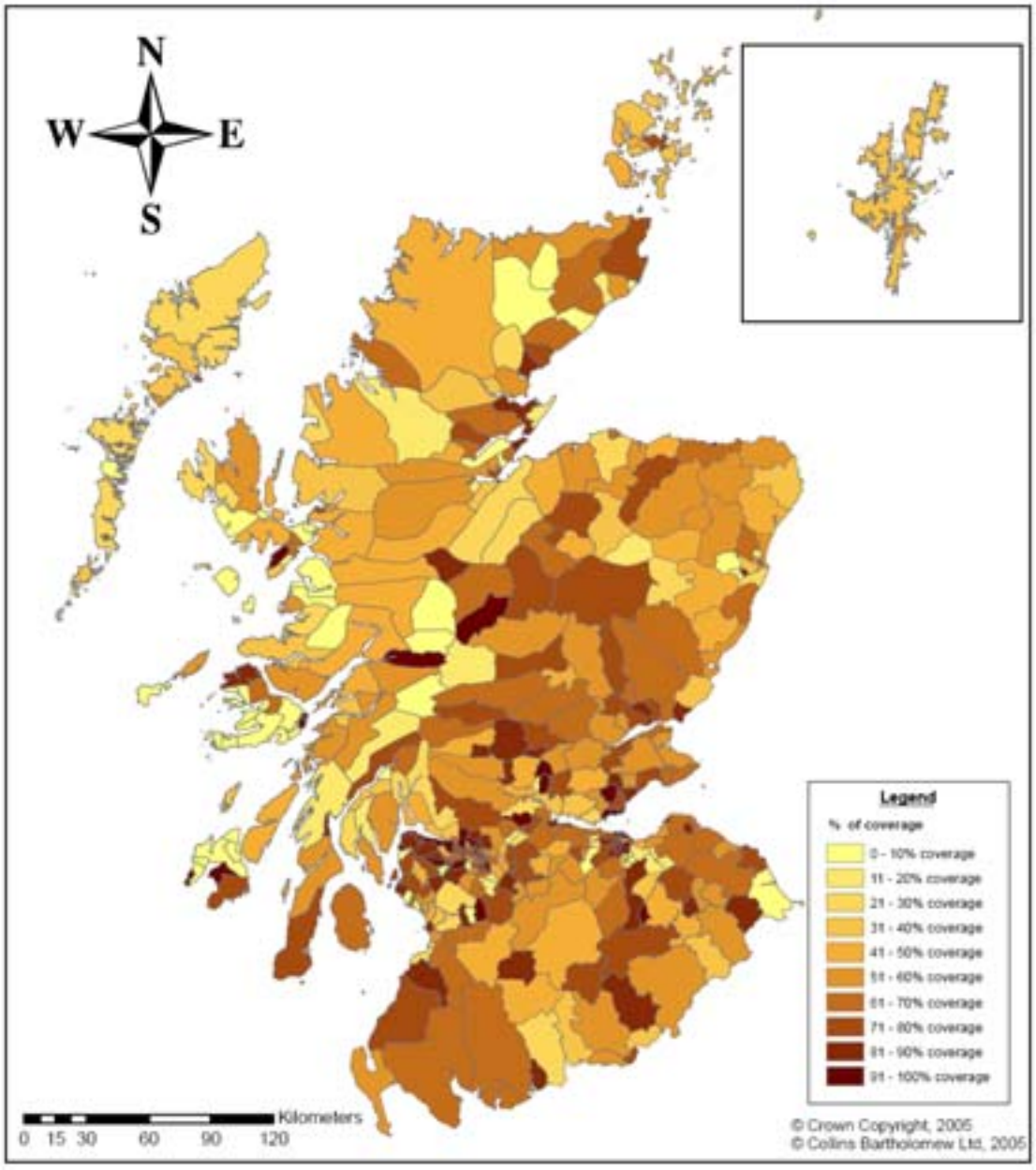
Figure 3-3 Projected 2B coverage of households by the end of 2010, by postal district [source: SQW]



2.5B

3.19 We have also developed projections for the availability of services in the order of 15Mbit/s ("2.5B" – a subset of our 2B generation), using an assumption that only cable customers and customers within 1 km radial distance from an ADSL2+ enabled BT exchange would be able to obtain such services[9]. The map below shows our projections for 2.5B coverage by the end of 2010, by which time we expect the coverage to have reached its maximum level of c.61% of Scottish households (46% in HIE area, 62% in SE area).

Figure 3-4 Projected "2.5B" coverage of households by the end of 2010, by postal district [source: SQW]

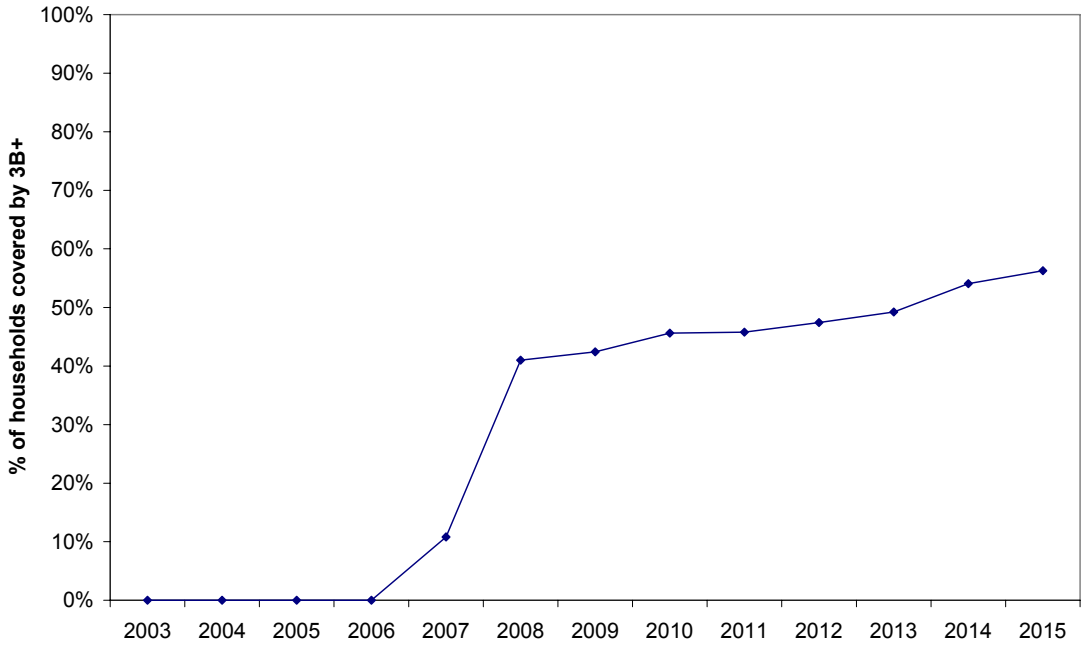


[9] We estimate that c. 47% of households in Scotland are within 1 km radial distance from a BT exchange.

Third generation broadband and above (3B+)

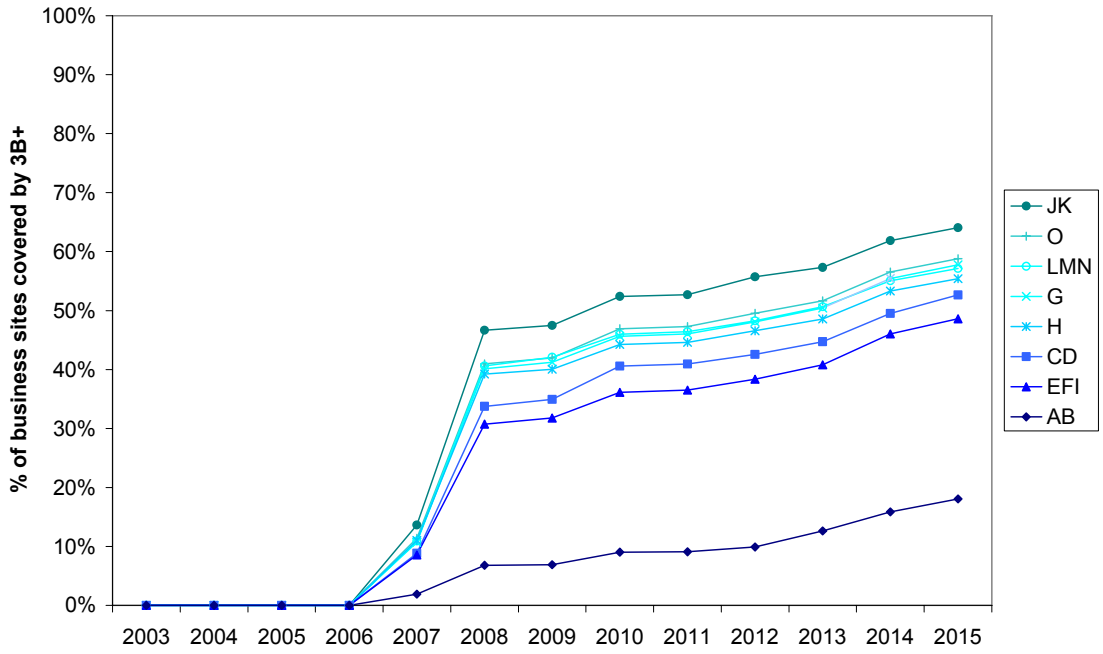
3.20 Regarding 3B+, our expectations are that such bandwidths will become reasonably widely available in Scotland's cities by 2008, but that they will take a long time to extend into smaller towns and rural areas. As shown in the chart below, our projection is for 3B+ coverage to rise rapidly from 0% in 2006 to c. 41% by the end of 2008 (0% in HIE area, 45% in SE area), but for coverage growth to be relatively slow thereafter, rising to c. 56% by the end of 2015 (10% in HIE area, 60% in SE area).

Figure 3-5 Projected household coverage of 3B+ in Scotland [source: SQW]



3.21 When we consider the coverage of business sites, we observe a significantly slower and lower 3B+ coverage of sites in the predominantly rural SIC sections A&B (Agriculture, hunting and forestry; and Fishing). By the end of 2015, our projection is for just 18% of sites in these industries being able to access 3B+ services, whereas 64% of sites in section J&K (Financial intermediation; Real estate, renting and business activities) would have coverage by then.

Figure 3-6 Projected business site coverage of 3B+ in Scotland, by SIC grouping [source: SQW]



3.22 The maps below compare our indicative projections for 2010 and 2015 for the household coverage of 3B+ services in Scotland, by postal district.

Figure 3-7 Projected 3B+ coverage of households by the end of 2010, by postal district [source: SQW]

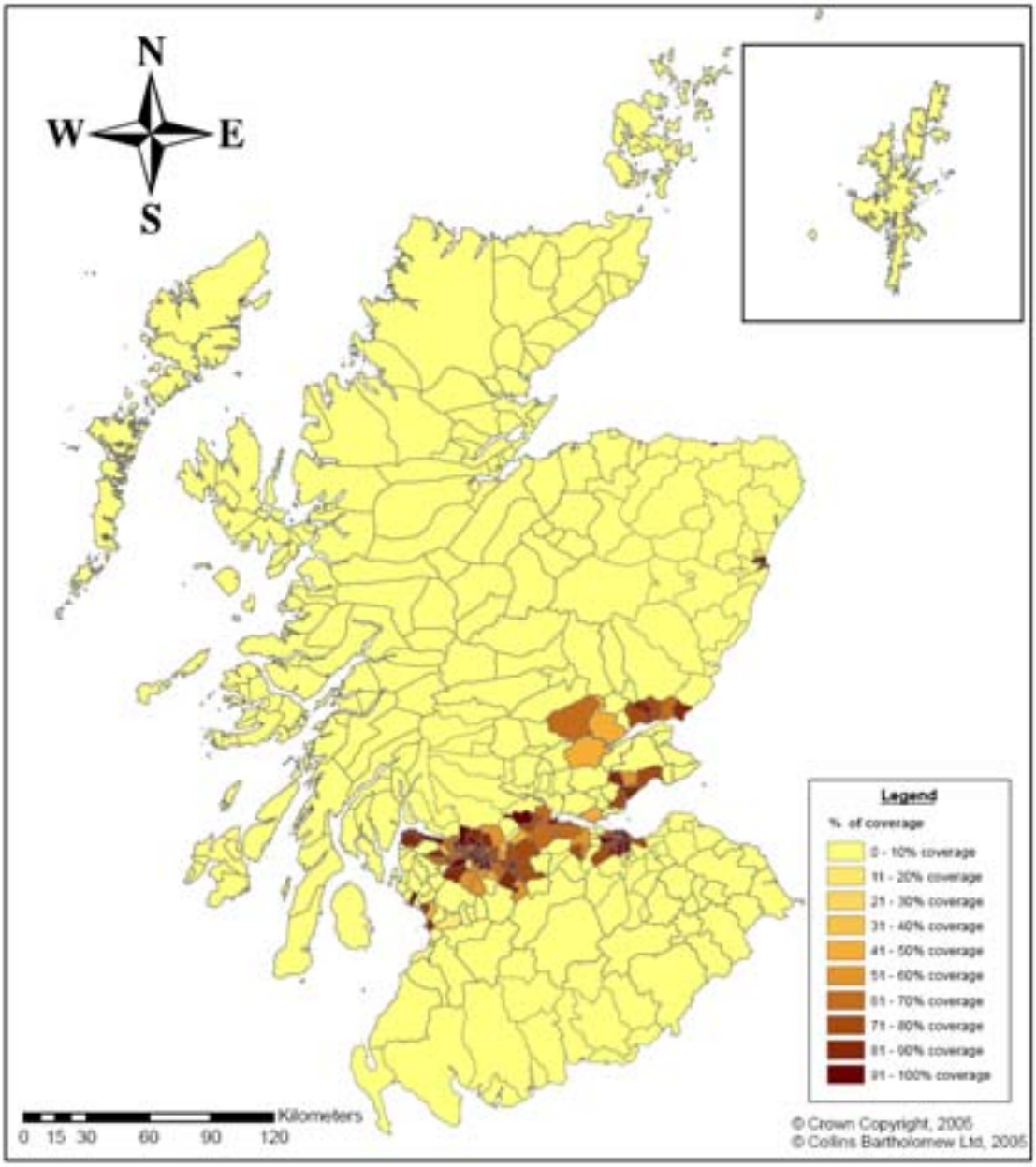
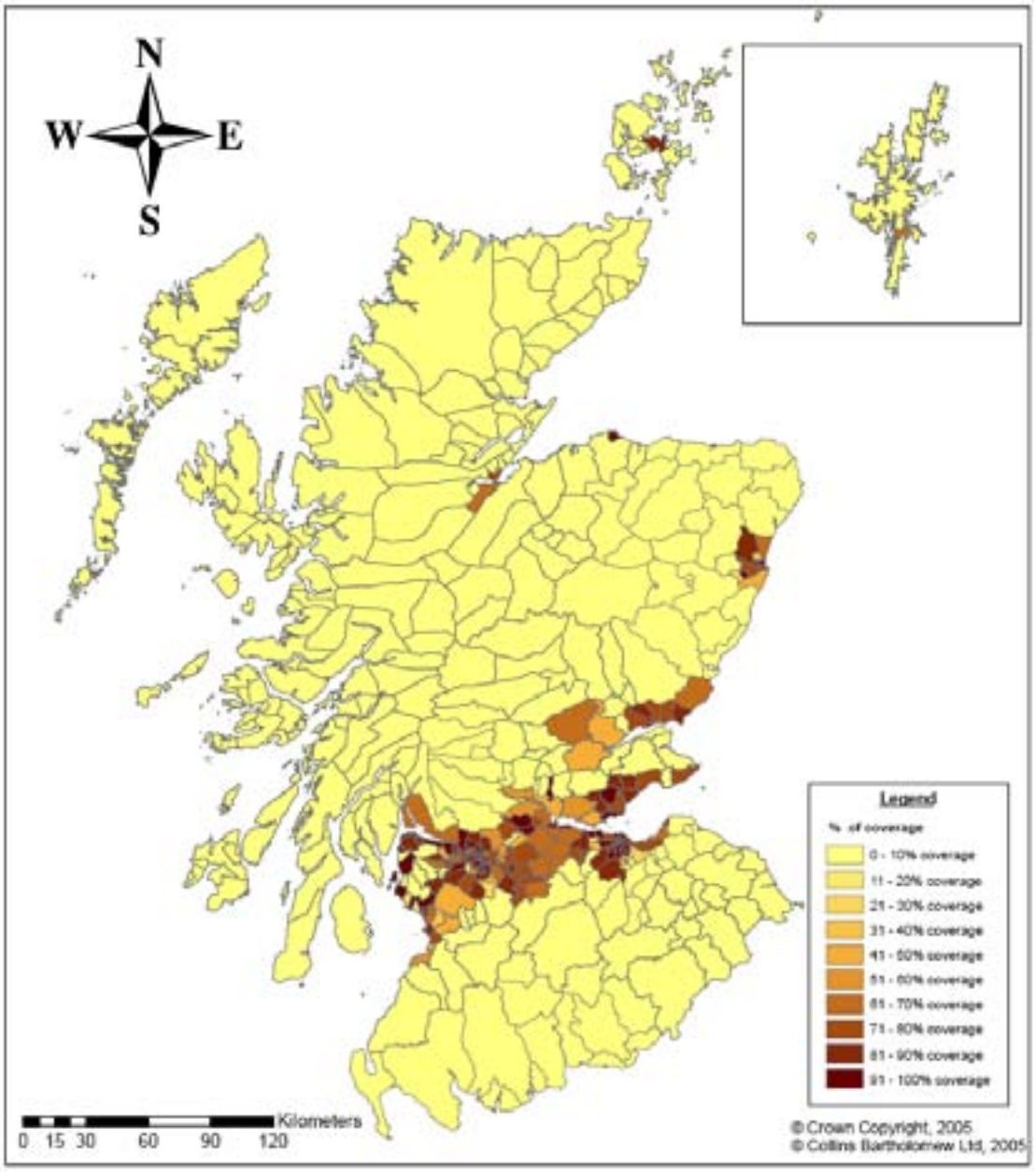


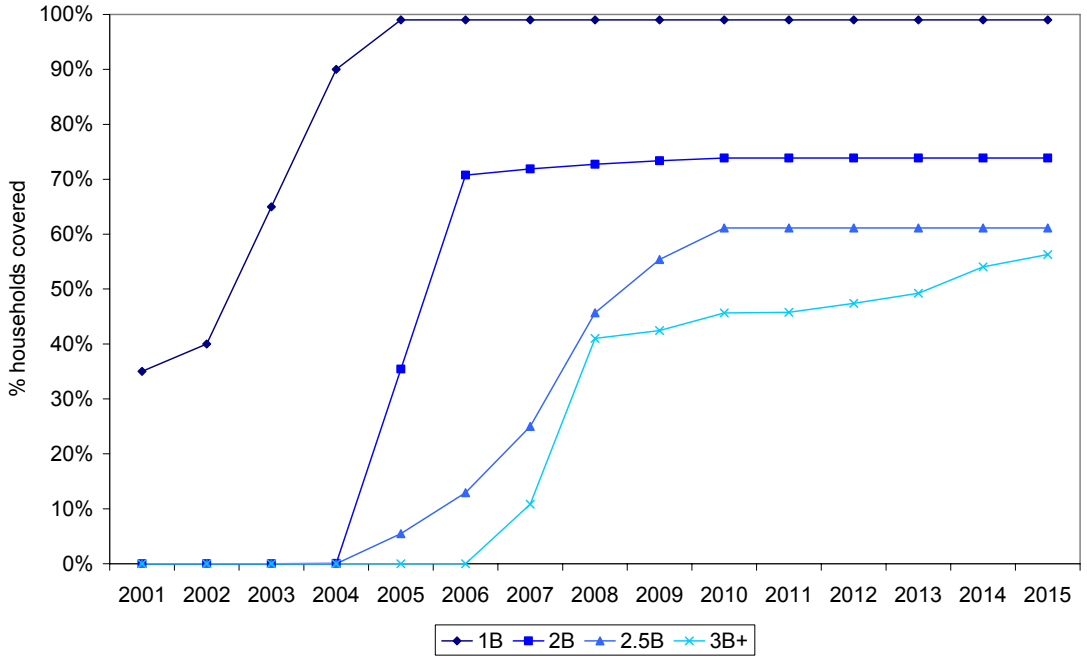
Figure 3-8 Projected 3B+ coverage of households by the end of 2015, by postal district [source: SQW]



Coverage - summary

3.23 A new 'broadband divide' has already started to open up between urban and rural areas of Scotland, in terms of the availability of 2B services (at least 5Mbit/s). As illustrated in the chart below, our expectation is that there will remain a significant proportion of the population (c. 26%) who will remain unable to access such services in the foreseeable future due to line lengths.

Figure 3-9 Comparison of the household coverage of various broadband generations [source: SQW]



3.24 Furthermore, there is the prospect of a much more persistent divide emerging in 3B+ services (50Mbit/s +) from 2007 onwards. Whereas the roll-out of 1B and 2B services in rural areas require upgrades in core transmission, backhaul capacity and exchange equipment (but use the existing copper access infrastructure), the bandwidths associated with 3B+ services go beyond the capabilities of the legacy BT copper access infrastructure and necessitate the extension of fibre deep into the access network – to the cabinet, if not the home. There would be major costs associated with such a roll-out, and – in areas with no infrastructure level competition – relatively little incentive for BT (or anyone else) to risk such an investment, given that 3B+ services would be competing with 1B and 2B services in these areas.

4 Take-up

Market developments

4.1 Take-up of broadband continues apace in the UK, and we are seeing the emergence of a number of applications that are likely to stimulate demand for higher bandwidths. Some recent relevant market developments include the following:

- In April 2005, Microsoft launched "MSN Video Conversation", within the new MSN Messenger 7.0, offering free full-screen video calling over the internet, with synchronised audio and video. Logitech, the market leader in webcams, is achieving more than 60% year-on-year growth in sales of webcam units, and IDC estimates that total worldwide PC camera sales rose from c. 3 million units in 1999 to 18 million in 2004.

- UK-wide, the number of internet users using broadband surpassed the number using dial-up for the first time in June 2005.

- Video conferencing capabilities were added to Skype's IP telephony application, through Dialcom's launch in June 2005 of a freely downloadable plug-in.

- The BBC announced (August 2005) its intention to have at least one of its major TV channels streaming via broadband within a year, and to launch MyBBCPlayer (providing access to the last seven days of TV and radio programmes) in 2006.

- BT stated in early September 2005 that it had sold 500,000 wholesale broadband connections in Scotland.

- Apple launched the new iMac G5, in October 2005, which includes a built-in camera for video-conferencing (e.g. using Apple's "iChat AV" application).

- BSkyB acquired Easynet, the LLU operator, in October 2005, in order to be able to offer the triple play of telephony, television and broadband internet.

- In May 2006 BSkyB launched its nationwide High Definition TV service, and the BBC commenced a trial of HDTV over Freeview in London.

Key messages from consultations

4.2 Key messages from our consultations regarding take-up were as follows:

- Almost all of our consultees expect the vast majority (90% to 100%) of internet users to be using broadband by 2010, given recent broadband price and take-up trends and the major incremental benefits offered by 1B vs dial-up. Indeed, it was suggested that ISPs may consider withdrawing support for dial-up internet access services if and when volumes reduce to levels at which dial-up starts to become uneconomic.

- There was some concern that there may remain a minority of households who are 'digitally excluded' through not having internet access, let alone broadband – whether through deliberate choice, lack of awareness of the benefits, or lack of the means to afford a computer and/or internet subscription. As broadband technology develops to provide an ever-richer internet experience for the 'haves', the 'have nots' will be at an increasing social and economic disadvantage.

- Upstream bandwidth is becoming more important to consumers, with the increasing popularity of applications such as interactive video calls, the exchange of digital photos, and peer-to-peer music and video file sharing (whether legal or illegal).

- The premiums associated with 2B services (versus 1B services) are not likely to be large. There appears to be a window of c. £15-£30 per month for mass market consumer broadband expenditure. There will be a free upgrade from 1B to 2B in many cases.

- There is currently perceived to be no single killer application for NGB services. It is more likely to be a combination of applications that will drive demand for higher bandwidths. For consumers, the most frequently cited applications driving a shift to higher bandwidths were:

  - video on demand (accessing broadcasters' archives, and superseding DVD postal services for films);
  - music downloads;
  - High Definition TV (requiring at least 8Mbit/s per stream); and
  - online gaming.

- There was quite a wide spectrum of opinion as to the prospects for HDTV in the UK. Most consultees were of the view that it was going to have a considerable impact and noted the prevalence of 'HD Ready' television sets in electrical outlets on the High Street; however, a minority noted that the UK TV market is very different to that of

the US (where HDTV is now in over 4 million households), and that demand may not be as strong here.

- There was also a high degree of uncertainty regarding the growth of PC-based video calls. Some consultees noted that a shift to video-based personal communications requires a significant cultural change, and were sceptical as to whether video calls/conferencing would ever really be heavily used by consumers or businesses, while others noted the growing popularity of video instant messaging amongst the under-25s.

- For businesses, it was noted that the availability of higher speed broadband services could potentially lead to a re-distribution of processing power in IT architectures – moving back to a more centralised model with 'thin client' terminals, and with SMEs increasingly using Application Service Providers (ASPs). Remote back-up will become more prevalent, for example. Upstream bandwidths will be as important as downstream bandwidths in such a model, as the communication flow is two-way.

- Voice over IP would rapidly be adopted by businesses: 70% of new voice systems being installed in corporates use IP handsets, and it is expected that smaller businesses will follow suit before long. However, VOIP does not require 2B or 3B+ bandwidths: 1B is sufficient.

Modelling assumptions

Households

4.3 Our estimates of the number of households using each generation of broadband have been derived through the application of diffusion curves, using the assumptions that:

- the saturation level of internet penetration will be very high at c. 95% eventually (c. 80% by 2015);
  - in the very long term we see internet becoming as pervasive as televisions and telephones in Scotland's households - and indeed, the boundaries between internet and TV are becoming increasingly blurred with the forthcoming introduction of IPTV. c. 97% of Scottish households have television sets, c. 98% have telephones;
  - average annual price reductions in computer prices over the last 40 years have been in the order of 10%-20% p.a.; a 10% p.a. price reduction in the future would mean that an entry-level computer costing £270 in 2005 (e.g. Dell's Dimension 1100) will cost less than £100 in 2015 (at 2005 prices); ultra-thin client developments (e.g. Ndiyo's Nivo initiative) could potentially

result in sub £100 devices well before then; in short, the cost of getting access to the internet will become less and less of a barrier - even for the more disadvantaged groups;

  - we assume that once people have obtained access to the internet, they won't give it up as they get older – i.e. today's silver surfer 65-year olds will still be using the internet when they're 75 (just as they'll still be using their TV sets);

  - young people - brought up with the internet and ICT at school, and generally more tech-savvy than their parents – will be looking to have internet access when they establish their own homes;

  - across the UK c. 30% of retirees are now online [source: Oxis (2005)] - up from 22% in 2003; if c. 26% of Scotland's households are 65+ by 2015, as per GRO projections, and if c. 50% of those are online by then - this would leave c. 13% of Scottish households being offline due to the 'age factor' by 2015 (cf our projected total of c. 20% offline households by 2015).

- the saturation level of broadband amongst internet households will also be very high, at c. 90%; a minority of households will remain on narrowband connections through inertia (whether dial-up or always-on services at less than 0.5Mbit/s);

- of those broadband users with access to 2B or 3B+ services, c. 90% will eventually be using these higher bandwidth offerings, as consumer-oriented 2B services will be available at little or no price premium vs 1B;

- of those broadband users with access to 3B+ services, 3B+'s eventual share will be substantial but not dominant at c. 30%, as we expect there to be a substantial price premium associated with such services.

4.4 Different rates of growth have been applied to these penetration parameters, benchmarked where possible with historic data for 2001-2005, as shown in the charts below.

Figure 4-1 Assumed growth in Scottish household internet penetration [sources: Scottish Household Survey, SQW estimates]

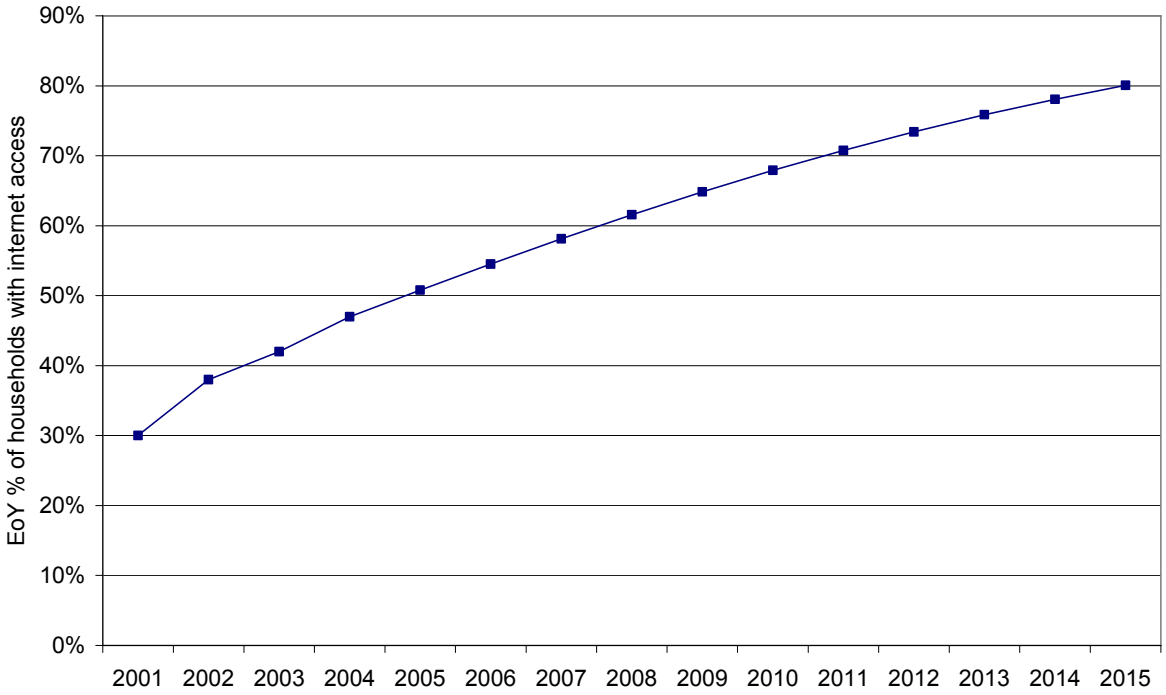


Figure 4-2 Assumed growth in broadband penetration of Scottish internet households [source: SQW]

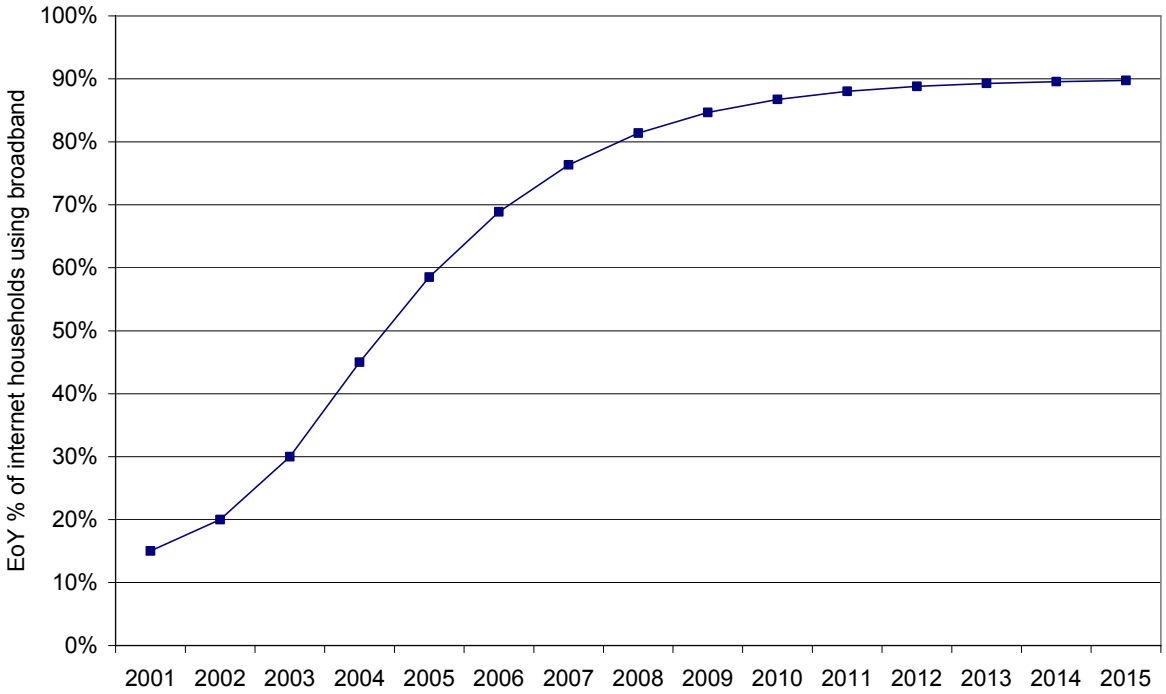


Figure 4-3 Assumed growth of 2B/3B+ penetration of Scottish broadband households, of those with access to 2B/3B+ [source: SQW]

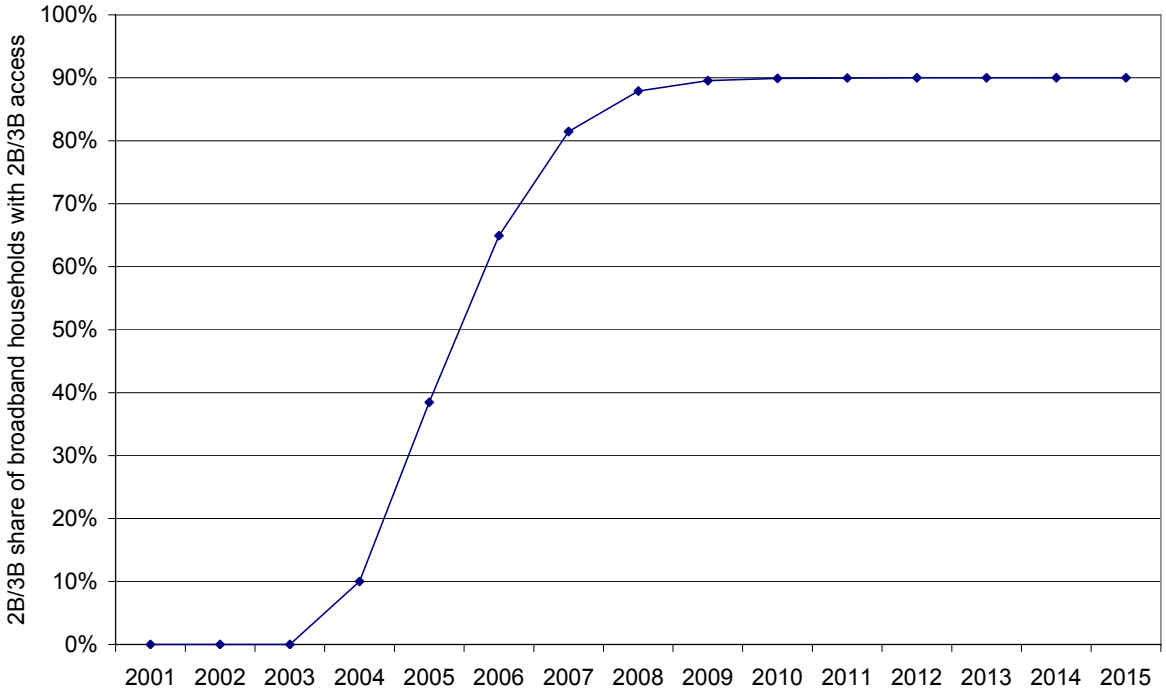
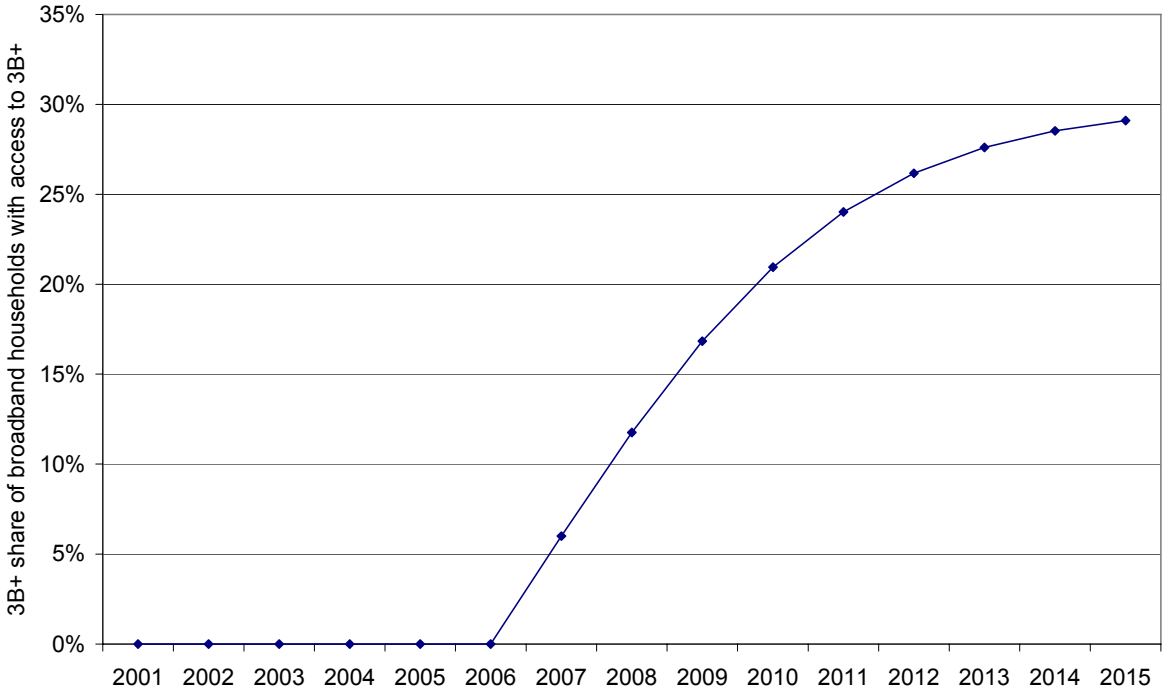


Figure 4-4 Assumed growth of 3B+ penetration of Scottish broadband households, of those with access to 3B+ [source: SQW]



Business sites

4.5 The above four penetration parameters have also been used in generating our business adoption projections:

- internet penetration of sites;
- broadband penetration of internet-enabled sites;
- 2B/3B+ share of broadband connections; and
- 3B+ share of broadband connections.

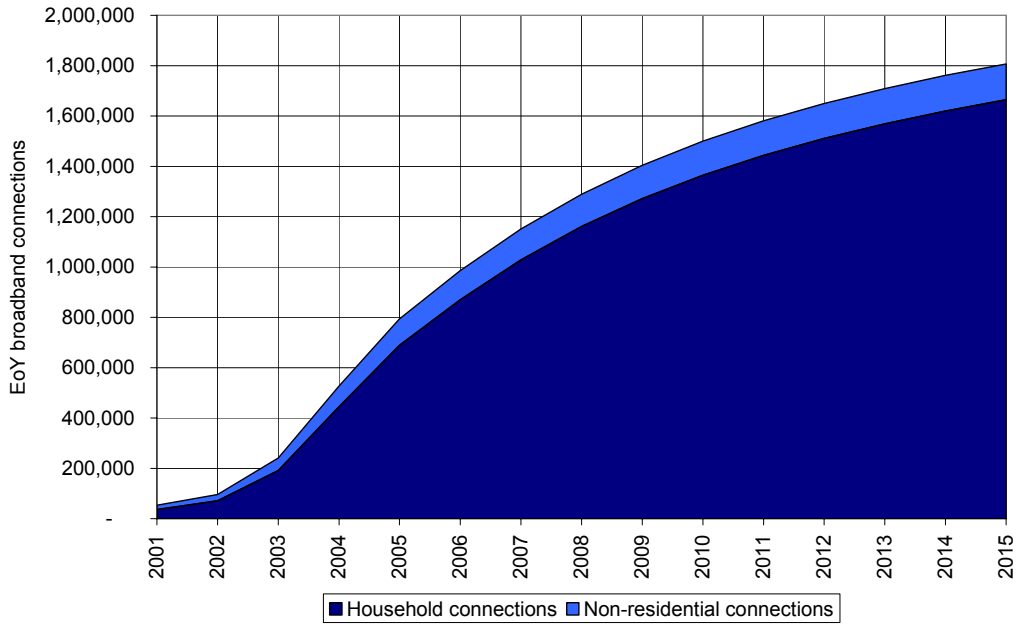
4.6 We have applied diffusion curves to each of our four employment bands within each of our eight SIC groupings – benchmarked where possible against data from the Scottish E-Business Survey 2005 (SEBS 2005).

- For sites with 50-199 or 200+ employees, we have generally assumed eventual saturation penetration levels of 90% to 100% for each of the above four parameters in all SIC groupings.
- For the 11-49 employment band, we have assumed slower growth rates, and saturation levels of:
  - 90% to 100% for internet penetration;
  - 90% to 100% for broadband penetration of internet-enabled sites;
  - 70% to 90% for 2B/3B+ share of broadband connections; and
  - 40% to 70% for 3B+ share of broadband connections.
- For the 1-10 employment band, we have assumed slower growth still, and saturation levels of:
  - 80% to 99% for internet penetration;
  - 85% to 100% for broadband penetration of internet-enabled sites;
  - 60% to 80% for 2B/3B+ share of broadband connections; and
  - 20% to 40% for 3B+ share of broadband connections.
- The SIC groupings' relative propensities to adopt have been informed by our recent work for DEFRA [SQW (2005)] and the data from SEBS 2005, with SIC sections A&B being assigned the slowest growth rates and lowest saturation levels, and SIC sections J&K having the fastest growth rates and highest saturation levels.

Take-up projections

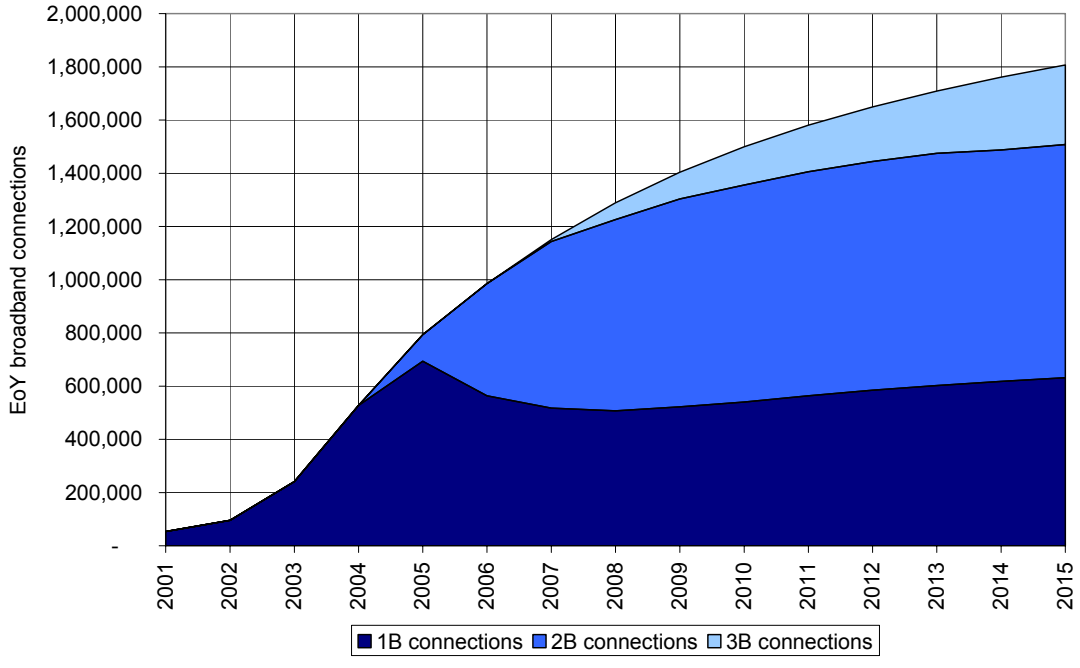
4.7 We estimate that approximately 0.8 million broadband connections were in use in Scotland at the end of 2005, and that the total will rise to c. 1.8 million by 2015, of which c. 1.67 million will be for households, as shown in the chart below. Growth from 2010 onwards is driven mainly by households obtaining internet access for the first time.

Figure 4-5 Projected total broadband take-up in Scotland [source: SQW]



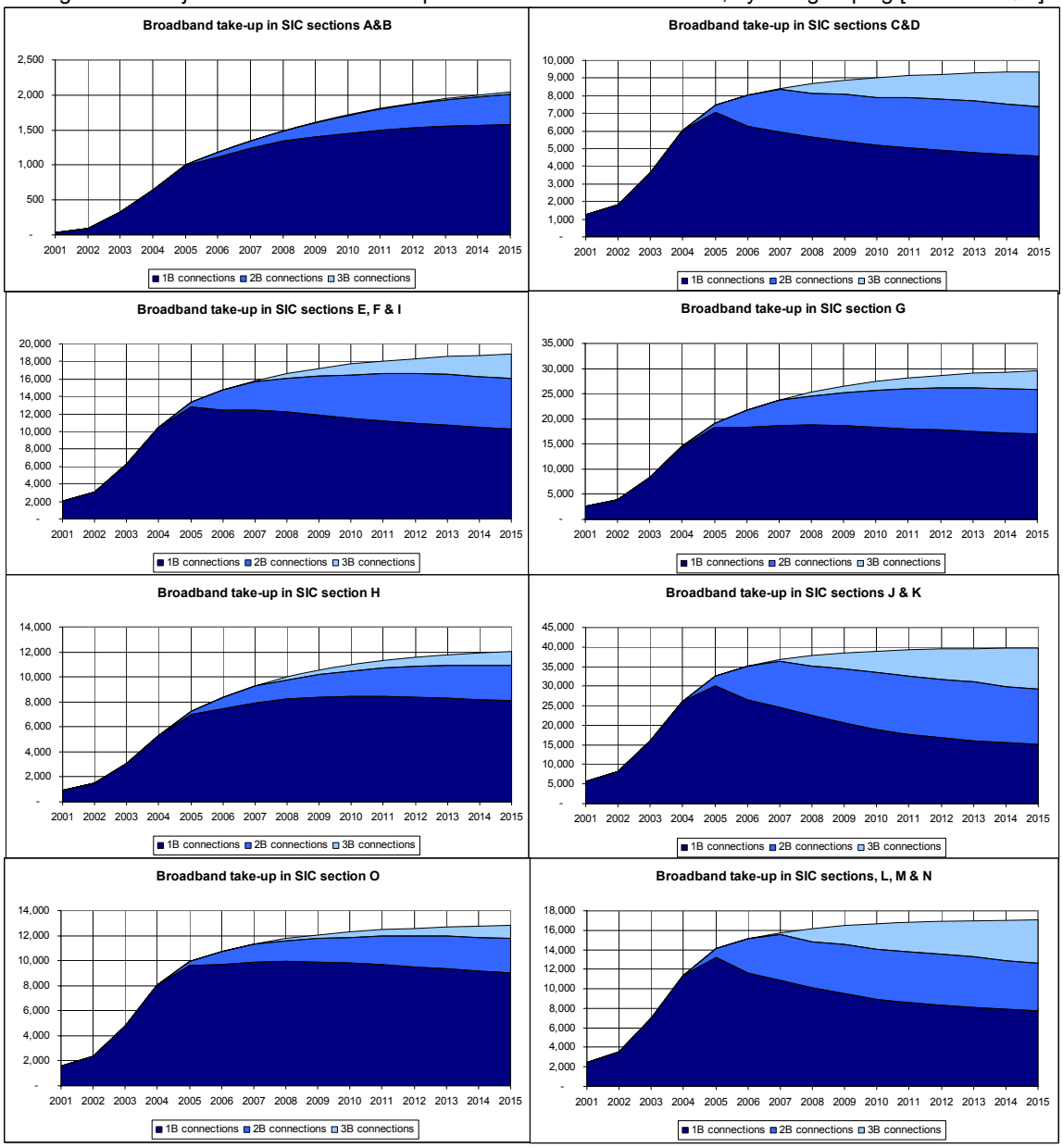
4.8 By 2010, we anticipate that c. 36% of broadband connections will be at 1B bandwidths, 54% will be 2B, and 10% will be 3B+, as illustrated in the chart below.

Figure 4-6 Projected broadband take-up in Scotland, by broadband generation [source: SQW]



4.9 Focusing on business take-up, our indicative estimates of the profile of 1B/2B/3B+ take-up by SIC grouping are shown in the following charts:

Figure 4-7 Projected broadband take-up at business sites in Scotland, by SIC grouping [source: SQW]



4.10 The breakdown of cumulative 1B, 2B and 3B+ connection volumes for these SIC groupings is given in the table below.

Table 4-1 Cumulative end-of-year business broadband connections, by SIC grouping and broadband generation [source: SQW]

		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
AB	1B	33	91	328	639	996	1,113	1,237	1,338	1,405	1,453	1,500	1,534	1,557	1,570	1,577
	2B	-	-	-	0	6	67	104	144	201	257	299	338	372	402	430
	3B	-	-	-	-	-	-	0	3	5	9	11	15	22	31	39
CD	1B	1,258	1,829	3,644	6,028	7,070	6,258	5,947	5,671	5,418	5,202	5,041	4,896	4,769	4,657	4,560
	2B	-	-	-	2	410	1,784	2,403	2,456	2,663	2,709	2,837	2,909	2,940	2,855	2,805
	3B	-	-	-	-	-	-	77	574	817	1,131	1,270	1,419	1,572	1,812	1,989
EFI	1B	2,070	3,073	6,228	10,443	12,802	12,419	12,398	12,201	11,892	11,530	11,242	10,963	10,703	10,468	10,262
	2B	-	-	-	4	531	2,315	3,322	3,842	4,484	4,940	5,354	5,636	5,818	5,782	5,824
	3B	-	-	-	-	-	-	78	570	861	1,243	1,481	1,755	2,044	2,474	2,759
G	1B	2,562	4,005	8,408	14,468	18,314	18,294	18,681	18,738	18,598	18,330	18,070	17,787	17,504	17,236	16,993
	2B	-	-	-	9	890	3,474	4,965	5,718	6,626	7,302	7,931	8,380	8,706	8,780	8,924
	3B	-	-	-	-	-	-	111	842	1,265	1,773	2,103	2,468	2,827	3,324	3,652
H	1B	947	1,474	3,089	5,311	7,010	7,456	7,917	8,213	8,371	8,412	8,424	8,383	8,308	8,210	8,099
	2B	-	-	-	5	261	948	1,344	1,540	1,813	2,053	2,275	2,455	2,611	2,692	2,797
	3B	-	-	-	-	-	-	34	243	363	512	613	731	849	1,018	1,140
JK	1B	5,717	8,149	15,972	26,033	30,102	26,565	24,514	22,407	20,508	18,879	17,659	16,723	16,023	15,509	15,136
	2B	-	-	-	42	2,417	8,527	11,848	12,659	13,947	14,452	15,011	15,000	15,007	14,449	14,169
	3B	-	-	-	-	-	-	407	2,783	4,088	5,663	6,617	7,757	8,580	9,741	10,454
O	1B	1,595	2,368	4,798	8,040	9,624	9,695	9,885	9,938	9,898	9,793	9,665	9,512	9,344	9,171	8,998
	2B	-	-	-	6	324	1,051	1,414	1,611	1,864	2,069	2,278	2,449	2,602	2,692	2,801
	3B	-	-	-	-	-	-	28	202	302	433	521	627	732	882	994
LMN	1B	2,476	3,532	6,946	11,375	13,231	11,647	10,842	10,097	9,466	8,941	8,581	8,294	8,064	7,878	7,726
	2B	-	-	-	6	928	3,500	4,741	4,747	5,046	5,120	5,251	5,260	5,200	4,956	4,863
	3B	-	-	-	-	-	-	181	1,329	1,945	2,595	2,967	3,348	3,713	4,199	4,483

Totals	**1B**	16,657	24,522	49,414	82,338	99,149	93,446	91,422	88,602	85,555	82,539	80,182	78,093	76,271	74,700	73,351
	2B	-	-	-	73	5,766	21,667	30,140	32,718	36,645	38,902	41,234	42,427	43,258	42,606	42,613
	3B	-	-	-	-	-	-	917	6,547	9,647	13,360	15,584	18,121	20,338	23,480	25,510

4.11 In the next section of this report we consider the potential incremental impacts on business productivity of 1B, 2B and 3B+ connections, for each of the 'market sector' SIC groupings (i.e. all the above groupings except L, M & N).

5 Economic impact

Evidence from the literature on the economic impact of ICT/broadband

Studies on the economic impact of ICT

5.1 There is a growing body of evidence in the literature that ICT does have significant **positive impacts on productivity and economic output**. For example:

- London Economics (2003) found that ICT capital deepening contributed an average of 0.8 percentage points annually to UK economic output from 1992 to 2000 (25% of the total output growth), and accounted for an average contribution of 0.76 percentage points annually to UK average labour productivity growth over that period.

- Rouvinen and Maliranta (2003) analysed a sample of 2,000 Finnish firms over the period 1998-2001, and found that, on average, the productivity of ICT-equipped labour is 8% to 18% higher than for other workers.

- Oulton and Srinivasan (2005) found that ICT capital accounted for 28% of the growth in output per hour in the UK market sector in 1990-2000 (with the proportion rising to 46% in the second half of that decade).

- Bloom et al (2005) estimate that a doubling of IT stock is associated with an increase in productivity of between 2% and 4%. They also report that US Multinational Enterprises (MNEs) in the UK have 8% higher productivity than domestic UK firms, while other MNEs in the UK are only 5% more productive: over 80% of this productivity advantage for US-owned plants is attributed to better use of ICT. They suggest that superior management practices of US subsidiaries may explain their ability to extract higher returns from IT.

- DCITA (2005) analysed productivity growth in Australia's service sector in the period 1984/5 to 2001/2, and found that, after taking away the effect of increased capital spending per worker, technological factors (the ICT revolution in particular) accounted for between 59% and 78% of productivity growth in service industries.

- Farooqui (2005) analysed the impact of UK business spend on telecoms services, and found that telecoms use has a large positive and significant effect on firm output – explaining up to 7.5% of the productivity differences in manufacturing firms (after accounting for the effects of IT capital). There is also a strong association between IT investment and spend on telecoms – with increased spending on the latter compounding the effects of IT investment. Enabling manufacturing workforces with

internet raises productivity by 2.9% for every 10% of the workforce enabled, and this is additional to the effects of increased IT investment.

5.2 A number of studies emphasise that there is a substantial **lag effect** at work, as businesses take time to recognise, design and implement complementary 'organisational investments' (in business process change) before they realise the full benefits of their ICT investments:

- In OECD (2004), Gretton et al report on a study into the impact of ICT on productivity in Australia. They found that the productivity response followed an inverted 'U' pattern as the duration of ICT use increased – with the productivity impact of computer take-up being largely complete after a period of adjustment of around 5 years.

- Brynjolfsson and Hitt (2003) analysed the effect of computerisation for 527 large US firms over the period 1987-1994, and found that the contributions associated with computerisation are up to five times greater when measured over long (5-7 year) periods than when measured over short (1 year difference) periods.

5.3 There are significant **variations between sectors** – with the nature of the business determining the extent to which it can benefit from ICT:

- London Economics (2003) estimated that the annual contribution[10] of ICT capital deepening to labour productivity growth in the period 1992-2000, varied from 0.0 percentage points (Mining and quarrying) to 1.24 (Financial intermediation) to 6.27 (Post and telecommunications - which should, perhaps, be regarded as a special case).

- Bank of England (2005) notes that business services, distribution and finance – which together account for c. one third of aggregate UK output – were responsible for almost two thirds of capital deepening in the 1990s. The growth of labour productivity of these sectors in the UK substantially outperformed that of the market sector as a whole, with particularly marked gains in the past couple of years.

Studies on the economic impact of broadband

5.4 While the above research is focused on the impact of ICT in general, some studies have sought to estimate the economic impact of broadband, in particular – at local, national and supra-national levels.

5.5 Given the relatively recent availability and take-up of affordable broadband services, these studies have not been able to analyse economy-wide historical impacts attributable to broadband – and it may yet be a couple of years before sufficiently long and robust series of

[10] Taking the average of their 'low software' and 'high software' scenarios

data are available for the UK regarding business adoption of broadband, to allow such an analysis. The previous studies – and our study – have necessarily had to make 'educated guesses' as to what the economic impact of broadband may be.

5.6 The existing studies essentially take one or both of the following approaches:

- estimating consumer surplus and producer surplus - e.g. Criterion Economics (2001); PricewaterhouseCoopers et al (2004);
- estimating the impact on Gross Domestic Product - e.g. Gartner (2002); Criterion Economics (2003); CEBR (2003); ACIL Tasman (2004).

5.7 In SQW's view, the first of these approaches is problematic. It relies on being able to judge the price elasticity of broadband services[11] at some point in the future when broadband penetration has saturated (bringing the market into equilibrium). Given the pace of change in broadband markets, and the difficulties of accurately determining price elasticities (now, yet alone many years' hence), we consider there to be particularly high error margins associated with this method. Furthermore, Scotland's economy is far from being a 'closed system': much of the 'consumer surplus' associated with broadband in Scotland will, in practice, contribute to the wealth of other nations (e.g. through increased Scottish expenditure on music, videos, games etc. sold online by companies entirely outwith the country).

5.8 For the purposes of our research, therefore, we have chosen to focus on the impact on business productivity and Scotland's GDP – the most widely recognised measure of Scotland's wealth - rather than on the consumer/producer surplus.

5.9 Annex C summarises the methodologies adopted by four previous studies into the impact of broadband on GDP. The key features are captured in the table below.

Table 5-1 Key features of four previous studies into the GDP impact of broadband

Study	Key features
Gartner, "The Payoff of Ubiquitous Broadband Deployment", July 2002	Gartner applies a simple "correlation slope" for GDP per capita vs broadband penetration (c. $47k at 50% penetration vs c. $43k at 30% penetration) to the US GDP: implying c. 10% higher net output at a 50% broadband penetration than at a 30% penetration. This results in an incremental $5.4 trillion in US GDP over 10 years, or an average of c. $500 billion incremental annually, growing from zero in 2000 to c. $1000 billion annually by 2010 (implying, by extrapolation, c. **$1500 billion** annually by 2015).
Criterion Economics, "The Effects of Ubiquitous Broadband Adoption on Investment, Jobs and the US Economy", September	Criterion calculates an impact of broadband on US GDP, on the basis of the effect of increased investment. They assume a broadband penetration of 95% of US households by 2021. The projection is for a $146 billion investment in broadband networks in the US over the period 2003-2021 ($53bn in CGB, $93bn in NGB). Criterion takes an average employment multiplier of c. 18 new jobs for each $1m of capex, captured within 1 year (with equipment manufacturers such as ADC Telecommunications, Ciena, Lucent, Nortel benefiting from this network investment), and an average output multiplier of 2.82 (i.e. $2.82 increase in GDP for $1 increase in network investment).

[11] To establish the difference between the price that consumers would be willing to pay and the price that is actually charged.

2003	Under an accelerated scenario (95% penetration by 2013), telco investment in broadband in US leads to cumulative increase of $465bn in GDP over 2003-2013 – an average of $46bn annually – peaking at 546k additional jobs in 2010. Certain other industries are assumed to increase their own annual investments by 10%, as a result of broadband, leading to an additional $66bn in annual GDP. This would imply a total average annual US GDP impact of **$110 billion**.
CEBR, "The Economic Impact of a Competitive market for Broadband"; November 2003	CEBR applies 3 inputs to a UK macroeconomic model: • a productivity effect: assuming that broadband contributes 0.01%-0.06% annually to productivity growth in 4Q03, rising to 0.04%-0.22% in 4Q15 ("cautious" versus "inclusive" scenarios); • a reduction in the cost of internet connectivity, leading to reduced cost of living and boosted consumer spending; • increased business investment – required to roll out broadband. This results in a steep rise in the projected impact on UK GDP to c. £12billion annually by 2007, then a more gradual rise to **£22 billion** by 2015.
ACIL Tasman, "Economic Impacts of Broadband Adoption in Victoria", June 2004	For each broad industry sector, Tasman allocates one of three broadband take-up curves (early/mid/late adopters). They assume different average annual productivity shocks per sector (e.g. 0.06% for Primary agriculture, vs 0.47% for Communication). These productivity shocks are distributed over time, on the basis of broadband take-up profile – with the greatest overall productivity shock being in 2008, the year of fastest projected broadband growth. Their 'less conservative' case assumes employment growth (the 'conservative' case doesn't). Applying these inputs to Tasman's macroeconomic model of the Victoria economy results in a projected annual impact on Victoria's Gross State Product rising to **AUS$1.5 billion to AUS$2.5 billion** by 2008 (vs the reference case of no broadband adoption), reducing to AUS$0.6bn-AUS$1.4bn in 2015. Over the period 2004-2015, the average annual contribution of broadband to GSP growth is 0.47%-0.82%.

Firm-level evidence on the impact of broadband

5.10 In support of the above economy-level analyses, there is ample evidence that businesses themselves consider broadband to be important to their operations.

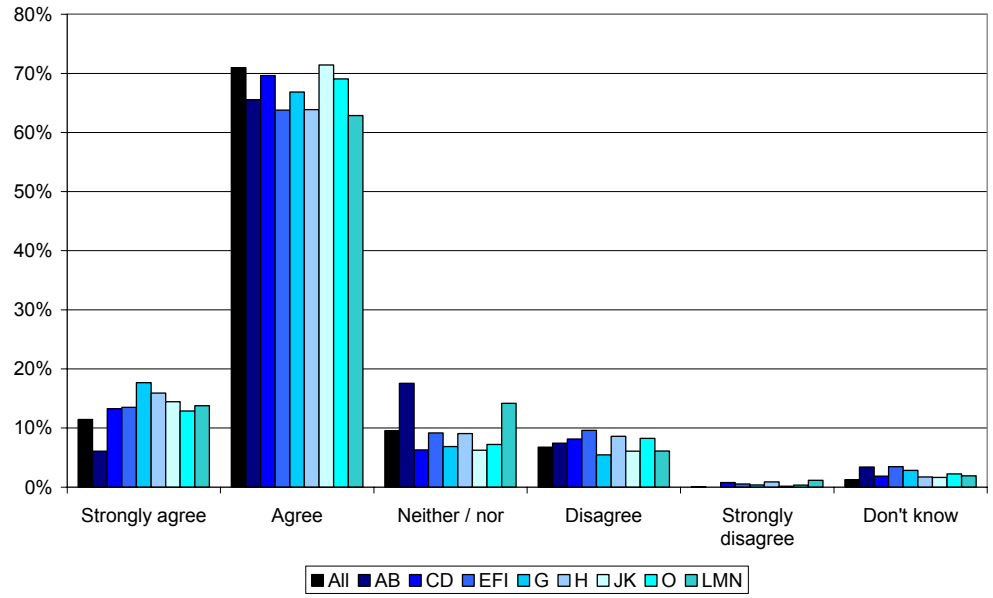
5.11 For example, the DTI has compiled a large selection of broadband case studies (available at http://www.liveworkplaybroadband.org.uk/). In Annex D we have summarised examples from these case studies for each of the SIC groupings considered in our model, in order to provide qualitative context for our critical assumption that broadband helps improve business productivity.

5.12 Large scale surveys confirm that broadband is perceived to be an important technology for many businesses. For example:

- In an SQW/NOP survey for DEFRA [SQW (2005)], business broadband users across England were asked to rate the importance of broadband to their firm, on a scale of 1 to 10. The average 'scores' from both urban and rural businesses were remarkably high, at 7.8 and 7.3 (out of 10) respectively.

- In SEBS 2005, 82% of business broadband users agreed (or strongly agreed) that broadband provided them with more scope to make continuous improvements, as illustrated – by SIC grouping - in the chart below.

Figure 5-1 Broadband users' response to the statement "[Broadband] provides more scope to make continuous improvements to how we do business", by SIC grouping [source: SEBS 2005]



Business applications enabled by broadband

5.13 In this sub-section, we briefly consider the business applications enabled by each broadband generation, in order to inform our estimates of their respective incremental productivity impacts.

5.14 For the purpose of this analysis, we compare the 'entry level' bandwidths at each broadband generation. Our definitions in section 2 of this report considered only the downstream peak bandwidths; however, in practice, many business applications are dependent on the upstream bandwidth, as well as the downstream connectivity. We have therefore needed to assume a 'typical' upstream bandwidth associated with the entry level to each generation of broadband, informed by the current 1B market offerings, the emerging 2B services (e.g. via cable modem, ADSL2+ and 8Mbit/s ADSL), and the mooted capabilities of 3B+ services (e.g. via VDSL2 and DOCSIS 3.0). The 'representative' upstream and downstream bandwidths considered in this analysis are shown in the table below:

Table 5-2 Representative downstream and upstream bandwidths considered for our analysis of business applications [source: SQW]

Generation	Representative downstream bandwidth	Representative upstream bandwidth
Dial-up	50kbit/s	30kbit/s
1B	500kbit/s	250kbit/s
2B	5Mbit/s	500kbit/s
3B+	50Mbit/s	30Mbit/s

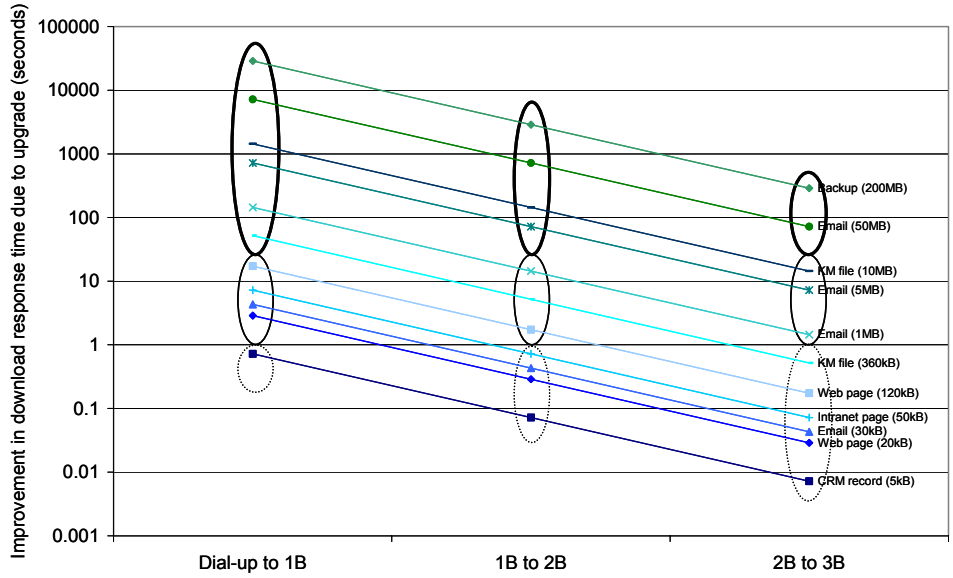
5.15 In order to illustrate the improvements in response time associated with the upgrades between broadband generations, we have considered a set of example business applications at various file sizes as shown in Table 5-3 below.

Table 5-3 Example file sizes and business applications [source: SQW]

Example file size	Example business application
5kB	A customer record accessed by the end user of a Customer Relationship Management (CRM) system
20kB	A simple web page (such as www.google.co.uk)
30kB	A text email (no attachments)
50kB	A page from a company intranet
120kB	A relatively rich web page (such as www.ba.com, or www.bbc.co.uk)
360kB	A document in a company's Knowledge Management (KM) system (the average size of MS Word documents in Microsoft's intranet, 2003)
1MB	An email, attaching a copy of a presentation
5MB	An email, attaching a large spreadsheet based model
10MB	A GIS map in a company's KM system
50MB	An email, attaching a 5 minute video clip
200MB	A system backup file (of data changes since the last backup)

5.16 Figure 5-2 and Figure 5-3 below illustrate the improvements in response time[12] associated with each generation upgrade, for each of the above example file sizes/applications, in the downstream and upstream directions respectively.

Figure 5-2 Improvement in **download** response times due to upgrade (log scale)



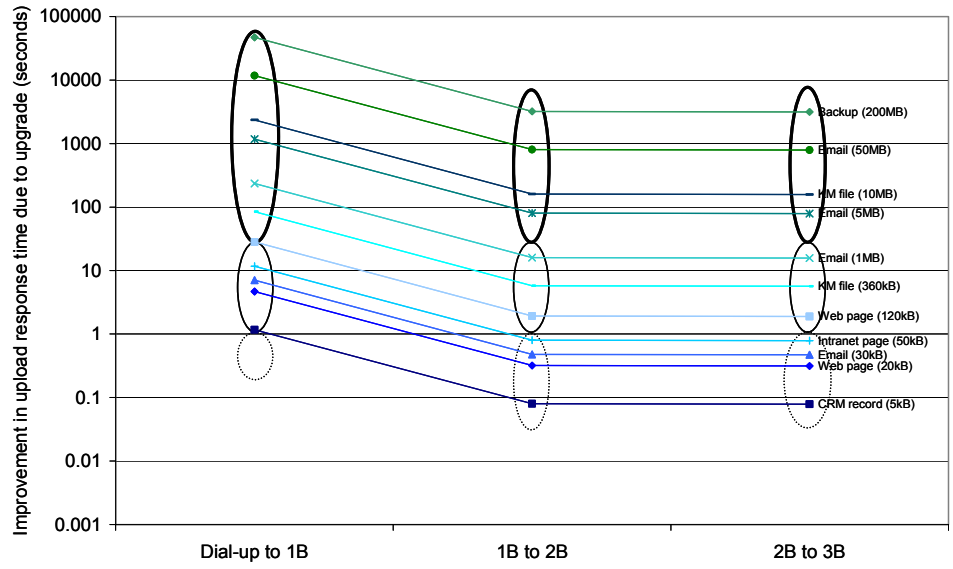
Key:

File sizes for which the upgrade leads to major (>30s) improvement in response time

File sizes for which the upgrade leads to significant (1s-30s) improvement in response time

File sizes for which the upgrade leads to insignificant (<1s) improvement in response time

Figure 5-3 Improvement in **upload** response times due to upgrade (log scale)



Key:

File sizes for which the upgrade leads to major (>30s) improvement in response time

File sizes for which the upgrade leads to significant (1s-30s) improvement in response time

File sizes for which the upgrade leads to insignificant (<1s) improvement in response time

[12] i.e the time taken to transfer the relevant file, assuming that the end user's connectivity is the limiting factor in the transfer

5.17 These charts serve to illustrate some important points:

- For some high usage, modest file size applications there are negligible benefits from upgrading to 2B and 3B+ bandwidths. For example, the Google home page (c. 20kB) could be loaded in 0.03s with 2B as opposed to 0.3s with 1B, and a 50kB intranet page would load in 0.008s with 3B, as opposed to 0.08s with 2B: differences that are likely to be imperceptible to the end user.
    - If we assume a 40kB average (non-spam) email message size in 2004 [source: Verisign (2004)], and a 10% p.a. average annual growth rate in email message size [source: HP (2005)], then we could expect average email message sizes to be c. 100kB by 2015. Such messages would take 16s to download using dial-up, 1.6s on 1B, 0.2s on 2B and 0.02s on 3B: representing a substantial improvement for a dial-up to 1B upgrade, some improvement for a 1B to 2B upgrade, but an imperceptible difference between 2B and 3B+.
- For the dial-up to 1B upgrade, the *download* response time is perceptibly better (i.e. a difference greater than 1s, say) for files of c. 7kB or more; the equivalent threshold file size is c. 70kB for the 1B to 2B upgrade, and c. 700kB for the 2B to 3B upgrade.
- Applications requiring data to be *uploaded* benefit from the upgrades at significantly smaller file sizes. For the dial-up to 1B upgrade, the *upload* response time is perceptibly better (with a difference greater than 1s) for files of 4kB or more, and the equivalent threshold file size is about 60kB for both the 1B to 2B upgrade and the 2B to 3B upgrade.
- When we consider much larger file sizes, we observe improvements in response times which make previously impossible or cumbersome applications feasible: accessing a 10MB spreadsheet in a company's (off-site) KM system would take c. 16s with 2B, versus more than two and half minutes with 1B; a 200MB backup file could be uploaded to a secure remote server in c. 50s with 3B, versus 53 minutes with 2B.

5.18 We now turn to consider *streamed* applications, such as voice and video communications, which are consumed in real-time and are therefore particularly intolerant to delay.

5.19 According to Cisco, an uncompressed (G.711) VOIP call can be supported by a symmetrical bandwidth in the order of c. 90kbit/s, whilst compression techniques (e.g. using G.729, G.723 codecs) can reduce this requirement to c. 30kbit/s.

5.20 With 1B typically providing c. 250kbit/s upstream, we can see that VOIP calls can readily be supported by 1B connections. Whilst upgrades to 2B and 3B+ would allow a greater number of simultaneous VOIP calls to be supported by a single connection, an SME could obtain a similar outcome simply by using multiple 1B connections.

5.21 The situation is different, however, when we consider video. While this is a much more bandwidth-hungry application than voice, the advent of advanced video compression techniques – in particular, H.264 (MPEG-4 Part 10) and VC-1 (Microsoft's competitor to H.264) – is leading to significant improvements in the quality of video that can be delivered over modest bandwidths.

5.22 The table below shows the resolution that can be achieved at different levels of VC-1 coding, for example, together with our estimate of which broadband generation is required to support each level: both for video streaming (e.g. of a webcast, which is dependent on downstream bandwidth, but not upstream bandwidth at the end user's site) and for video conferencing (which is dependent on upstream bandwidth as well as downstream bandwidth).

Table 5-4 Representative resolutions for different levels of VC-1 coding [source: Microsoft]

Indicative broadband generation required to support video streaming at various resolutions

	Profile	Level	Maximum Bit Rate	Representative Resolutions by Frame Rate (Format)
1B	Simple	Low	96 Kbps	176 x 144 @ 15 Hz (QCIF)
1B		Medium	384 Kbps	240 x 176 @ 30 Hz 352 x 288 @ 15 Hz (CIF)
1B	Main	Low	2 Mbps	320 x 240 @ 24 Hz (QVGA)
2B		Medium	10 Mbps	720 x 480 @ 30 Hz (480p) 720 x 576 @ 25 Hz (576p)
2B		High	20 Mbps	1920 x 1080 @ 30 Hz (1080p)
2B	Advanced	L0	2 Mbps	352 x 288 @ 30 Hz (CIF)
2B		L1	10 Mbps	720 x 480 @ 30 Hz (NTSC-SD) 720 x 576 @ 25 Hz (PAL-SD)
2B		L2	20 Mbps	720 x 480 @ 60 Hz (480p) 1280 x 720 @ 30 Hz (720p)
2B		L3	45 Mbps	1920 x 1080 @ 24 Hz (1080p) 1920 x 1080 @ 30 Hz (1080i) 1280 x 720 @ 60 Hz (720p)
3B+		L4	135 Mbps	1920 x 1080 @ 60 Hz (1080p) 2048 x 1536 @ 24 Hz

1B, 2B

3B+

Indicative broadband generation required to support video conferencing at various resolutions

5.23 Note that the above table indicates the *maximum* bit rates at each level of coding: i.e. the actual bit rates at each coding level will be below these rates. According to Apple, H.264 could typically provide 640x480 pixel resolution (24 frames per second) at c. 1-2Mbit/s, 1280x720 (24fps) at c. 5-6Mbit/s, and full high definition 1920x1080 (24fps) video at 7-8Mbit/s.

5.24 Given these indicative resolutions at various bandwidths, we anticipate that Scottish businesses will start to experiment with person-to-person video-conferencing via their PCs over 1B connections; it will gradually grow in popularity as a business application over 2B connections, and both person-to-person and multi-party video-conferencing will become mainstream once 3B+ services start to become widely available in urban areas (2008 onwards).

5.25 Video streaming (i.e. in the downstream direction only) is already reasonably well supported over 1B connections, and we would expect the availability of 2B services to further enhance the quality of video delivery (such as company webcasts, product training videos etc.). Large corporates can potentially make substantial cost savings through video-based product training for their large and distributed salesforces, for example. However, we suspect that the

economics of video-streamed training will be less compelling for SMEs - not least because the up-front costs of production are spread across a much smaller audience than in a corporate. We anticipate that video conferencing will be a more important, and widely used, application for Scottish businesses than video streaming, in the medium term.

5.26 Our overall assessment of the incremental benefits to businesses associated with each generation of broadband is summarised in the table below:

Table 5-5 Incremental business benefits associated with each broadband generation [source: SQW]

Dial-up to 1B	**1B to 2B**	**2B to 3B**
• Ability to use the phone and the internet at the same time • Always on connection • Cheaper internet access (for all but the lightest users) • Faster web access • Faster email • Ability to send and receive larger email attachments (e.g. up to, say, 5MB) • Option to implement a functional intranet across a multi-site firm • Makes home-working (full-time, part-time or occasional) more attractive and feasible • Faster access to off-site company databases, e.g. for CRM, SCM, ERP applications • Option to implement a functional extranet with suppliers, customers and collaborators • Easier in-house updating of own website (hosted off-site) • Faster downloading of customer orders (from own website) • Much improved video streaming quality • 'Experimental quality' person-to-person video conferencing • Option to integrate VOIP into company CRM and SCM systems (e.g. 'click to call') • Prospect of reduced phone bills (through VOIP)	• Ability to send and receive still larger email attachments • Allows richer screens for CRM, SCM, ERP applications • Significantly faster uploading and downloading of files to off-site KM systems • High quality video streaming • Moderate quality person-to-person videoconferencing • Experimental quality multi-party video conferencing • Support for an increased (c. x2) number of simultaneous VOIP calls	• Ability to send and receive still larger email attachments • Significantly faster uploading and downloading of files to off-site KM systems • High quality person-to-person and multi-party videoconferencing • Near-LAN speed connectivity into off-site company systems • Enables frequent system backups to remote secure facilities • Makes hosting own website feasible (with good response times) • Support for a much greater (c. x60) number of simultaneous VOIP calls

5.27 In summary, our assessment is that there are very considerable incremental benefits associated with businesses upgrading from dial-up to 1B broadband, which are likely to translate into very significant productivity improvements over time. We also believe that there will be substantial incremental benefits in upgrading from 1B to 2B and from 2B to 3B+ (some applications for which will not have not been invented yet). At this stage, we are of the view that the incremental productivity impacts of the 1B to 2B upgrade and of the 2B to 3B+ upgrade are unlikely to be as great as those of the move from dial-up to 1B (each providing in the order of a further 25% to 50% of the potential productivity gains from 1B).

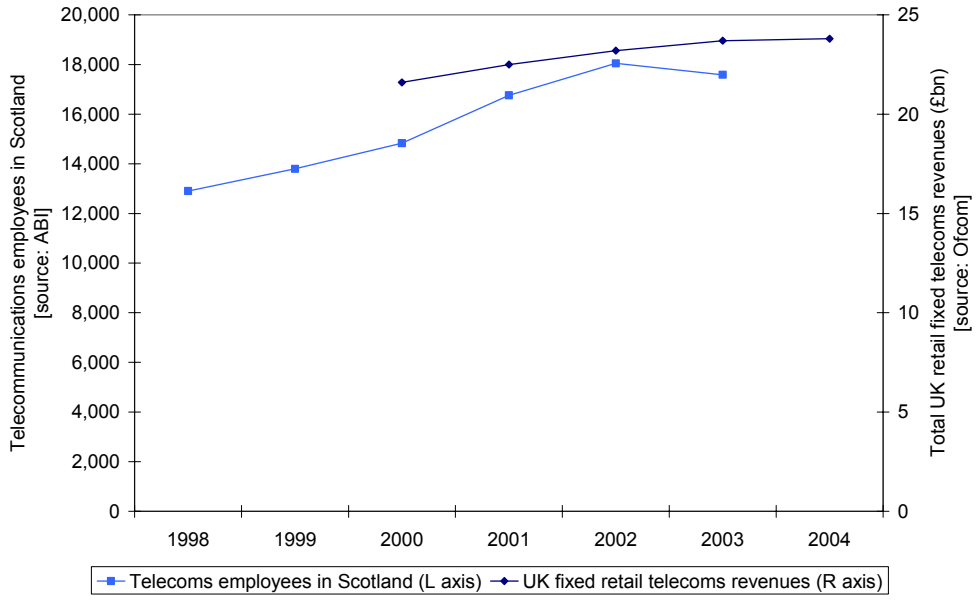
Broadband's impact on the GVA of the telecoms supply chain

5.28 In addition to the productivity impacts for ICT users, we need to consider whether there is a significant impact on the GVA of the telecoms supply chain in Scotland, from provision of the various generations of broadband service.

5.29 Our conclusion is that this is likely to be a relatively minor source of economic impact, in Scotland's case, for the following reasons:

- There is little evidence to date that the telecoms sector GVA has been substantially increased as a result of 1B broadband. Competition between telcos/ISPs appears to be ensuring that the value created by this technology is primarily accruing to the users rather than the telcos/ISPs, with intense price competition bringing broadband prices down towards – or even below - dial-up prices.
  - For example, BT's 2005 Annual Report states that *"The [BT Retail] gross margin percentage decreased by 0.9 percentage points in the 2005 financial year after a decrease of 0.2 percentage points in the 2004 financial year. The decline primarily reflects the change in revenue mix from traditional business to lower margin new wave services."*
  - As illustrated in the chart below: UK retail fixed telecoms revenues have flattened out, and the number of employees in telecommunications (SIC 64.2) in Scotland has been flat/falling.

Figure 5-4 UK retail fixed telecoms revenues, and telecommunications employees in Scotland [sources: Ofcom (2005), Annual Business Inquiry]



- In contrast to Criterion (2003) – which analysed the impact of broadband for the US economy - we cannot assume that much if any value from telcos' investments in

broadband in Scotland will be captured by equipment manufacturing plants located in Scotland.

- The development of the broadband market has led to the emergence of Next Generation Networks – and in particular, BT's 21CN. In the absence of broadband, there would be no 21CN, which would imply:
  - no £10 billion investment over five years (say £200 million p.a. in Scotland – though, as noted above, we expect that the bulk of this investment will be to the benefit of equipment manufacturers using plants located outwith Scotland);
  - but also no subsequent £1 billion p.a. operational cost savings, as a result of 21CN (say £100 million p.a. in Scotland) – some of which is likely to be achieved through a reduction in staff costs.
- If there was no mass market broadband, then it would appear likely that competition would be less intense in the telecoms sector, and that IP telephony would not be posing such a threat to voice revenues (fixed and mobile). In the hypothetical case of a Scotland with no broadband, therefore, it is possible that current and future GVA in the telecoms sector would actually be higher than in the with-broadband scenario.
- While 2B appears unlikely to involve major incremental network investment, 3B could potentially involve significant revenues for the construction industry in Scotland (digging up roads, laying new duct, installing new cabinets etc.).
  - If BT eventually mirrors what Deutsche Telekom and SBC have already started in their respective territories, this could involve c. £1 billion p.a. additional investment across the UK (say £100 million p.a. in Scotland). If c. 50% of this investment goes to the Construction sector (employing people in Scotland) this would imply an increase in Construction turnover in the order of £50 million p.a., or c. £20 million p.a. increase in direct Construction GVA (assuming a c. 40% ratio of GVA to turnover for the Construction sector). Applying a (Type 2) multiplier of 1.9 for Construction gives an overall potential GVA impact in the order of £40 million p.a..
  - However, this does not take into account the wealth creation effects of alternative uses of a 3B network investment (e.g. dividends to shareholders, including funds managed in Scotland). We therefore suspect that the overall net GVA impact for Scotland of this 3B construction boom (if it happens) is likely to be less than £40 million p.a.. As will be seen later in this section, this is small relative to the impacts of improved productivity for broadband users.

Modelling assumptions

5.30 Our economic impact model applies the projected business take-up rates to a set of assumptions regarding the impact of broadband on the productivity of broadband adopters, in order to generate a first order approximation of the effect on the overall Gross Value Added (GVA) of Scotland's market sector.

5.31 The overall structure of the model is illustrated in section 2. In summary, our projections for cumulative annual broadband connections in each employment size band and SIC grouping are combined with assumptions regarding the average number of employees per site in each size band, to derive annual projections of the total number of employees in each SIC grouping at sites newly-connected to the various generations of broadband. We then apply 'S-curves' describing the productivity impact of the various generations of broadband by year after adoption, and an assumed baseline GVA per employee in each SIC grouping, in order to derive our estimate of the overall annual impact on Scotland's market sector GVA. Our key assumptions are summarised below.

Employment levels and supply chain

5.32 We have assumed no impact of broadband on employment levels, given the current low levels of unemployment in Scotland. For simplicity, we have assumed **constant employment** levels in every SIC grouping; increases in productivity per employee therefore feed through directly into increases in GVA.

5.33 Given the above discussion regarding the telecoms supply chain, we have also assumed **no material incremental effect on the telecoms supply chain GVA** resulting from broadband network investment.

Productivity impact

5.34 We have divided our market sector SIC groupings into high, medium and low impact categories, on the basis of the differential impacts of ICT observed in the literature:

Table 5-6 Assigned broadband impact categories of our SIC groupings [source: SQW]

Broadband impact category	SIC groupings
High	J&K
Medium	C&D; E,F&I; G; H; O
Low	A&B

5.35 A lag effect has been incorporated, such that broadband adopters do not see the full productivity benefits of broadband for some years after adoption, given that it takes time to recognise, design and implement the complementary 'organisational investments'. Informed by our literature review, we have assumed a **lag ranging from four to six years**. Broadband

productivity effects are assumed to be largely complete after four years for High impact sectors, five years for Medium impact sectors, and six years for Low impact sectors. Diffusion (S) curves have been applied to these productivity shocks, rising from zero impact in the year of adoption.

5.36 For our Medium impact sectors, we have assumed that 1B broadband adopters eventually become **5% more productive** (over five years) than they would have been if they had not adopted broadband – i.e. an average annual productivity shock[13] of c. 1%. This assumption[14] has been informed by our literature review, including the observation in Farooqui (2005) that telecoms use accounts for up to 7.5% of the productivity differences in manufacturing firms, after accounting for the effects of IT capital investment.

5.37 We have assumed that the annual impact of 1B for our High impact sector adopters is approximately **twice** that for the Medium impact sector adopters: c. 2%, leading to an eventual impact of 8% (over four years). The annual impact of 1B for our Low impact sector adopters has been assumed to be approximately **a quarter** that for the Medium impact sector adopters: c. 0.25%, leading to an eventual impact of 1.5% (over six years). These assumptions regarding the relative impacts for different sectors have, again, been informed by our literature review, including London Economics (2003), which found that ICT capital deepening accounted for c. 1.24 percentage points growth in labour productivity in Financial intermediation in the UK in the period 1992-2000, versus 0.55 for Manufacturing and 0.10 for Agriculture, forestry and fishing (taking the average of the low software and high software scenarios).

5.38 Guided by the discussion above re the business applications enabled by broadband, the incremental impact from the use of 2B (rather than 1B) has been assumed to be **33%** of the incremental impact of the use of 1B (rather than dial-up). Similarly, the incremental impact from the use of 3B (rather than 2B) has been assumed to be **33%** of the incremental impact of the use of 1B (rather than dial-up).

5.39 When these incremental impacts are combined, therefore, a firm in a High impact SIC grouping, for example, (such as a financial services company) is assumed - eventually - to be up to c. 13% more productive (8% + 2.7% + 2.7%) using 3B than it would have been if it had remained on dial-up. With our assumed 3B take-up profiles and productivity lag effects, this maximum productivity impact only starts to be achieved from 2011 onwards.

[13] Note that this productivity shock is applied to broadband adopters, as they adopt, not to the whole sector. Overall productivity shocks across the sector will therefore be significantly lower than this level.

[14] This is the single most sensitive assumption in our model. It should be noted, of course, that there are inherent uncertainties surrounding it, including the extent to which productivity benefits may be 'competed away' in the longer term (i.e. with benefits increasingly accruing to consumers through lower prices, rather than accruing to businesses) and also the extent to which these initial productivity shocks may be supplemented by longer term second order effects associated with different ways of doing business.

5.40 To put this maximum impact into context, Barnes and Haskel (2000) found a wide dispersion of productivity levels within UK (manufacturing) industry sectors: with the 90th percentile firm being 3.5 to 6 times more productive than the 10th percentile firm in most sectors. Productivity dispersion tends to be higher in service industries.

Baseline productivity

5.41 We have used a baseline GVA per employee in 2000 (at 2000 prices), derived by dividing Scottish GVA data per SIC grouping from ONS (2004) by the relevant employment data from the Annual Business Inquiry (ABI).

5.42 This will tend to overstate the baseline GVA per employee in each SIC grouping, as the ABI does not include the self-employed (c. 11% of market sector employment in Scotland). However, this effect should be cancelled out in our overall GVA impact modelling approach, as the employee data from ABI is also used in our model to estimate the numbers of broadband-connected people in the market sector workforce (which will therefore be understated, as it excludes the self employed). While there are higher proportions of self-employment in certain sectors (e.g. construction, business services), this should have no effect on our overall GVA impact calculations.

5.43 The FISIM (Financial Intermediation Services Indirectly Measured) adjustment in ONS (2004) has not been included in our baseline GVA per employee, as we are not able to distribute this adjustment across our SIC groupings. This could potentially mean that our total GVA projections for the market sector are overstated by 3% to 4% - but we consider this to be well within the margin of error for our projections.

5.44 The assumed baseline values of GVA per employee in Scotland are shown in the table below.

Table 5-7 Baseline GVA per employee in the year 2000 [sources: ONS (2004), ABI]

SIC grouping	GVA per employee in the year 2000, £ (2000 prices)
AB	31,978
CD	43,206
EFI	43,257
G	21,677
H	16,205
JK	40,245
O	29,209

Economic impact projections

5.45 Our economic impact projection is, of course, based on a combination of assumptions around which there are inherent uncertainties – the incremental productivity impacts per broadband adopter at different broadband generations, the growth of 2B and 3B+ coverage and the rate of broadband take-up. Having tested the sensitivity of our model to these various assumptions, we estimate that the annual GVA of Scotland's market sector in 2015 will be in the order of **£2 billion to £6 billion** higher than it would have been otherwise (at 2000 prices).

5.46 Our central projection is that annual GVA of Scotland's market sector will be c. **£3.4 billion** higher in 2015 than it would have been otherwise (at 2000 prices) – up from an impact of £0.8 billion in 2005.

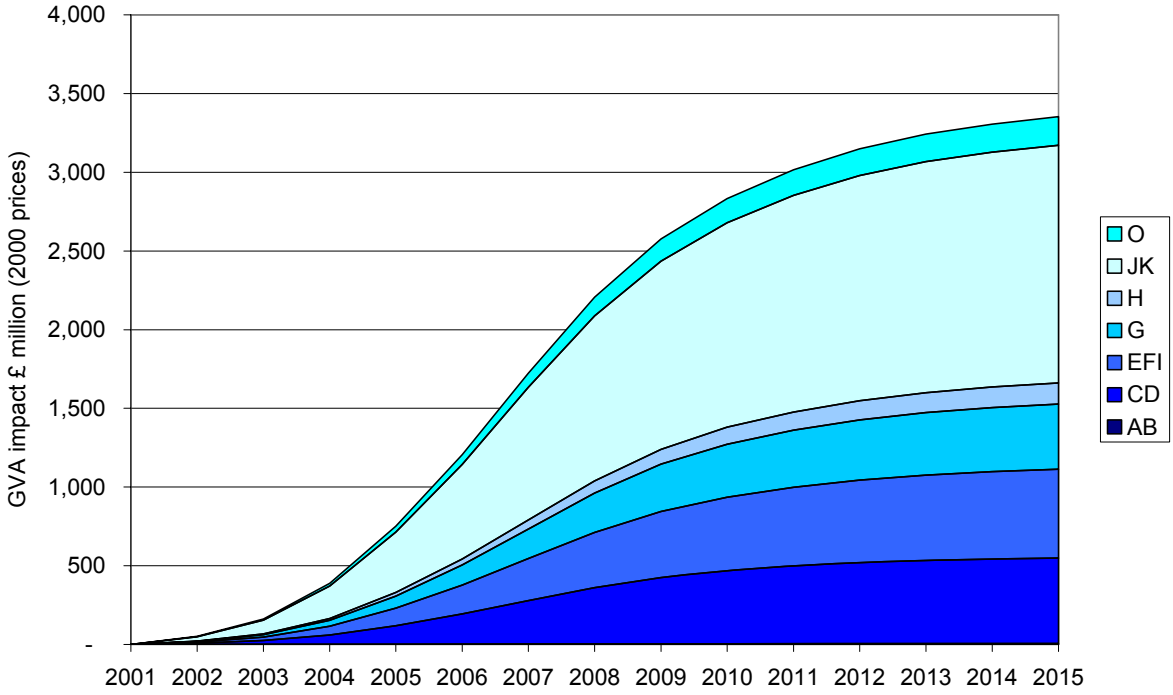
5.47 As shown in Table 5-8 and Figure 5-5 below, much of the overall impact (45%) is expected to accrue to the J&K SIC grouping[15] (financial services; real estate, renting and business activities). These are the industries that have adopted broadband most rapidly, and the sectors in which ICT has a disproportionately large impact, given the nature of their operations.

Table 5-8 Projected impact of broadband on Scotland's market sector GVA, by SIC grouping £ million (2000 prices) [source: SQW]

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
AB	-	0	0	0	0	1	1	2	3	4	5	5	5	6	6
CD	-	8	25	60	119	193	277	358	422	465	494	514	528	537	543
EFI	-	7	22	55	111	184	268	352	420	467	500	524	542	555	564
G	-	5	15	37	76	127	187	249	301	337	363	383	397	407	414
H	-	1	4	11	22	38	57	77	94	107	115	122	127	131	134
JK	-	29	88	206	384	601	842	1,048	1,196	1,299	1,376	1,431	1,468	1,492	1,511
O	-	2	7	18	37	62	91	119	140	154	163	170	175	178	181
Totals	**-**	**52**	**162**	**389**	**751**	**1,206**	**1,724**	**2,206**	**2,576**	**2,833**	**3,016**	**3,149**	**3,242**	**3,306**	**3,353**

[15] The J&K SIC grouping accounted for approximately 25% of employees in Scotland's market sector in 2004.

Figure 5-5 Projected impact of broadband on Scotland's market sector GVA, by SIC grouping £ million (2000 prices) [source: SQW] (note that SIC grouping AB is at the bottom of this chart, but not visible)

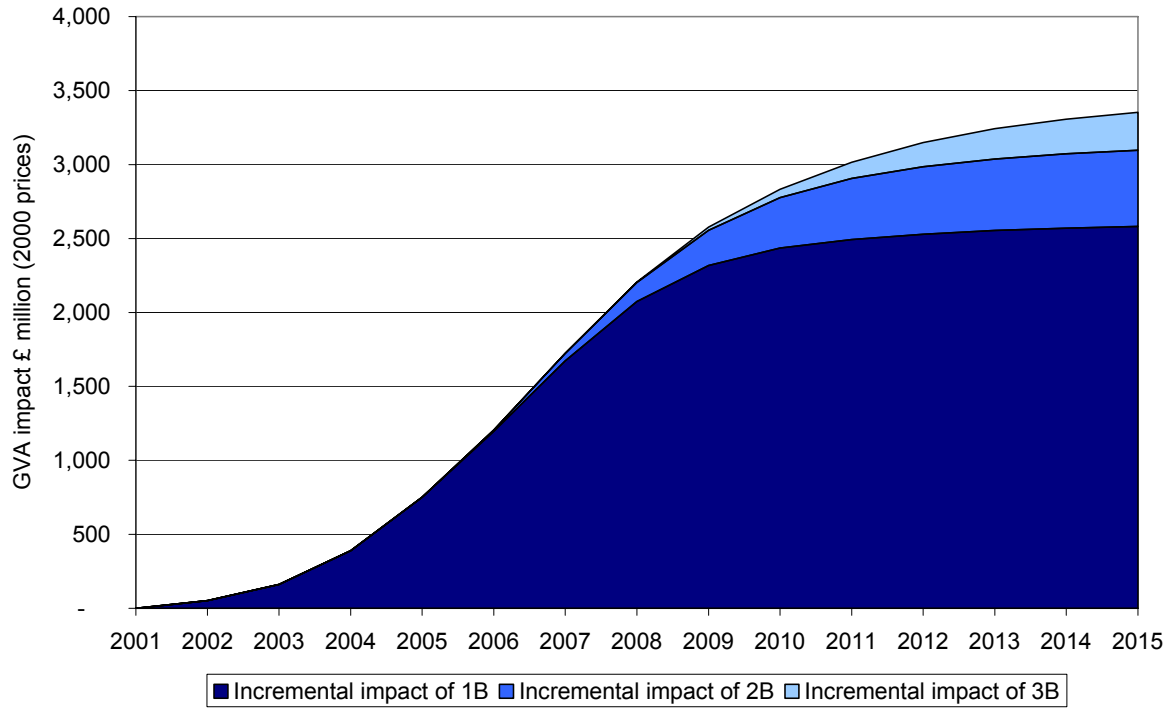


5.48 The bulk of the overall impact (77% in 2015) derives from the incremental benefits of 1B broadband vs dial-up (see Table 5-9 and Figure 5-6 below). This is due to three factors: the roll-out and take-up of 2B and 3B+ broadband happens later than that of 1B; the incremental productivity benefits of 2B vs 1B and of 3B+ vs 2B are each assumed to be lower than the incremental benefits of 1B vs dial-up; and there is a lag of four to six years before businesses upgrading to these bandwidths realise the full incremental productivity benefits associated with that upgrade.

Table 5-9 Projected impact of broadband on Scotland's market sector GVA, by broadband generation, £ million (2000 prices) [source: SQW]

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Incremental impact of 1B	-	52	162	389	751	1,196	1,672	2,074	2,318	2,435	2,493	2,529	2,554	2,571	2,583
Incremental impact of 2B	-	-	-	-	0	10	52	130	238	342	413	455	483	502	515
Incremental impact of 3B	-	-	-	-	-	-	-	2	21	56	109	165	206	233	255
Totals	**-**	**52**	**162**	**389**	**751**	**1,206**	**1,724**	**2,206**	**2,576**	**2,833**	**3,016**	**3,149**	**3,242**	**3,306**	**3,353**

Figure 5-6 Projected impact of broadband on Scotland's market sector GVA, by broadband generation, £ million (2000 prices) [source: SQW]



5.49 The above chart and table need to be interpreted with care: the 'incremental impact of 1B' in any year does *not* only relate to those businesses using 1B (as opposed to 2B or 3B+) connectivity in that year. To take an example: a business in SIC grouping C&D that adopted 1B broadband in 2003, upgraded to 2B in 2007, and upgraded to 3B+ in 2011 is assumed, by 2015, to be 8.1% more productive than it would have been if it had remained on dial-up: 5% from adopting at least 1B broadband (fully realised by 2015), plus 1.7% incremental benefit from adopting at least 2B broadband (fully realised by 2015), plus 1.4% incremental benefit from adopting 3B+ (four fifths of the way along an S-curve to the maximum 1.7% benefit for 3B+).

Cross-checks on our economic impact projection

5.50 In this sub-section we briefly provide some cross-checks on the above projection, in order to confirm that it appears reasonable.

5.51 Firstly, we note that our central projection of market sector GVA being £3.4 billion higher than it would be otherwise in 2015 would correspond to c. 4.6% of market sector GVA in that year (assuming 1.9% p.a. real growth, the average Scottish market sector growth rate for 1995-2004). Given the strategic importance of broadband for economic development, as perceived by Scotland's business organisations and policy makers, this implied proportion of 2015 market sector GVA does not appear to be outlandish.

5.52 Secondly, we have considered what share of total market sector GVA growth this would imply for broadband over the period.

- If we assumed that the future real growth of market sector GVA is constant at 1.9% p.a. (the average Scottish market sector growth rate for 1995-2004), then our projections would imply an average 20% share of annual GVA growth attributable to broadband (and the ICT investments and business process changes enabled by broadband) in the period 2001-2015.

- If we assumed a future 2.5% market sector GVA growth rate (the long term UK trend rate for real GDP growth), then our projections would imply an average 14% share of annual GVA growth attributable to broadband.

5.53 We consider this implied 14%-20% growth share to be credible, in the light of recent evidence [Oulton and Srinivasan (2005)] that ICT capital deepening accounted for 46% of the growth in productivity in the UK market sector in the second half of the 1990s. Assuming that this level of overall ICT impact will be sustained in the period 2001-2015, our projection would therefore imply that something in the order of a third to half of the productivity benefits associated with ICT would not be realised if broadband were not available.

5.54 This appears to be reasonable (or potentially conservative), given that ICT investments being made by businesses are increasingly reliant on sites having broadband connectivity – especially for multi-site firms[16], as illustrated in the table below.

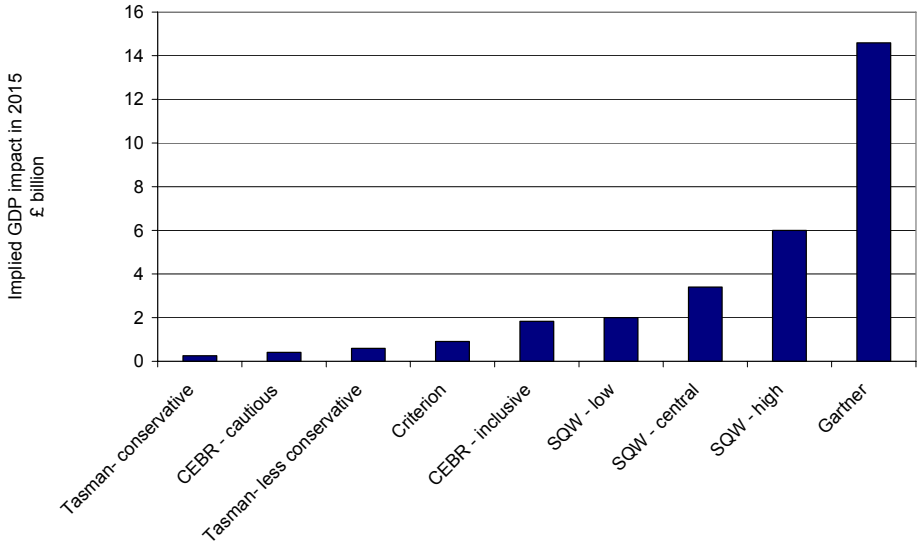
[16] We have not been able to source any data as to the proportion of GVA in Scotland associated with multi-site vs single-site firms. As an indication, however, we note that the SQW (2005) survey in England found that 19% of urban respondents in the 2-9 employment band were multi-site, 44% in the 10-49 band, 78% in the 50-249 band and 86% in the 250+ band.

Table 5-10 Indicative broadband dependence for various business ICT investments [source: SQW]

	Degree of dependence on the firm having broadband connectivity	
ICT investments	**Single site firms**	**Multi-site firms**
PC hardware, monitors, printers etc.	Low	Low
Server hardware	Low	Low
Standard PC software (email, word processing, spreadsheets, etc.)	Low	Low
Intranet	Low	High
Knowledge management systems	Low	High
Customer Relationship Management systems	Low	High
Website (hosted externally)	Medium	Medium
Geographic Information Systems	Medium	High
Virus protection and application/operating system updates	High	High
Extranets and Supply Chain Management systems	High	High
Enterprise Resource Planning systems	High	High
Video conferencing equipment	High	High
Remote monitoring/management of IT systems	High	High
Remote backup	High	High
Application Service Provider services	High	High

5.55 Thirdly, we have cross-checked our projections against those of the four previous studies summarised in Annex C. A ballpark indicator of what these previous studies would imply for a developed economy of c. 5 million people can be derived from a very crude pro rata calculation, on the basis of relative population sizes. This results in a wide range of implied annual GDP impacts in 2015 for a country the size of Scotland - from £0.3 billion to £15 billion, as shown in the chart below.

Figure 5-7 Comparison of SQW's projections for the impact of broadband in 2015 with extrapolated/pro rata projections from other studies (for a developed economy of 5 million people) [source: SQW]



5.56 Of the four studies, the CEBR study from 2003 is the most relevant comparator, as it is UK-focused. Applying our simple pro rata calculation on the basis of population would imply an annual GDP impact in 2015 of c. £1.8 billion for Scotland (under CEBR's 'inclusive' scenario, which they considered to be the more likely). However, we note that actual broadband take-up has been accelerated by no less than *five years* compared with CEBR's demand projections, which were themselves relatively bullish at the time: CEBR expected 10 million broadband connections in the UK by the end of 2010 (6.1 million by the end of 2005), whereas the latest estimates from Ofcom indicate that there were 11.1 million connections as of March 2006.

5.57 While our economic impact projections are higher, on a pro rata basis, than those of three of the four comparator studies from 2002 to 2004, we are comfortable that this is justified in the light of recent actual growth in broadband availability and take-up, and given the growing body of evidence in the literature regarding the importance of ICT-related innovation for productivity growth.

5.58 Finally, we note that there is some emerging evidence that broadband is indeed having a real and measurable impact on the economic growth of developed countries.

- In a US-wide study, Lehr et al (2006) report that between 1998 and 2002, communities in which mass-market broadband became available by December 1999 experienced more rapid growth in employment, in the number of businesses overall, and in the businesses in IT-intensive sectors. This finding is supported by matched sample regressions, which control for community level factors known to influence broadband availability and economic activity.

- There appears to be some positive correlation between broadband penetration in developed countries and their time-shifted GDP growth. For the G7 countries[17], we plotted the annual 2005 GDP growth rate against the annual growth in broadband penetration in the years 2002, 2003, 2004 and 2005. Interestingly, we found a *negative* correlation when considering the most recent broadband growth rates, but a *positive* correlation when considering the broadband growth rates for 2002 and 2003. In particular, there was a strong and significant positive correlation (R-squared of 0.84)[18] between 2005 GDP growth and the 2002 growth in broadband penetration, as shown in the chart below.

  - While this correlation needs to be treated with caution, as there are only seven observations, we found it striking that the observed R-squared was as high as 0.84 given the many other factors affecting GDP growth in these

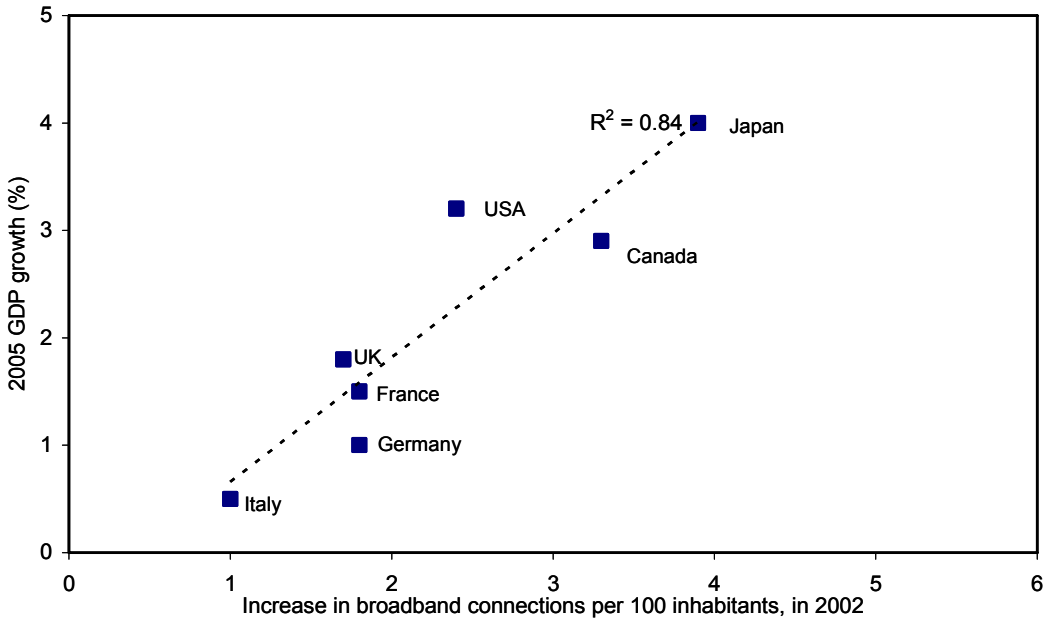
[17] Note that these seven countries account for approximately 60% of world GDP, at market exchange rates.

[18] R-squared is a measure of the strength of the correlation between two variables, ranging from 0 (no correlation) to 1.0 (perfect correlation).

countries[19]. By way of comparison we found, for example, that the positive correlation between these countries' 2005 GDP growth and their 2001 R&D expenditure as a proportion of GDP was much weaker - at an R-squared of 0.54.

- The three year difference between 2002 (the year taken for the growth in broadband penetration) and 2005 (the year taken for GDP growth) would appear to provide some support for our assumption of a lag of four to six years before the full benefits of broadband are realised, as this corresponds to a peak annual impact after two to three years.

Figure 5-8 2005 GDP growth versus 2002 growth in broadband penetration, for the G7 countries [sources: SQW analysis, The Economist (for GDP data), OECD (for broadband data)]



[19] A one-tailed t-test on this data confirms that we can be 99.5% confident in rejecting the null hypothesis that there is no positive relationship between the 2005 GDP growth in these countries and their 2002 growth in broadband penetration.

Impact of the *Broadband for Scotland* intervention

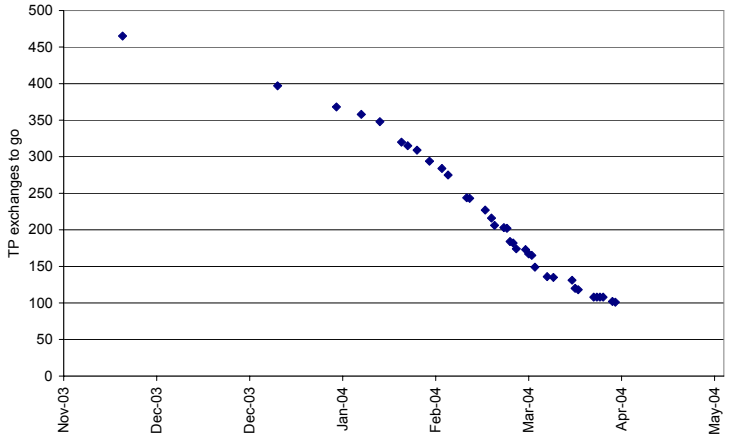
5.59 We now turn to consider the economic impact of the Scottish Executive's *Broadband for Scotland* intervention.

5.60 In December 2002 (when the coverage of affordable broadband services stood at c. 40% of Scotland's population) the Scottish Executive announced that it would seek to increase the level of coverage to 70% by March 2004. Following an analysis of the intervention options, the Scottish Executive, Scottish Enterprise and Highlands and Islands Enterprise set about an intensive demand stimulation programme, under the brand *Broadband for Scotland* – including a major advertising campaign (TV, radio and press), the launch of an impartial website (www.broadbandforscotland.co.uk), and assistance to local broadband campaigns. These activities had the effect of raising awareness of broadband in Scotland, and accelerating the rate of registrations of interest in receiving ADSL service, under the 'trigger point' mechanism that was being run at that time by BT[20].

5.61 As at the end of March 2003 there were 94 Scottish exchanges on BT's trigger point list (with a median exchange size of c. 6,000 household lines). However, in November 2003 BT announced a major extension to the trigger point scheme – allocating trigger points to every exchange serving more than 300 lines. This brought the total number of Scottish exchanges on the trigger point list to 465 as at the end of November 2003 (with a median exchange size of c. 600 household lines).

5.62 The chart below illustrates that all but 101 of these 465 exchanges had reached their trigger levels by the time BT called a halt to the scheme in April 2004 (at which point they committed to enable every exchange that had been assigned a trigger level, by summer 2005).

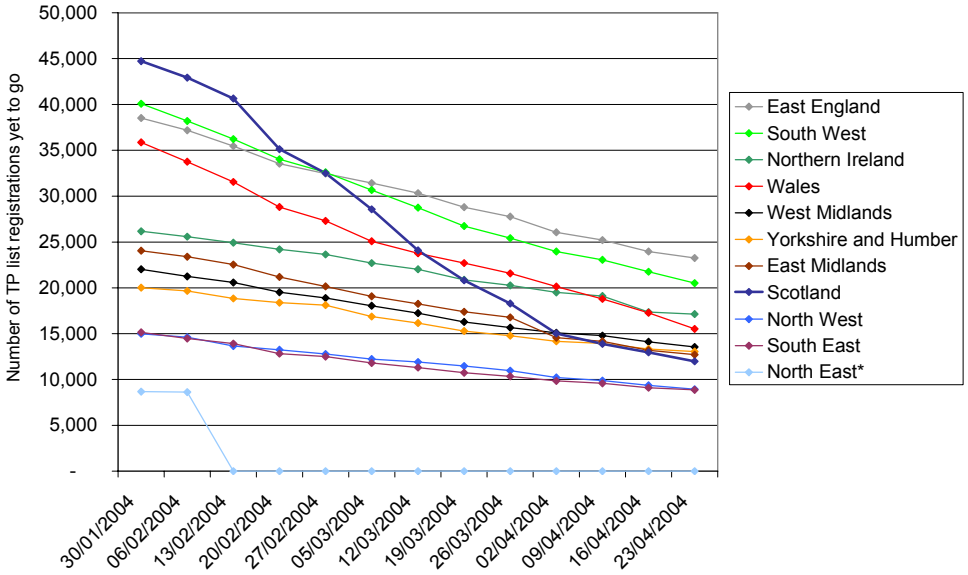
Figure 5-9 Exchanges yet to reach their trigger levels in Scotland [sources: bt.com, SQW 2004]



[20] Under this scheme, BT allocated a 'trigger point' (e.g. 300, 500) to selected non-broadband exchanges. Once the number of households/businesses registering their interest in ADSL had reached the trigger level, the relevant exchange would be scheduled to be enabled for broadband – typically within 3 to 5 months of triggering. Stimulating an increased rate of registrations was therefore an effective means of accelerating the roll-out of broadband to unserved areas.

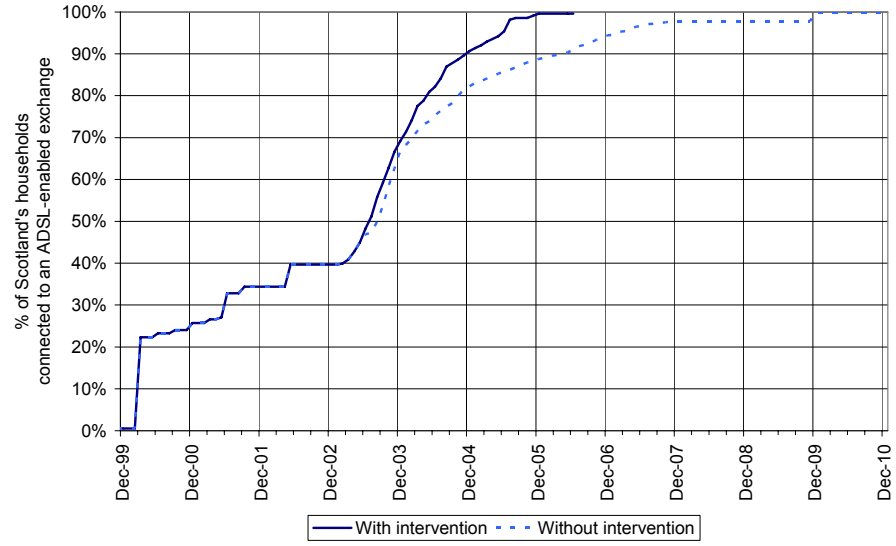
5.63 The rate of ADSL registrations appears to have been particularly high in Scotland. The chart below compares the trends in 'registrations yet to go' on the trigger point lists of the UK nations and regions[21] in early 2004.

Figure 5-10 'Registrations yet to go' on the trigger point lists of UK nations and regions in early 2004 [sources: bt.com, SQW analysis, 2004]



5.64 In Figure 5-11 below, we present our estimate of the 'counterfactual' coverage of affordable broadband in Scotland (i.e. what the coverage would have been in the absence of any intervention by the Scottish Executive and its agencies) in terms of the proportion of Scotland's households connected to an ADSL-enabled exchange (a reasonably close proxy to overall population coverage for 2003 onwards).

Figure 5-11 Actual vs counterfactual broadband coverage in Scotland [sources: SQW analysis, Samknows (for exchange activation dates)]



[21] The 'registrations to go' in the North East reduced to zero in February 2004, as all North East exchanges were removed from the trigger point list at that stage due to a supply-side intervention by One NorthEast.

5.65 Our key assumptions in developing the above chart are as follows:

- We have assumed that the public sector demand stimulation intervention started in April 2003 (although, in fact, there were some initiatives pre-dating this – especially in the Highlands and Islands).
- For those exchanges on the trigger point list at the end of March 2003, our counterfactual projections apply their March 2003 average rates of registrations per day per line.
- For those exchanges on the trigger point list at the end of November 2003, our counterfactual projections apply the lowest regional average rate of registrations per week per exchange observed across the UK nations and regions over the period January 2004 to April 2004 (which was 2.4 registrations per exchange per week).
- The exchanges in the Executive's Supply Side Intervention have been included as scheduled in the 'actual' coverage line; for the counterfactual we have assumed that these exchanges would have been upgraded at the end of 2009 – i.e. towards the end of BT's 21CN roll-out.
- We have assumed that the average lag between an exchange reaching its trigger level and being enabled was four months.
- We have assumed that BT would have let the trigger point mechanism run its course (and not committed to enabling all exchanges with trigger levels), in the absence of the interventions that substantially accelerated the rate at which exchanges were reaching their trigger points. It should be noted that it was, of course, the combined effect of interventions and campaigns throughout the UK – not just in Scotland – that accelerated demand registrations and ultimately led to BT's decision to enable all exchanges with trigger levels.

5.66 The implications of this analysis are that the *Broadband for Scotland* interventions accelerated affordable broadband coverage as follows:

- 70% coverage was brought forward by c. 3 months;
- 90% coverage was brought forward by c. 17 months;
- near 100% coverage was brought forward by c. 4 years.

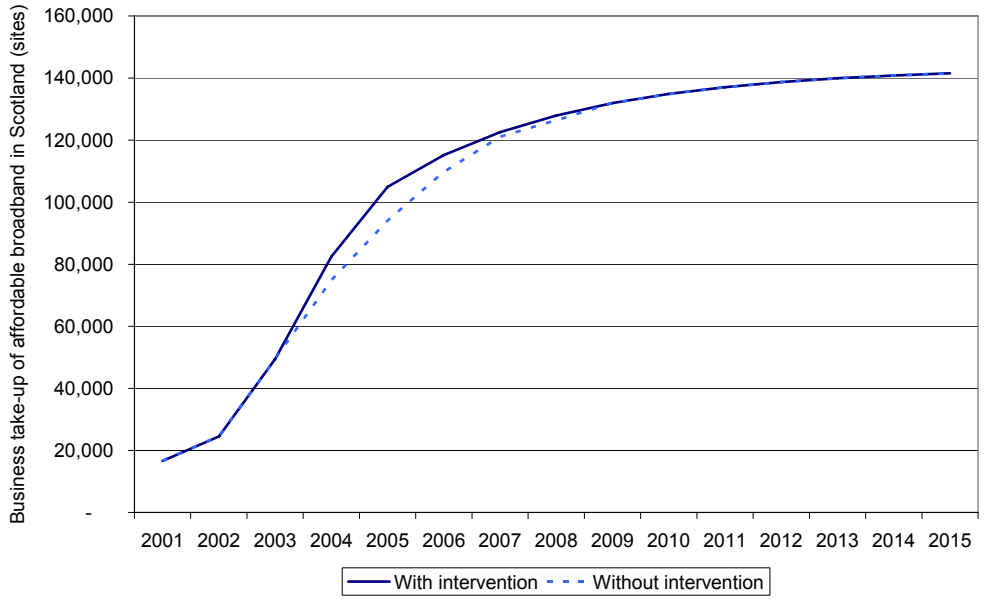
5.67 As a cross-check on our counterfactual projection, we compare in the table below the actual and counterfactual coverage levels versus the affordable broadband coverage in other countries as at 3Q05, as reported in Ovum (2006). Our counterfactual projection appears to be reasonable, placing Scotland's coverage between that of Australia and Canada, and significantly above that of Ireland.

Table 5-11 Comparison of affordable broadband coverage as at 3Q 2005 [sources: Ovum (2006), SQW]

Country	Population coverage
UK	99.7%
Scotland (actual)	***99%***
South Korea	97%
Japan	96%
France	95%
US	94%
Germany	91%
Sweden	90%
Italy	90%
Canada	89%
Scotland (counterfactual)	***87%***
Australia	85%
Ireland	81%

5.68 By applying the counterfactual coverage levels to our business take-up model, we can observe the acceleration in business broadband take-up resulting from the intervention[22]. The chart below suggests that c. 11,000 more Scottish business sites were connected to broadband as at the end of 2005 than would have been the case otherwise - c. 10% of the total business connections at that time.

Figure 5-12 Projections of broadband take-up by businesses in Scotland, with and without intervention [source: SQW]



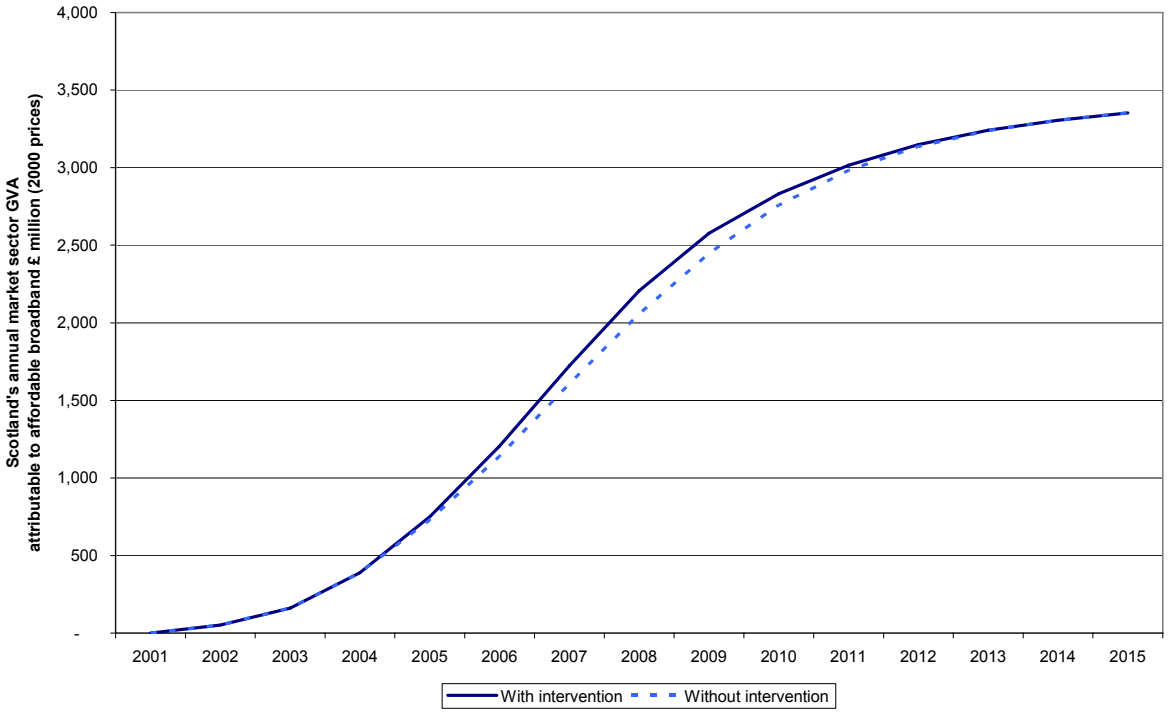
[22] There is also a strong case for arguing that the *Broadband for Scotland* campaign accelerated business broadband take-up in areas that were already broadband enabled. We do not have robust counterfactual data for the take-up rate in enabled areas in the absence of intervention, however, and we have therefore restricted our analysis to the take-up brought forward as a result of accelerated coverage.

5.69 Finally, we have applied the counterfactual business take-up to our economic impact model. As illustrated in Table 5-12 and Figure 5-13 below, our model suggests that the economic impact of the *Broadband for Scotland* intervention will peak in the year 2008, with the annual market sector GVA being approximately **£150 million** higher in that year than it would have been otherwise (at 2000 prices). If we assume real market sector growth of 1.9% p.a., this difference would represent c. 0.23% of total market sector GVA in the year 2008.

Table 5-12 Projected annual GVA impact of affordable broadband for Scotland's market sector – with and without intervention, £ millions (2000 prices) [source: SQW]

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
With intervention	-	52	162	389	751	1,206	1,724	2,206	2,576	2,833	3,016	3,149	3,242	3,306	3,353
Without intervention	-	52	162	389	730	1,140	1,606	2,058	2,447	2,758	2,983	3,136	3,239	3,306	3,353
Difference	**-**	**-**	**-**	**-**	**21**	**66**	**117**	**148**	**129**	**75**	**33**	**13**	**3**	**-0**	**-0**

Figure 5-13 Projected annual GVA impact of affordable broadband for Scotland's market sector – with and without intervention, £ million (2000 prices) [source: SQW]



5.70 Over the period 2003-2015, the Present Value[23] of the above differences in market sector GVA is c. **£500 million**.

[23] Taking 2003 to be year 0, and discounting at 3.5% as per HM Treasury Green Book guidance

6 Social impact

6.1 Having considered the economic impact of broadband, we now describe some of the important *social* implications of the technology, at its various generations. Specifically, we consider the impact of 1B, 2B and 3B+ broadband on: consumers; transport; education and health services; and e-Government.

Consumers

6.2 As demonstrated by the rapid growth in household take-up of broadband in the UK, the technology brings substantial benefits to consumers as well as to businesses. Indeed, operators' business cases for broadband roll-out are typically predicated on the consumer – rather than business – market.

6.3 Our assessment of the incremental benefits of each broadband generation is shown in the table below. Downstream and upstream bandwidths assumed for this comparison are as per the levels shown in Table 5-2.

Table 6-1 Incremental benefits to consumers associated with each broadband generation [source: SQW]

Dial-up to 1B	1B to 2B	2B to 3B
• Ability to use the phone and the internet at the same time • Always on connection • Cheaper internet access (for moderate to heavy users) • Faster web access • Ability to send and receive larger email attachments (e.g. digital photos, up to, say, 5MB) • Enables faster (downstream-limited) music downloads, e.g. from iTunes (e.g. c. 1 minute instead of 10 minutes for a 4MB MP3 file) • Enables faster (upstream limited) P2P file sharing of music files – legal and illegal (e.g. c. 2 minutes instead of 20 minutes for a 4MB MP3 file) • Enables (downstream-limited) video downloads, e.g. from iTunes (e.g. c. 10 minutes for a 40MB TV episode) • Enables overnight P2P file sharing of video files (e.g. c. 5 hours for a 500MB movie) • Less lag, smoother gameplay, and wider choice of games (e.g. via Xbox Live) for online gaming • Makes home-working (full-time, part-time or occasional) more	• Ability to send and receive still larger email attachments (e.g. home video clips) • Enables faster (downstream-limited) music downloads, e.g. from iTunes (e.g. c. 6 seconds instead of 1 minute for a 4MB MP3 file) • Enables faster (upstream limited) P2P file sharing of music files – legal and illegal (e.g. c. 1 minute instead of 2 minutes for a 4MB MP3 file) • Enables faster (downstream-limited) video downloads, e.g. from iTunes (e.g. c. 1 minute instead of 10 minutes for a 40MB TV episode) • Enables faster P2P file sharing of video files (e.g. c. 2.5 hours instead of 5 hours for a 500MB movie) • Less lag, smoother gameplay for online gaming • Improved access to office systems for home-workers • Ability to obtain IPTV services, including HD and SD quality broadcast TV and video on demand • Moderate quality person-to-	• Ability to send and receive still larger email attachments • Very rapid music downloads, e.g. from iTunes (e.g. 0.6 seconds for a 4MB MP3 file) • Much faster (upstream limited) P2P file sharing of music files – legal and illegal (e.g. c. 1 second instead of 1 minutes for a 4MB MP3 file) • Much faster (downstream-limited) video downloads, e.g. from iTunes (e.g. c. 6 seconds instead of 1 minute for a 40MB TV episode) • Much faster P2P file sharing of video files (e.g. c. 2 minutes instead of 2.5 hours for a 500MB movie) • High quality person-to-person and multi-party videoconferencing (incl via games consoles) • Seamless, near-LAN speed connectivity for home-workers into company systems

attractive and feasible • Easier and more reliable e-commerce and online banking • Easier and richer (e.g. photos, videos) updates to personal/community websites • Much improved video streaming quality • More reliable audio streaming quality • 'Experimental quality' person-to-person video conferencing • Prospect of reduced phone bills (e.g. through Skype)	person videoconferencing • Experimental quality multi-party video conferencing • Support for an increased (c. x2) number of simultaneous VOIP calls	

6.4 As with the business applications discussed previously, there are diminishing returns associated with upgrades to successive generations, for those applications involving modest file sizes, but much more compelling benefits associated with these upgrades when considering large files – video files, in particular.

6.5 With video now accounting for the majority (61%) of global Peer-to-Peer (P2P) file sharing traffic [source: CacheLogic, 2005], we suspect that this – mostly illegal – activity will remain popular, and will be a major beneficiary of moves to higher bandwidths – especially when 3B+ services (with their much higher upstream bandwidths) become widely available.

6.6 From the diversity of opinions expressed by our consultees (see Annex B for examples), it is clear that there are genuinely high levels of uncertainty surrounding the consumer benefits and levels of demand for applications enabled by 2B, and especially 3B+ services.

6.7 We also note that many of the potential benefits of 2B and 3B+ services will require complementary technical and commercial developments, in order to be realised. For example:

- rights owners implementing robust Digital Rights Management (DRM) technology, to allow legal paid-for video downloading[24];
- operators launching commercial IPTV services, including high definition services;
- broadcasters moving to producing programmes in High Definition format (e.g. the BBC aims to make all its programmes in HDTV format by 2010);
- consumers buying HD Ready TV sets;
- ISPs increasing the size limits for email messages and mailboxes, to allow larger attachments to be handled;

[24] Note that Sony has recently had to stop shipping CDs with the Sony-BMG 'rootkit' DRM technology, as this had been exploited by virus writers to infect users' computers with a Trojan.

- computer manufacturers integrating webcams into their products, in order to simplify video conferencing (as per the new Apple iMac G5).

6.8 Regarding IPTV services (whether standard definition, SD, or high definition, HD), it should be noted that similar or substitute services are (or will be) delivered via platforms other than broadband – both in areas which have 2B/3B+ coverage and in those without. In particular:

- Satellite TV
  - Near Video on Demand (NVOD) has been available since 1998 via Sky Box Office, with several recent films being shown at 30 minute intervals throughout the day.
  - BSkyB launched High Definition TV via its satellite platform in May 2006. The Sky HD box includes 160 gigabytes for customers' recording, plus additional storage to support BSkyB's future plans for 'push VOD' (which broadcasts movies to hard disks, for later playback).
- Cable TV
  - NTL and Telewest have offered their Front Row NVOD service since 1998, offering a choice of up to 30 films.
  - NTL and Telewest are also currently in the process of rolling out more advanced VOD services across the UK. For example Telewest's Teleport service is available to customers with a TV subscription (i.e. no broadband subscription or additional equipment required), and offers Teleport Replay (popular TV programmes shown over the last 7 days), Teleport Movies (a library of c. 300 films) and Teleport TV (a range of popular series, documentaries, comedy and children's programmes).
  - Telewest launched HDTV services to its cable TV customers in March 2006. There are plans to roll-out the service over the NTL network by the first quarter of 2007.
- Digital Terrestrial TV (DTT)
  - The BBC started a limited technical trial of HDTV over Freeview in May 2006 – although, due to spectrum limitations, it is unlikely that HDTV services will become widely available on the DTT platform until after analogue switch-off in 2008-2012.

6.9 From a digital inclusion perspective, our consultations indicate that the primary issue is whether people in excluded or disadvantaged groups (e.g. those on low incomes; the unemployed, older people; people with disabilities, learning difficulties, literacy and

numeracy problems; and people for whom English is not the first language) have access to the *internet* at all, rather than whether they have *broadband* internet access.

6.10 With 1B broadband services now available at prices as low as £10 per month, the financial barriers to taking up broadband have become minimal. The purchase of a computer (and the associated peripheral equipment) is currently a much more significant barrier – e.g. £300 for Dell's entry-level desktop.

6.11 Many of our consultees were optimistic that broadband-related technology and commercial developments over the next few years would help to foster digital inclusion, by stimulating increased internet penetration. For example:

- As noted above, the costs of entry-level computers are likely to fall below £100 (at 2000 prices) by 2015.
- The increasing use of broadband for services such as HDTV, VOD and online gaming raises the prospect of certain excluded groups buying broadband for the enhanced entertainment options, and then finding that the household has obtained internet access 'for free' (with the access device potentially, in the future, being a TV set or gaming console rather than a computer).
- More than 80% of people in the UK own a mobile phone, and 3G phones are reducing in price and gaining popularity (IDC estimated 13% of UK mobile phones shipments to be 3G in 2005). For people living in Scotland's urban areas, at least, we can expect an increasing number of those people without fixed internet at home to have access to the internet via their mobile phones.
- Advances in the quality and ease of video conferencing over the internet may make the internet interesting to new audiences – including elderly people with close family members living in different parts of the UK or overseas, and ethnic minority households seeking to maintain contact with relatives in other countries.

6.12 Some of our consultees suggested that the availability (or non-availability) of broadband may have an impact on house prices, as broadband internet becomes a 'must have' for households. After five years of 1B availability in parts of Scotland, we have yet to see broadband being cited regularly in newspaper advertisements for houses, though it is starting to be mentioned in a few particulars: for example, our search on 'broadband' on the ESPC website returned six results from 5067 properties for sale. It will be interesting to see if this becomes more prevalent over the next two or three years, now that broadband penetration has reached a critical mass.

6.13 For now, it appears that widespread 1B availability is encouraging (rather than the lack of higher speed broadband discouraging) people to consider moving to rural locations to live

and/or work. In SQW (2005) we report that c. 30% of urban business said that they would consider operating from a rural location now that broadband is available. Anecdotal evidence appears to support this: for instance, an article in the Scotsman of 22nd September 2005 quotes a representative of estate agents GM Thomson, providing an explanation for the recent relative strength of house prices in Galloway:

- *"There are other factors at work. A gradual dawning by outsiders that the region is not that isolated - this is especially true of eastern Galloway, where travel times to Glasgow on the M74 can be as little as 70 minutes. Combined with the* ***widespread provision of broadband*** *to rural exchanges, an increased acceptance by employers of home working and finally a greater awareness of the quality of property available for up to 40 per cent less than one might pay in Perthshire or Stirlingshire."*

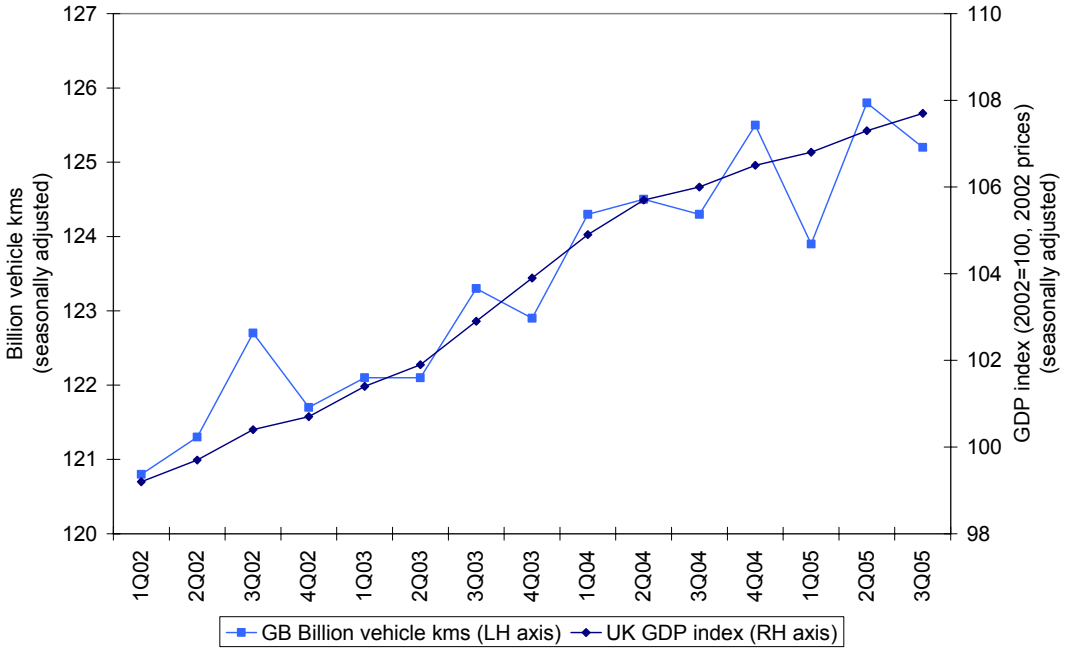
Transport

6.14 It has frequently been claimed that broadband helps – or will help – to ease transport congestion and pollution. Video-conferencing reduces the need for business people to travel to meetings, online shopping reduces the need to visit the shops, and broadband enables people to work from home – thereby cutting down on commuter traffic.

6.15 We tested these hypotheses with our consultees (see example of their comments in Annex B). While there was a general agreement amongst this group (professionals/senior management in, for the most part, large high tech companies) that broadband has led to a significant increase in teleworking, there was also a consensus that road traffic and congestion do not appear to have been reduced perceptibly as a result.

6.16 The impact of ICT/broadband on travel is a complex area, and it has generated major studies in its own right. We do not attempt to address the issue comprehensively in this report. Having listened to our consultees' views and reviewed some of the relevant literature, however, we observe that broadband can have both positive and negative effects on traffic levels. Halden (2005) notes that there is a complex matrix of second order effects, and that the travel demand increases generated by increased economic development may exceed the efficiency benefits from e-working. As shown in the chart below, an increase in GDP tends to be associated with an increase in the national traffic levels.

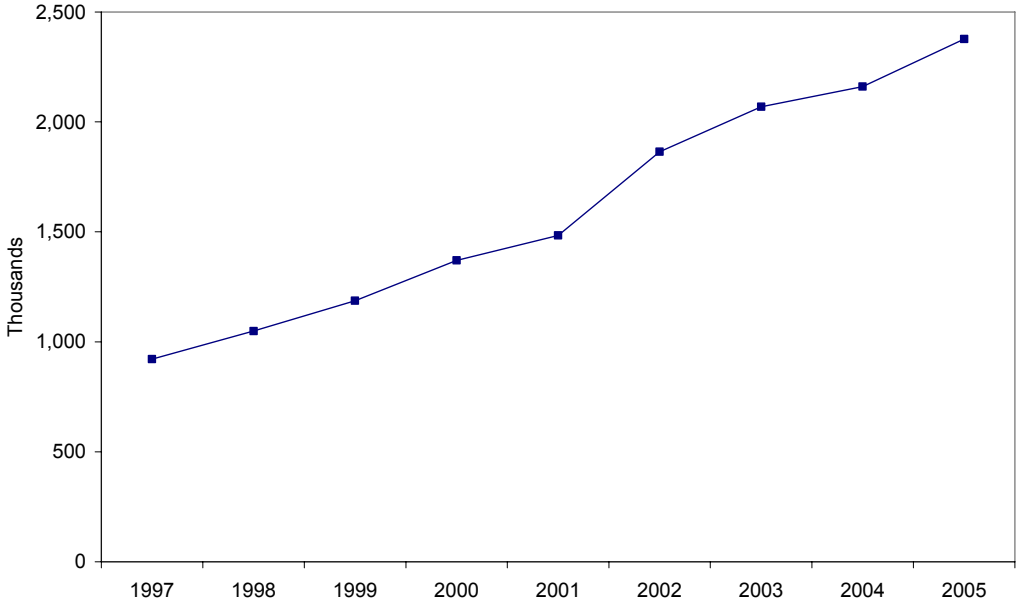
Figure 6-1 Great Britain all-vehicle traffic levels and the UK GDP index, 2002-2005 [sources: Department for Transport, ONS]



6.17 If, as we suggest in the previous section, broadband makes a significant contribution to economic growth (and that 2B and 3B+ each bring significant incremental economic benefits over and above the effect of 1B broadband), then the increased levels of wealth and economic activity will tend to lead to more cars per household, and more miles travelled by commercial vehicles in distributing products.

6.18 Whilst we suspect that the availability of broadband may not, on balance, lead to any appreciable reduction in traffic levels and congestion, the positive changes in travel patterns that broadband *can* enable should not be overlooked. ONS (2005) reports a major growth in teleworking in the UK, from 0.9 million in 1997 to 2.4 million in 2005 (144k – 6% of all in employment – in Scotland), with a noticeable acceleration in 2002 when the UK availability of affordable broadband was rising steeply.

Figure 6-2 UK teleworkers (home-workers who use both a telephone and a computer at home) [source: ONS (2005)]



6.19 BT (2004) suggests that additional home-working could potentially reduce commuting mileage by 10% in Great Britain. The potential reduction is estimated to be significantly smaller in Scotland, though, at 5% - driven by the findings of an NOP survey in December 2003, that 13% of respondents in Scotland would like to home-work, versus 23% for Great Britain as a whole and 35% in London. It would appear that, in a given region, the severity of congestion and the average commute time are strong influences on people's propensity to work from home.

6.20 A more subtle effect of occasional home-working is that it allows people to stagger their journeys to avoid peak periods – thereby reducing congestion. Halden (2005), however, suggests that there is a consistent finding that e-working impacts more upon public transport use than car use – and indeed that e-working encourages people to switch transport mode, from using public transport at peak times to using their cars at uncongested times of day.

6.21 We would anticipate that the increased bandwidths associated with 2B and 3B+ broadband can only serve to make teleworking still more attractive. 3B+ in particular, with its substantially higher upstream speeds, would allow seamless connectivity into office systems for remote teleworkers. As per the discussions above re consumer and business applications, we are also optimistic that recent advances in the quality and ease of video-conferencing over the internet will lead to increased business use of this technology; this, in turn, has the potential to reduce the sense of isolation sometimes felt by people working remotely, thereby reducing the social pressures for them to travel into the office.

Education and health

6.22 The larger sites in the education and health services (universities and colleges, large secondary schools, and hospitals for example) are more akin to large corporate users than to SMEs, in that they have very substantial bandwidth requirements, combined with the budget to be able to afford the necessary Wide Area Network connectivity.

6.23 However, the arrival of affordable 1B has allowed broadband connectivity to be extended to the much larger numbers of small-to-medium size sites, such as primary schools, smaller secondary schools, GP surgeries, dentists and pharmacies.

6.24 The advent of 'affordable' 2B and 3B+ services is unlikely to have much impact for the large sites, in our view (they will continue to use advanced 'corporate-strength' data services), but will have substantial incremental benefits for the smaller sites. For example:

- 2B and 3B+ bandwidths would allow schools to access content on the Scottish Schools Digital Network (SSDN) intranet much faster.
  - E.g. a 100MB educational video could be downloaded in c. 16 seconds with 3B, or in c. 3 minutes with 2B, as opposed to c. 30 minutes with 1B.
- With 3B+ services in particular, given their much higher upstream bandwidths, high definition video conferencing will be possible – improving the usefulness and practicality of remote video-based consultations between city-based specialists and patients/doctors in more remote parts of Scotland.
- 2B and 3B+ bandwidths could potentially allow the extension of the Picture Archiving and Communications System (PACS) to GPs' desktops.
  - E.g. a 50MB X-ray image could be retrieved in 8 seconds using 3B, or in 80 seconds using 2B, as opposed to 13 minutes using 1B.
- Such bandwidths will allow for a re-distribution in data storage – away from local storage (e.g. at schools or GP surgeries), to more secure centralised data warehouses.

6.25 As well as these direct benefits, resulting from the health and education sites themselves having access to higher bandwidths, we also envisage significant further benefits associated with 'users' having such access at home. For example:

- 2B and 3B+ could allow family members and health workers to maintain more frequent 'face-to-face' contact with the elderly and infirm in their own homes, using video-conferencing over the internet – hopefully as a complement to, rather than a substitute for, actual physical visits.

- Teachers would have faster remote access from their homes to the SSDN intranet – helpful, for example, in viewing educational videos in the course of their lesson preparation.

- People who may not otherwise be in a position to consider further education may find it possible to engage in FE courses, if video-streamed lectures enable them to do more of the learning in their own homes.

6.26 In summary, 1B is already bringing significant benefits to the delivery of health and education services in Scotland. We foresee that these services could well have a much higher reliance on video-based (and large image file) applications than will be the case for a typical business. We therefore expect the higher bandwidths associated with affordable 2B and 3B+ services to bring substantial incremental benefits to the health and education sectors in Scotland – where they are available. Given our prediction of the emergence of a persistent digital divide between urban and rural areas in the availability of 3B+ services, in particular, this clearly raises a potential policy concern.

e-government[25]

6.27 Our consultees[26] were generally of the view that e-government services are improving, but that they have some way to go to catch up with best practice in the private sector, in terms of site design, process re-engineering and integration across different departments.

6.28 Certain e-government applications were applauded – online tax returns and online road tax renewal, for example. We note that the financial incentives to small businesses to file their returns online (a £250 credit, for filing the 2004/5 return online) have had a huge impact. HM Revenue & Customs Employer Bulletin for October 2005 reports that 935,000 businesses sent their Employer's Annual Returns online for the 2004/5 financial year, compared with 85,000 for the 2003/4 financial year: an increase in usage of 1000% in a single year.

6.29 1B broadband helps to increase the take-up of e-government services, by making their use quicker, easier and more reliable. For example, the HM Revenue & Customs homepage (c. 50kB) loads in c. 8 seconds using dial-up, but in less than 1 second using 1B.

6.30 However, we see relatively little scope for the usage of 2B and 3B+ services by Scotland's citizens bringing further benefits to the e-government user experience:

[25] In this sub-section, we are considering 'e-government' in the relatively narrow sense of citizen/business interactions with government (other than health and education related services, which are considered in the previous sub-section) conducted via the internet.

[26] It should be noted that e-government was not, of course, the sole focus of this study. While we interviewed the head of the e-Government and Take-up team at the Scottish Executive, and asked the opinions of our industry consultees, a full programme of e-government consultations – including, for example, each of Scotland's 32 Local Authorities – was not within the scope of our commission.

- E-government websites must continue to be designed with dial-up users in mind, in order to ensure that citizens without broadband internet access (whether through choice or non-availability) can still use the services.

- Upgrades to 2B and 3B+ will therefore lead to almost imperceptible improvements in website response times (typically, improvements of less than 1 second).

- There do not appear to be any compelling video streaming applications. It will be possible to put streamed video recordings of council meetings, planning inquiries, tourism promotions etc online (and we are sure that such developments will become more common); however, we are sceptical as to whether such applications are likely to attract mass market usage.

- The potential for citizens and business to video-conference with public sector employees over the internet is interesting (rather than simple phone conversations). Again, there will surely be experiments in this area over the next few years, as internet video-conferencing becomes easier and higher quality. Our expectation, however, is that the use of video is unlikely to become common for such interactions.

6.31 In short, we consider that 1B broadband provides a key enabling technology, which is a necessary (though not sufficient) condition for substantial growth in the use of e-government services over the next couple of years. The advent of 2B and 3B+ services is unlikely, however, to provide similar incremental benefits, as far as e-government services are concerned. Site design, process re-engineering and better integration between departments need to be higher priorities than video content and richer web pages.

7 Policy implications

7.1 In this section we consider the rationale for further public sector intervention in the Scottish broadband market. We then outline our recommended policy actions.

Rationale for public sector intervention

7.2 The above assessment of the benefits of broadband in general, and of NGB in particular, does not necessarily form a *case* for further intervention[27]. Public sector intervention could, in practice, distort the broadband market and lead to unintended adverse consequences. As set out in the HM Treasury *Green Book*, there needs to be a genuine argument for intervention on the grounds of market failure or social equity (or both), where the benefits from intervention exceed both the financial and other (e.g. distortional) costs in sustainable ways.

7.3 Furthermore, *timing* of any interventions will be an important consideration, given that this is such a rapidly-moving market. The Scottish Executive's programme of interventions in the 1B market achieved substantially higher impact than would otherwise have been possible, thanks to the decision to defer the supply-side intervention, in favour – initially - of demand-side measures.

Market failure ?

7.4 Is there a case for further intervention in the broadband market[28] in Scotland on the grounds of improving market efficiency ?

7.5 Such intervention may be justified if there are supply-side market failures or demand-side market failures:

- A **supply side market failure** is where there is demand for a product or service at a price that would cover all costs (including the cost of capital), but insufficient supply at that price.
- A **demand-side market failure** is where informed, economically 'rational' consumers would purchase an offered product or service, but actual consumers do not.

[27] i.e. Intervention over and above the 1B-related initiatives undertaken in the course of the *Broadband for Scotland* programme.

[28] We are considering the *mass-market* for broadband here – i.e. the market addressing the needs of households and SMEs. We exclude from this analysis any consideration of Scottish Enterprise's Project ATLAS (which provides dark fibre infrastructure in selected business parks), the rationale for which is articulated elsewhere, including in the European Commission's state aid decision letter.

7.6 Given that UK operators have launched 2B services, and that 3B services are being developed and are mooted to be introduced in 2007, **we consider it unlikely that there is a genuine supply-side market failure** here.

- The broadband market is intensively competitive in Scotland's urban areas, with a three way battle for infrastructure-level market share between the cable companies, the LLU operators and BT Wholesale. The last 24 months have seen substantial increases in the bandwidths offered to customers, at very little or no premium to their previous bandwidth offerings.

- While rural areas of Scotland are not seeing such intense competition (as they are typically not served by cable companies or LLU operators), most do at least have access to 2B services from a variety of ISPs, following BT Wholesale's national launch of ADSL Max services at the end of March 2006.

  - The areas in Scotland not included in this roll-out – the 20 'untriggered' exchanges in the Western Isles plus the 148 Exchange Activate exchanges – should obtain this service once BT's 21CN roll-out reaches them, but the timetable for this roll-out is yet to be released. In the case of the Western Isles, it is possible that Connected Communities[29] will launch 2B services. It is also possible that some of the exchanges which are currently Exchange Activate will be upgraded to full platform ADSL in advance of 21CN roll-out, under the SSI contract[30]. There is little doubt that BT and Connected Communities would launch such services in these areas if – in the light of the incremental costs and benefits - it was commercially feasible to do so.

- Consumers and businesses in some parts of Scotland will not be able to access 2B services (nor indeed the upper reaches of the 1B bandwidths) due to technical reach constraints. While this may be an 'equity' issue (see below), it would only represent a supply side market failure if the market is acting inefficiently: i.e. not providing service, even though incremental revenues would actually cover the incremental costs (including the cost of capital) of extending higher bandwidth services to these locations. There is little evidence to suggest that BT and other operators would not make economically rational investment decisions regarding such reach extensions (i.e. if these areas lack certain services, it will be because operators consider it commercially unviable to provide them in these locations).

[29] Note that Connected Communities' 1B service offerings are symmetric (see http://www.hebrides.net/western_isles_broadband_packages.htm); they have significantly higher upstream speeds than are typical for 1B services, and therefore already offer some of the benefits of the 'representative' 2B services considered in previous sections, such as improved video call quality.

[30] Under the SSI contract, BT's financial returns are capped at a pre-defined Internal Rate of Return. The supplier is therefore incentivised to make additional investments in the SSI exchanges (e.g. upgrading Exchange Activate exchanges to full platform ADSL) if the actually achieved financial returns would otherwise exceed this threshold.

- When we consider the *mobile* broadband market, we observe that there is intense infrastructure-level competition between five mobile network operators in the provision of 3G services, and that these services should extend to approximately 80% of the population by the end of 2007. In parallel to this, there is significant private sector investment going into the creation of Wifi hotspots/hotzones – including the recent announcement by The Cloud of its plan to roll-out city-wide hotzones in the UK, with the initial phase covering nine UK cities (including Edinburgh).

7.7 On the demand-side, the rapid growth over the last year in the take-up of 1B broadband by Scotland's households and businesses suggests that *lack of awareness* of broadband's benefits is a diminishing problem.

7.8 Similarly, whilst the 2B market is as yet nascent, there does not appear to be any irrational reluctance amongst consumers and businesses to move onto these higher speed services. Indeed, in many cases, these higher speeds are being offered as the default option as soon as they are launched.

7.9 From an economic development perspective, however, we consider that **there remains an important market failure in the extent to which businesses are exploiting the opportunities presented by their broadband connectivity**.

- As previously noted, there is a substantial lag between business investment in ICT and the realisation of the full benefits (our model assumes four to six years, depending on the sector). Furthermore, research suggests that US firms are substantially more effective at realising the benefits of ICT than are UK firms.

- It is widely recognised by policy-makers that SMEs face information-related market failures in ICT (large businesses, for the most part, having the resources to employ in-house ICT expertise) - see, for example EC (2005), which sets out the i2010 strategic framework.

- If companies had perfect information regarding the ways in which they could exploit ICT (including broadband-enabled ICT systems and processes), and the associated costs and benefits, then we would expect such lags to be considerably shorter, with the productivity improvements being pulled forward accordingly.

  - Accelerating the rate at which companies realise broadband-related benefits would have important economic benefits. Our model suggests that a one year reduction in the lags (i.e. bringing the lags down to three to five years, as opposed to four to six years) would increase the Present Value[31] of the impact of broadband on Scotland's market sector GVA over the period 2001-2015 by c. **£2 billion** (increasing from £20 billion to £22 billion).

[31] Taking 2001 to be year 0, and assuming a 3.5% discount rate.

7.10 Furthermore, there is a further **potential market failure[32] in respect of unidentified clusters of underserved demand**.

- With 'mainstream' 1B roll-out now complete, a very small proportion of households and businesses remain out of reach and unable to obtain affordable 1B services; it may be that such consumers are unaware of neighbours in their area facing the same situation. In some such cases a jointly procured network (for example, a hybrid satellite/wireless network[33]) could provide an attractive solution to the needs of this cluster of consumers.

- As 2B and 3B+ services are rolled out, there will be substantial numbers of consumers considering themselves underserved versus their urban counterparts (we estimate, for example that 15% of households in Scotland will remain unable to obtain downstream bandwidths over 5Mbit/s). Again, it is possible that there would be sufficient demand (and willingness to pay) in some cases to justify a supplier providing bespoke 2B solutions to such clusters – but only if the demand is aggregated.

Equity ?

7.11 There may be an argument for public sector intervention in a market on the grounds of addressing an unacceptable inequity facing certain communities – even if this introduces an element of economic 'inefficiency'. Indeed, the Executive's Supply Side Intervention was an example of such an initiative – addressing the political objective of making 1B services available to every community in Scotland.

7.12 Given that a) we are currently at the start of the 2B market in the UK, b) we are still a year or more away from 3B+ services being introduced into the market, and c) telecoms technology and business models tend to develop rapidly, **we cannot yet say with absolute certainty which areas will remain persistently underserved** by the market, left to its own devices. Earlier in this report we have presented our indicative estimates of future geographic coverage; however, these are, inevitably, *estimates* – not *fact*.

7.13 Furthermore, **it is too early to judge whether the future lack of 2B and 3B+ services in certain areas will represent an unacceptable inequity**.

[32] Arguably, this is a supply-side as well as a demand-side market failure: a supply-side failure in that commercially viable clusters of underserved demand exist but operators are not aware of them and do not address them; a demand-side failure in that economically rational consumers in these clusters would aggregate their demand and procure a service. Note this is a similar argument to that used for assisting collaborative R&D.

[33] See, for example, the privately financed networks established by CMS Broadband in South West Scotland (http://cmsbroadband.net/), and by Dick Fleming Communications in Aberdeenshire (http://www.dfcommunications.com/). Note also, however, that many such satellite/wireless networks depended on Aramiska for their satellite backhaul, and their services were therefore severely disrupted when Aramiska collapsed in January 2006.

- It is possible, in practice, that multiple 1B (or 2B) lines could be used to address the bulk of the needs of businesses with a higher bandwidth requirement in such areas. ISPs such as Nildram, Andrews & Arnold and Vaioni are already offering bonded ADSL services, whereby two or more ADSL lines are bonded together to offer higher throughputs. Furthermore, the advent of ADSL2+ services brings the prospect of bonded services becoming more 'mainstream', since the ADSL2+ standard was designed to enable seamless bonding (whereas the ADSL standard wasn't).
  - Encouragingly, bonding could also potentially alleviate some of the 'out of reach' issues associated with 1B and 2B services: for any given distance from the exchange, the use of two bonded copper pairs will approximately double the achievable upstream and downstream bandwidths.
  - However, it should be noted that bonding requires one or more additional copper pairs and ADSL services to be connected to the customer's premises. There are significant cost implications of this, which result in bonded ADSL services being more realistic for businesses than for households. Also, it will not always be the case that spare copper is available in the access network (we note that BT was using 77% of its total access copper pairs as at March 2003).
- As far as households are concerned, it is likely that the primary driver of 2B and 3B+ usage will be *entertainment*, rather than business needs, learning or e-government (e.g. film/TV video file downloads, HDTV etc.). Some of these broadband-delivered entertainment services will be competing with services delivered via a platform that is already almost ubiquitously available in Scotland – i.e. BSkyB's satellite platform.
- As discussed in the previous section, the higher bandwidths associated with affordable 2B and 3B+ services could potentially bring substantial incremental benefits to the health and education sectors in Scotland, and the persistent absence of such services could potentially put rural and remote areas at an unfair disadvantage in terms of their access to health and education resources. The discussion on DSL bonding above, however, illustrates that the severity of this potential future disadvantage is far from certain, as yet.

Policy recommendations

7.14 Having considered the above arguments for intervention, we set out below our recommendations for policy action by the Scottish Executive and its partners. Some of these actions are specifically for the Scottish Executive (including liaison with other parties, such as Ofcom); others are more relevant to Scottish Enterprise and Highlands and Islands Enterprise. As the success of the *Broadband for Scotland* programme was founded on close partnership working between these three organisations, our recommendations are addressed to the Executive, SE and HIE as a group.

7.15 Our recommended overall approach is to refrain from major intervention in the 2B and 3B+ markets at this stage, but to minimise avoidable barriers to network investment and ensure that Scottish businesses are well informed regarding the opportunities presented by broadband-enabled ICT. The first step, however, is to ensure that ICT as a whole is given sufficient weight, at a policy-making level, as a driver of productivity growth in Scotland.

Recommendation 1: Radically increase the profile of ICT within Scottish productivity policy

7.16 This study is, of course, concerned with Next Generation Broadband. In considering policy actions related to NGB, however, we have found it impossible to avoid making certain recommendations regarding ICT in general, given that the benefits of NGB are inherently dependent on the exploitation of broadband-enabled ICT (and all that that entails in terms of investment, skills and process innovations). The market failure, discussed above, concerning businesses under-exploiting the opportunities presented by their broadband connectivity is particularly relevant.

7.17 In our reviews of the literature regarding the economic impact of ICT/broadband, and the relevant policies of other countries, it has struck us forcibly that other governments appear to be placing a significantly higher emphasis on ICT's contribution to economic productivity than is currently the case in Scotland.

7.18 For example: in France, the President recently (December 2005) announced that he is making the 'digital revolution' one of the country's two priorities in industrial policy (the other being the post-oil energy revolution); and in Finland, the Prime Minister chairs the Information Society Council, the second annual report of which (February 2006) places particular emphasis on the productivity and efficiency gains produced by ICT. We note also that the OECD's peer reviews of "ICT Diffusion to Business" in seven countries place substantial emphasis on the need for clear statements of ICT policy and for co-ordination of policy between government departments [OECD (2005)].

7.19 In contrast, Scotland does not currently have an overall ICT policy as such, nor is there any explicit mechanism for co-ordinating external-facing ICT initiatives across government[34]. Of most concern, in our view, is the lack of emphasis on ICT in the area of Enterprise policy. The *Framework for Economic Development in Scotland* (2004) makes little mention of ICT other than references to broadband and to ICT in schools; and of 198 key workstreams identified in the 2006/07 Business Plan of the Enterprise Transport and Lifelong Learning Department, only three are explicitly related to ICT[35], and *none* of these are really aimed at improving the exploitation of ICT by Scottish businesses.

7.20 While *Smart Successful Scotland* (2004), the strategic guidance to the Enterprise Networks, also refers to broadband and includes "Use of e-business to create competitive advantage" as one of its twelve priorities, we note that there are no specific actions or budget in response to this priority in Scottish Enterprise's Operating Plan for 2006-2009, as e-business support is being mainstreamed.

7.21 We are *not* arguing against the case for mainstreaming operational e-business support. Our concern is that there appears to be an emerging mismatch between the growing recognition of the importance of ICT in productivity growth and its diminishing profile in Scotland's policy agenda – especially now that the broadband availability problem is perceived, by many, to be 'resolved'.

7.22 Our view is that, as a key driver of productivity growth, ICT needs to be given a higher profile in Scotland's policy agenda. Our specific recommendations are set out below:

- **R1.1 Develop and maintain an overall ICT policy for Scotland**
  - There are various ICT-related policies in Scotland, notably: a digital inclusion policy (*Digital Inclusion: Connecting Scotland's People*, 2001 – which is currently in the process of being reviewed); Scottish Enterprise's e-business strategy (*Update to Connecting Scotland,* 2001); the Scottish Executive's broadband policy (*Connecting Scotland: Our Broadband Future – Making it Happen*, 2002); a policy addressing e-government (*Customer First: A Strategic Framework for the Scottish Executive and Scottish Local Authorities 2004-2007*, 2004); a strategy for ICT in NHS Scotland (*National eHealth/IM&T Strategy 2004-2008*, 2004); and a strategy for ICT in education (*Learning and Teaching Scotland Operating Plan 2006/07*, 2006).

[34] Note that the Scottish Executive Information Systems Steering Group (SEISSG) co-ordinates large internal ICT programmes within the Executive.

[35] "Implement online registration of Modern Apprenticeship frameworks"; "Seek to ensure that public sector investment in e-learning is co-ordinated and identify opportunities from collaborative e-learning development, including through the Interactive University"; and "Assess practicality and benefits of on line applications for some elements of grant support following introduction of new schemes in 2007".

- There is, however, no overall ICT strategy pulling together the various strands of activity. While the Digital Scotland Task Force presented a wide-ranging report in the year 2000, to which the Scottish Executive responded, this did not result in the development of an overarching strategy, and we are not aware of any ongoing comprehensive monitoring of progress against the Digital Scotland initiative's recommendations.

- We suggest that the development and maintenance of an overall ICT policy for Scotland would have value in: raising the profile of ICT – especially in terms of ICT as a driver of productivity growth; providing a structured process for ensuring that appropriate resources are being made available; providing a comprehensive framework for monitoring our progress towards becoming an information society; and encouraging coordination, where appropriate, between departments. Such an overall policy should complement the specific strategies mentioned above, rather than subsume them.

- In particular, we recommend that it would also be timely now to update the broadband strategy (*Connecting Scotland: Our Broadband Future – Making it Happen*), to reflect the current situation of near ubiquitous 1B connectivity and the findings of this study on Next Generation Broadband, and to provide a framework for action in the broadband arena over the next few years.

- Looking at the experience of other small countries, which have become recognised leaders in the usage of ICT, we note that there are overarching and relatively up-to-date ICT policy statements in Denmark (*IT and Telecommunications Policy Report*, 2006); Finland (*Efficiency and Vitality in Future Finland*, 2006); the Netherlands (*Better Performance with ICT: Update of the ICT Agenda of the Netherlands 2005 – 2006*, 2005); Norway (*eNorway Status Report*, 2004); and Sweden (*From an IT policy for Society to a Policy for the Information Society*, 2005). While having such an overarching policy is no guarantee of success, there are certainly 'good practice' lessons to be learnt from some of Scotland's competitors.

- **R1.2 Ensure appropriate coordination of ICT-related activities across departments**

  - There are, of course, important and large-scale ICT-related activities underway in many of the Executive's departments. However, there do not appear to be any formal structures or processes to assist coordination between these activities, other than the Broadband Strategy Officials Group, whose remit, as the name implies, is limited to broadband.

  - We are certainly *not* advocating centralised control of all ICT-related work within the Executive, nor are we suggesting resource-intensive attempts to extract minimal synergies. However, on the face of it, there would appear to

be important linkages to be exploited between, for example, e-government and e-business, e-health and digital inclusion, and e-business and ICT skills education. We also note that governments in other countries have typically implemented some sort of inter-departmental coordination of ICT.

- We consider that there would be value in the Scottish Executive providing some structures and processes for the 'light-touch' inter-departmental coordination of ICT-related activities, through sharing knowledge and developing value-creating linkages.

- **R1.3 Monitor the impact of ICT, and broadband, on Scotland's productivity**

  - This study has presented projections for the economic impact of affordable broadband in Scotland. These are, necessarily, informed future-looking estimates, as broadband is as yet too recent a development to allow its economic impact to be ascertained from historical economic data. This should change over the next couple of years, however; and ICT in general, of course, has been in use for many years.

  - Large-scale studies to measure the historic impact of ICT have been conducted at the UK level - notably the recent studies by the London School of Economics and the Office for National Statistics, which linked a number of large datasets. In order to ensure that Scotland's ICT policy-making is founded in robust data, we suggest that the Executive's Statistics Service should seek to develop measurements of the historic impact of ICT and broadband at the Scotland level, using growth accounting and/or econometric techniques, and incorporating, if appropriate, information from SEBS into the analysis.

- **R1.4 Raise with HM Treasury the question of whether the tax system should be used to incentivise business investment in ICT-related innovation**

  - In the UK, ICT equipment is treated as 'Plant and Machinery' for tax purposes, with a 25% annual Writing Down Allowance on a reducing balance basis, but with SMEs able to obtain a 40% First Year Allowance (FYA). In the period April 2000 to March 2004, small businesses (<50 employees) could obtain a 100% FYA on ICT equipment, but this was discontinued.

  - Some commentators have made an argument for tax measures to incentivise ICT-related innovation. It could be argued that the contribution of ICT to innovation and productivity growth is just as important – or possibly more important – than that of traditionally-defined R&D. For example, the US Bureau of Labor Statistics estimates R&D contributes 0.1 to 0.2 percentage points to annual US productivity growth, while OECD (2004) estimates that

ICT capital growth contributed 0.8 percentage points to annual US GDP growth in the period 1995-2001.

- This does not, however, represent a sufficient case for tax breaks specifically to incentivise ICT-related investment and innovation. The arguments for the R&D tax credit[36] cite the existence of significant 'spillover' effects, whereby the 'social returns' from a company's R&D are greater than the 'private returns' to the company. There is mixed evidence as to whether ICT usage creates significant spillover effects on economies (i.e. benefits beyond the company investing in ICT). We also note that efforts to quantify expenditure on ICT-related innovation would encounter major definitional issues.

- It is well beyond the scope of this study to design or recommend a tax policy on ICT as a whole. Furthermore national taxation is a reserved matter (with the exception of the Scottish Parliament's tax varying powers on basic rate income tax). However, given that our research has served to highlight the evidence that ICT has a profound effect on the UK's (and Scotland's) productivity, and noting that the Chancellor's Pre Budget Report 2005 made little mention of ICT[37], we suggest that the Scottish Executive raises with HM Treasury the question of whether the tax system should be used to help incentivise ICT-related innovation by businesses. If the impact and value for money of the temporary scheme of 100% FYA for small businesses (2000/01-2003/04) has not already been evaluated, such an evaluation would appear to have an important contribution to make.

Recommendation 2: Ensure that existing publicly-funded ICT support is '2B ready'

7.23 Existing publicly-funded ICT-related support in Scotland includes websites, e-business advisers and series of seminars and workshops.

7.24 The advent of 2B (including 2.5B) services – and especially BT's national launch of its ADSL Max (up to 8Mbit/s) services – brings the prospect of many Scottish businesses being able to use significantly higher downstream and upstream bandwidths. This will enable certain applications and new ways of working that were not necessarily feasible using 1B services. For example: using instant messaging for inter-office video conference calls from the desktop; or using VOIP for multiple simultaneous calls.

36 The UK's R&D tax credit allows SMEs to deduct 150% of qualifying R&D expenditure (125% for large companies) from their taxable profits. If an SME incurs losses in the accounting period, they may alternatively claim a cash payment from HMRC of £24 for every £100 of R&D expenditure.

37 "Information and Communication Technology" was mentioned once in PBR 2005: in relation to providing pupils in deprived areas with home access to ICT. Other references to "IT" concerned the public sector's own use of IT.

7.25 It will be important to ensure that the publicly-funded sources of ICT support reflect the availability of 2B services, and that they explain how these higher bandwidths can be used for new applications and new ways of working (and also explain why certain other applications will see little benefit from these higher bandwidths).

7.26 Similarly, as and when 3B+ services reach significant levels of coverage, the support materials/advice will need to be updated to reflect the additional benefits enabled by these higher bandwidths.

7.27 Our specific recommendations are as follows:

- **R2.1 Ensure that the relevant websites reflect the availability, features and additional benefits of 2B services**
  - ➢ The key Scottish publicly-funded websites offering ICT-related advice include: www.bgateway.com, www.scottish-enterprise.com, www.hie.co.uk/ebusiness, and www.broadbandforscotland.co.uk.
- **R2.2 Ensure that publicly funded business advisers are aware of the availability, features and additional benefits of 2B services**
- **R2.3 Ensure that the content of publicly funded seminars/workshops raises business awareness of the availability, features and additional benefits of 2B services**

Recommendation 3: Exploit the broadband-enabled web as a channel for stimulating ICT-related innovation by Scottish businesses

7.28 The vast majority of Scotland's businesses now have internet access, and a large majority of those now have broadband. Given that the 'research on the internet' is one of the most frequently cited influences on business ICT investment decisions[38], the Scottish Executive and its partners need to consider whether they are fully exploiting the broadband-enabled web in influencing Scottish businesses' ICT decisions.

7.29 Our view is that much more could be achieved in this area. Our specific recommendations are as follows:

- **R3.1 Provide Scottish businesses with the ability to benchmark their ICT usage and business processes easily against similarly-sized peers in their own sector**
  - ➢ Through its various large-scale surveys, the public sector holds much information that could be extremely valuable in allowing businesses to

[38] See, for example, SQW (2005)

benchmark themselves against their peers. In particular, SEBS provides a rich source of data on e-business adoption in Scotland.

- Whilst reports are made available on SEBS, and there is a facility for searching the results for answers to individual/combination questions (at www.sebsonlinetool.com), this does not really allow businesses to benchmark themselves against their peers very easily.

- Other online tools, such as SAP's Value Calculator for Midsize Businesses at www.sap.com and the ScotlandIS benchmarking tool for ICT businesses at www.ict-benchmark.co.uk, provide useful insights as to how such benchmarking can be made to appear more directly relevant to a business. We would suggest, for example, that businesses are asked to answer two or three basic questions about their business (e.g. number of employees, sector, and number of sites), followed by a limited set of questions about their own ICT usage.

- Ideally, results would illustrate the position of the business relative to its peers of a similar size in the same sector in terms of the level of ICT adoption and usage (e.g. in intra-company processes, interfaces with customers, interfaces with suppliers, and overall). Having reported the benchmarking results, the tool could offer semi-tailored suggestions, such as "*Other companies of a similar size in your sector use an intranet. Click here to find out how this could help your business*."

- **R3.2 Assess the feasibility of developing and maintaining much richer ICT-related advice content on the web**

  - Certain ICT suppliers now provide extensive education materials re ICT on their websites using streaming technologies (e.g. Cisco's e-seminars for SMEs at www.cisco.com/global/UK/solutions/smb/smb_eseminars.shtml, and Microsoft's online small business tutorials at www.bcentral.co.uk, and Apple's iChat demo at www.apple.com/uk/macosx/theater/ichat.html).

  - We note that Scottish Enterprise is starting to use such technologies to provide online seminars. We consider that there is scope for extending these materials into more in-depth advice – for example, providing online 'tours' through an example intranet or Customer Relationship Management system. Short 'before and after' business training videos could perhaps illustrate the effect of ICT-enabled change on certain business processes.

  - We suggest that Scottish Enterprise and Highlands and Islands Enterprise should explore the costs and benefits of providing this much richer content, in discussion with key industry players.

- **R3.3 Explore the scope for collaborating with other UK nations and regions in the provision of web-based ICT advice to businesses**

  - The ICT issues facing SMEs in Scotland are not very different to those facing their counterparts in England, Wales and Northern Ireland. However, each nation and region currently has a different set of websites providing ICT-related advice (e.g. www.businesslink.gov.uk, www.broadband.wales.gov.uk, http://www.investni.com/index/develop/ebusiness.htm, www.telecomsadvice.org.uk, www.broadband4devon.org.uk, www.digitalyorkshire.org.uk, www.switchonshropshire.org.uk etc.).

  - There would appear to be significant potential benefits of scale in publicly funded bodies creating shared ICT-related advice content for the web. Pooled, the various partners' resources could develop and maintain a much richer (broadband-delivered) information source than each could afford individually.

  - We suggest that the Scottish Executive, Scottish Enterprise and Highlands ands Islands Enterprise should initiate discussions with their counterparts in England, Wales and Northern Ireland, to explore the potential for collaborating in future developments of web-based ICT advice to businesses.

- **R3.4 Consider creating and advertising a single memorable URL for ICT-related advice to Scottish businesses**

  - Even the best web content is of little use if it is rarely accessed by its intended audience. Relying on search engine optimisation is not sufficient, in this case: the objective is to *stimulate* ICT-related innovation by Scottish businesses, not just to make the process easier once a business has gone as far as researching its options.

  - We suggest that a 'call to action' is required, which could be achieved through sustained advertising combined with a memorable URL brand for a website offering genuinely useful and relevant advice and information.

  - In our view, the effectiveness of this advertising would be maximised if there was a *single* URL, promoted throughout Scotland as *the* place on the web for good, impartial ICT-related advice to businesses (i.e. the same URL in the HIE area as in the SE area). Apart from the economies of scale associated with sharing advertising costs, there would be wider benefits of scope: the higher the proportion of a company's contacts that use a given website, the higher the probability of it being recommended to the company through word-of-mouth.

- We are aware, however, that this would entail significant difficulties, in terms of positioning such an online brand alongside those of Business Gateway, Scottish Enterprise and Highlands and Islands Enterprise.

Recommendation 4: Develop mechanisms for identifying and aggregating under-served demand for broadband

7.30 The rapid acceleration of 1B roll-out in the UK in 2003 and 2004 was driven to a large extent by BT's 'trigger' mechanism, which provided a transparent means of identifying unserved demand.

7.31 We are now in the situation where a very small percentage of Scotland's population remains unable to obtain 1B service[39]. However, as discussed earlier in this report, much larger numbers are likely to remain without access to 2B and 3B+ services over the next several years.

7.32 There is potential for the market to provide broadband solutions (whether 1B, 2B or 3B+) in areas where sufficient underserved demand is identified. Furthermore, in some cases it may be that a group of households and businesses could aggregate their demand to purchase a solution that would not have been possible otherwise (in situations where any given supplier could not have borne the risk of rolling out a solution, without being guaranteed a certain level of business).

7.33 We suggest, therefore, that there is a role for the Scottish Executive and partners in identifying and aggregating under-served broadband demand. Our specific recommendations are discussed below.

- **R4.1 Develop a mechanism for identifying under-served demand for 1B, 2B and 3B+ broadband**

  - We note that mechanisms for registering unserved or underserved broadband demand have been developed elsewhere – see, for example, the Welsh Assembly Government's Broadband Brokerage Scheme at www.bbwo.org.uk and the Community Broadband Network's 'not-spot survey' at www.broadband-uk.coop. Our suggestion is similar in concept to these other initiatives, but somewhat different in certain operational aspects.

  - It is obviously important for such a mechanism to be targeted at households as well as businesses. In the case of Scotland, it would make sense for a registration mechanism to be placed on the www.broadbandforscotland.co.uk website, which has already benefited from substantial national advertising.

[39] Note that the Scottish Executive currently has a study underway into the extent of the 'reach' issue in Scotland and the potential policy options.

- Our recommendation would be to keep any questions asked of the users to the bare minimum, such that a registration could be completed within say 1 minute. However, the process needs to be designed to discourage bogus multiple registrations, and to ensure that the data on under-served demand is not superseded by events, such as house moves or indeed the roll-out of a solution to a particular area. This could potentially be achieved through address-based registration (i.e. the registrant selecting their address from a list for their postcode) combined with regular emails (e.g. every 3 months) to the registrant to obtain confirmation that their demand registration remains valid. Up-to-date information on under-served demand could then be made available to operators on a regular basis, in tabular and map formats.

- In promoting such a mechanism, it will be important to stress that registration simply helps to identify under-served demand, but in no way guarantees that a service will be made available.

- **R4.2 Develop a mechanism for aggregating under-served demand for 1B broadband**

  - Having identified under-served demand, there is a case for the public sector to identify clusters and facilitate demand aggregation where appropriate.

  - We suggest, however, that such aggregation attempts should initially be limited to clusters of unmet demand for basic 1B services (i.e. addressing households and businesses still unable to obtain a 500kbit/s service). The 2B and 3B+ markets are at too early a stage of their development – and there are as yet no 'tried-and-tested' gap-filling solutions, such as those used in various community networks for 1B services, to which such clusters could be pointed. As these markets develop, it may well be appropriate to extend aggregation to these higher bandwidths, and the mechanism used for 1B aggregation should be developed with this potential future expansion (involving much larger volumes) in mind.

  - We envisage that this aggregation mechanism would involve regular analysis of registrations of underserved demand – automatically looking up geographic co-ordinates for registrants' addresses, and using these to identify clusters exceeding a pre-defined trigger level (e.g. more than *x* addresses within a 1 sq km area). As and when clusters of sufficient size are identified, the relevant registrants could be alerted by email and invited to form a community procurement group, which in turn could be offered advice from the relevant LEC as to how to go about procuring a solution.

Recommendation 5: Minimise avoidable barriers to private sector investment in 2B/3B+ networks

7.34 The primary barrier to telcos investing in broaderband networks is that of uncertainty as to whether their incremental commercial returns will be sufficient to justify their incremental costs. While this is primarily driven by the levels of consumer demand and willingness to pay, there are certain barriers to investment that are within the control of the public sector. Our specific recommendations are discussed below.

- **R5.1 Facilitate a dialogue between operators and the Scottish Assessors Association regarding the rateable values of next generation broadband access infrastructures**

  - Telecommunications operators pay non-domestic rates on certain network assets (such as lit fibres and base stations). It has been argued that this represents a significant barrier to network investment in broadband – especially by alternative (non-BT) operators.

  - This is a particularly complex area. Differing valuation methodologies are applied to different types of operators (which has led to a current State Aid investigation regarding the rateable value of BT's network), and utilities such as gas and electricity companies also pay non-domestic rates on their distribution networks. In practice, any overall reductions in non-domestic rate income from the telecoms sector would need to be made up through increased non-domestic rate or Council Tax contributions from elsewhere.

  - The issue appears to be less of a barrier to investment in Scotland now than it was previously, thanks to a substantial reduction in the rateable value of lit fibre kilometres in the April 2005 revaluation, combined with the Scottish Executive's commitment to achieve parity with England in the 'poundage rate' by April 2007. However, it remains an issue. To provide a sense of scale: the rateable value of BT's network in Scotland is currently £51 million; those of NTL and Telewest are each in the order of £4.3 million.

  - Having briefly considered the feasibility of de-rating relevant telecoms assets or providing rates relief for network assets in rural areas, we have come to the view that these approaches would be fraught with difficulty, would take a long time to implement – and would not necessarily provide a substantial incentive for additional investment.

  - However, there is some scope for ensuring that rateable values of network infrastructure in rural areas reflect the lower returns that will typically be achieved from them, thereby 'levelling the playing field' to some extent. In particular, the Scottish Assessors Association (SAA) has already set a precedent of applying a different value per lit fibre km in the 'Highlands' and

the 'Lowlands' of Scotland (e.g. typically £225 per km for a single lit fibre pair in the Highlands, versus £450 in the Lowlands). While the current rates for fibre are dominated by core network infrastructure, we envisage significant roll-outs of fibre deeper into access networks with the advent of 3B+ networks. We suggest that the Scottish Executive should facilitate early dialogue between telecommunications operators and the SAA, in order to provide clarity as to how next generation broadband access infrastructure will be valued in Scotland.

- **R5.2 Continue to ensure that 'lane rentals' are not introduced in Scotland**

  - In 2003/04 the Scottish Executive consulted on the regulation of utility road works, including the option of introducing 'lane rentals' – charging operators for the duration of their road works. Following the consultation, the Executive decided not to introduce lane rental legislation in Scotland.

  - Lane rentals were piloted in Camden and Middlesbrough in the period 2002-2004; however, the monitoring report on the pilot concluded that there was little evidence that the scheme effected much improvement in the average duration of the works.

  - The advent of 3B+ services in the next couple of years is likely to lead to significantly increased levels of streetworks by the telecommunications sector. We would recommend that the Executive and Local Authorities should seek to minimise the disruption associated with these works, in discussion with operators, but should avoid the temptation to re-visit the lane rental debate, as this would serve to discourage investment by operators in these networks.

- **R5.3 Relax planning restrictions on antennas sited at customers' premises**

  - In 2004 the Scottish Executive consulted on proposed changes to planning regulations concerning 'satellite dishes and other antennas'. The proposals included some relaxations on the size and number of antennas permitted under the General Permitted Development Order (i.e. without the need to submit a planning application), while continuing to protect the environment from inappropriate development.

  - Similar consultations were conducted elsewhere in the UK, and this resulted in revised planning regulations being announced in England (October 2005) and in Wales (January 2006). No similar changes have been announced in Scotland as yet, however. We suggest that the Executive should progress such changes, having considered the consultation feedback, in order to ensure that wireless and satellite broadband technologies are not inappropriately disadvantaged by the planning regulations in Scotland.

- **R5.4 Support Ofcom's market-led approach towards the use of the 'Digital Dividend' spectrum**

  - Digital switchover – the cessation of analogue TV broadcasting in favour of the more efficient digital transmission – will lead to a substantial amount of radio spectrum being released for other uses (the 'digital dividend'). These other potential uses include, for example, wireless broadband services, new mobile services and HDTV over Freeview.

  - Ofcom is currently conducting a review to assess how the cleared spectrum should be made available for new uses. The overall approach is market-led, in order to ensure that this valuable resource is acquired by the organisations most likely to use it to the full.

  - Being at the front end of the digital switchover timetable (in 2008 and 2009), Scotland has the prospect of being amongst the first areas in the UK to benefit from the digital dividend. We suggest that the Executive should support Ofcom's market-led approach in the digital dividend review – recognising that the market (rather than the public sector) is best placed to determine whether the released spectrum should be used for fixed wireless broadband, new mobile services, or HDTV over Freeview, for example.

- **R5.5 Ensure that Scotland's interests are reflected in Ofcom's Wholesale Broadband Access Review**

  - Ofcom is due to undertake a Wholesale Broadband Access Review in 2006.

  - As Scotland has the lowest population densities in the UK, and is therefore likely to experience relatively slow roll-out of 3B+ services, it will be important for the Scottish Executive to ensure that the regulatory framework for Next Generation Broadband access serves to encourage investment in rural areas as well as urban areas.

Recommendation 6: Avoid market-distorting interventions in the 2B/3B+ markets

7.35 With broaderband services developing apace in other countries, it is tempting to advocate public sector intervention in order to ensure that Scotland doesn't get 'left behind'. Indeed, at least one major supply-side intervention in the 2B/3B+ market is being undertaken elsewhere in the UK.

7.36 The lesson of 1B roll-out in Scotland, however, has been that *timing* of intervention is critical: as has been noted earlier, the £24 million *Broadband for Scotland* programme (originally intended to get to 70% coverage) achieved substantially more impact than it would have

otherwise, thanks to the decision to defer a supply-side intervention in favour of demand-side measures.

7.37 Our view is that there are certain actions that should be avoided at this stage in Scotland's 2B/3B+ markets. Our specific recommendations are set out below.

- **R6.1 Refrain from offering 2B/3B+ subsidies to operators**
  - We consider it to be far too early in the development of Scotland's 2B/3B+ markets to use taxpayers' money to subsidise major network roll-outs.
  - There would be considerable 'deadweight' associated with such early intervention - funding activities that would to a large extent have been undertaken anyway. Furthermore, there are currently major uncertainties regarding the areas which commercial roll-outs will not reach, the extent of the incremental benefits of 2B and 3B+ services over and above those offered by 1B, and the possibility of technological developments (such as DSL bonding of 1B services) mitigating the lack of 2B/3B+ coverage.
  - We suggest that the Executive should review this position annually, but that the presumption should be against such subsidy, unless a genuinely compelling case for intervention on the grounds of equity or market failure emerges.
  - In view of the possibility of other public sector organisations in Scotland, such as Local Authorities, considering their own local interventions in this market, the Scottish Executive may wish to consider developing clear guidance on the associated State Aid issues. The outcome of the European Commission's formal investigation[40] into the Appingedam FTTH initiative in the Netherlands will clearly provide important input to this guidance.
- **R6.2 Avoid offering retail 2B/3B+ services off the back of networks built for the public sector's own use**
  - With many public sector organisations themselves making use of high capacity backbone services between major sites, it is sometimes argued that the public sector should sell spare capacity on these networks[41] to households and businesses.

[40] In July 2006, the EC decided to prohibit public funding of a planned fibre network in Appingedam in the Netherlands, on the grounds that "the planned aid would distort competition and harm private investment to an extent which would outweigh the positive effects of the project". This is the first time that the Commission has declared a subsidy for a broadband network incompatible with the state aid rules.

[41] These networks will typically be a combination of connectivity services leased from a commercial telecoms operator, rather than infrastructure actually owned by the public sector.

- Our view is that it is private sector operators that offer the most sustainable long term broadband solutions to householders and businesses. By offering commercial services off the back of networks built for their own use, the public sector would run a significant risk of distorting the market – potentially crowding out private sector investment.

- **R6.3 Avoid imposing compulsory duct/fibre/cabling requirements on property developers**

  - In 2003, the Office of the Deputy Prime Minister (ODPM) consulted on 'Building Regulations and Electronic Communications (Broadband)'. The proposals included an option to impose mandatory requirements on developers to install ducting for cabling to and within new buildings in England.

  - As a result of the consultation feedback, ODPM has moved away from imposing mandatory requirements towards issuing best practice guidance regarding the specifications of internal and external ducting should the developer decide to install it.

  - It would appear to be sensible for Scotland also to follow this approach. Mandatory requirements to install ducting would not be appropriate, in our view, as this would not be technology neutral (i.e. it would effectively subsidise wire-line solutions). There would also be the potential for imposing significant costs on developers for features that may not, in practice, be valued by their customers: internal ducting may be of little use to a household using a wireless home network, for instance. The decision as to whether to install internal and/or external ducting – whether for commercial or residential premises – is best left to the developers, who are the people best placed to judge the requirements of buyers and tenants in the property market.

- **R6.4 Refrain from offering broadband subsidies to businesses or households in areas unable to obtain 2B or 3B+ services at this stage**

  - There is an argument that businesses in areas unable to obtain affordable 2B or 3B+ services should be offered a grant for the purchase of similar, but more expensive services, on the grounds of equity with their peers in more favoured areas.

  - Our view is that it is too early in the 2B/3B+ markets to offer such subsidies. In the 3B+ market, of course, there is no material coverage as yet. In the 2B market, we have only just seen widespread coverage – with the launch of BT's 'Max' products.

- With potentially large numbers of Scottish businesses unable to obtain a 5Mbit/s service, the volumes and costs associated with such a grant scheme could be substantial, and the benefits would not be clear-cut, given the uncertainties at this stage over the incremental benefits and the possibility of technological developments.
- We suggest that the Executive should review this position annually, re-assessing the 'equity' argument as the 2B/3B+ markets develop and as the incremental benefits to businesses become clearer.

- **R6.5 Refrain from undertaking any high profile promotion of 2B/3B+ services at this stage**
  - The *Broadband for Scotland* programme created substantial value through its marketing campaign – not least through accelerating the rate of ADSL demand registrations, thereby pulling forward BT's broadband roll-out.
  - In the absence of any similar direct link between demand and supply, we suggest that the Executive should refrain from implementing a similar promotion specifically for broaderband services at this stage (i.e. through TV, press and radio advertising). The 3B+ market is yet to get underway, and the incremental benefits of the upgrade from 1B to 2B are not as unambiguous and compelling as the benefits of the upgrade from dial-up to 1B.
  - Furthermore, it would not be appropriate for the Executive to be promoting broadband, for example, on the basis of the consumer video applications that it can support, such as HDTV and video on demand, when similar services are or will soon be available via an alternative platform (i.e. satellite TV).
  - We suggest that it is currently more important, from the perspective of economic impact, to ensure that Scottish businesses are making optimal use of the broadband they already have.

Recommendation 7: Ensure that Scotland's planning system takes competitive broadband availability into account

7.38 Due to its distance limitations, broadband has inherent spatial aspects (unlike most other ICT equipment/services). As broadband becomes a 'must have' for households and businesses, the planning system in Scotland needs to take into account considerations of access to competitive broadband supply, just as it takes into account access to other infrastructure such as transport links. Our specific recommendations are set out below.

- **R7.1 Ensure that Scotland-wide data on planned new housing/employment sites is made readily available to operators**

- 3B+ services (including Fibre to the Home) are likely to become a reality for new build developments over the next couple of years. In the interests of ensuring competitive supply, the Executive should seek to ensure that operators are well informed of new build opportunities.
- Smaller operators will not necessarily have the resources to monitor individual planning application developments in each of Scotland's 32 Local Authorities. We consider that there is a case for aggregating data on significant new housing and commercial property developments on a pan-Scotland level, and for regular updates of this data to be made available to telecommunications operators.

- **R7.2 Develop a Planning Advice Note regarding broadband availability considerations**
  - The Scottish Executive issues Planning Advice Notes (PANs) which provide advice on good planning practice in Scotland. The only PAN related to telecommunications, at present, is that on Radio Telecommunications Masts, which focuses on the planning considerations associated with base stations in mobile and fixed operators' networks.
  - As broadband has become such an important consideration for both businesses and households, we suggest that there should now be some planning advice regarding how broadband availability considerations should be taken into account in the planning process – seeking to ensure, where possible, that new developments are not left with an inferior level of broadband service and/or a lack of choice of broadband supplier.

Recommendation 8: On completion of the 'Pathfinder' procurements, determine the optimum scale and scope for future public sector broadband demand aggregation initiatives

7.39 At the start of this decade, the concept of aggregating public sector demand for broadband was held out to be an important device through which affordable broadband roll-out would be accelerated in the UK. In practice, this does not appear to have been the case – at least, in the 1B market.

7.40 In Scotland's case, various difficulties have led to delays in the Pathfinder North and Pathfinder South projects, though these re-launched initiatives are now in the latter stages of their procurement phase. In the meantime, however, market developments, combined with the

Broadband for Scotland interventions, have led to all communities in Scotland already having access to affordable 1B services[42].

7.41 There is little doubt, however, that aggregated procurement of broadband services does make very good sense at some scale, in terms of getting good value for money and ensuring a standard communications platform over which new applications can be supported. There are trade-offs, though: the larger the scope and scale of a procurement, the lower the price per site is likely to be – but the more complex and time-consuming the project is likely to be.

7.42 On completion of the Pathfinder procurements, the Executive and its partners should conduct a review of lessons learnt, and develop pragmatic guidance for future Scottish public sector broadband procurements as to the optimal scale and scope of such activities.

[42] We note, however, that the Pathfinder procurements could potentially lead to improvements to the level of 1B service available in some areas and/or accelerate the roll-out of next generation services in some areas.

8 Summary of recommendations

Recommendation 1: Radically increase the profile of ICT within Scottish productivity policy

- R1.1 Develop and maintain an overall ICT policy for Scotland
- R1.2 Ensure appropriate coordination of ICT-related activities across departments
- R1.3 Monitor the impact of ICT, and broadband, on Scotland's productivity
- R1.4 Raise with HM Treasury the question of whether the tax system should be used to incentivise business investment in ICT-related innovation

Recommendation 2: Ensure that existing publicly-funded ICT support is '2B ready'

- R2.1 Ensure that the relevant websites reflect the availability, features and additional benefits of 2B services
- R2.2 Ensure that publicly funded business advisers are aware of the availability, features and additional benefits of 2B services
- R2.3 Ensure that the content of publicly funded seminars/workshops raises business awareness of the availability, features and additional benefits of 2B services

Recommendation 3: Exploit the broadband-enabled web as a channel for stimulating ICT-related innovation by Scottish businesses

- R3.1 Provide Scottish businesses with the ability to benchmark their ICT usage and business processes easily against similarly-sized peers in their own sector
- R3.2 Assess the feasibility of developing and maintaining much richer ICT-related advice content on the web
- R3.3 Explore the scope for collaborating with other UK nations and regions in the provision of web-based ICT advice to businesses
- R3.4 Consider creating and advertising a single memorable URL for ICT-related advice to Scottish businesses

Recommendation 4: Develop mechanisms for identifying and aggregating under-served demand for broadband

- R4.1 Develop a mechanism for identifying under-served demand for 1B, 2B and 3B+ broadband
- R4.2 Develop a mechanism for aggregating under-served demand for 1B broadband

Recommendation 5: Minimise avoidable barriers to private sector investment in 2B/3B+ networks

- R5.1 Facilitate a dialogue between operators and the Scottish Assessors Association regarding the rateable values of next generation broadband access infrastructures
- R5.2 Continue to ensure that 'lane rentals' are not introduced in Scotland
- R5.3 Relax planning restrictions on antennas sited at customers' premises
- R5.4 Support Ofcom's market-led approach towards the use of the 'Digital Dividend' spectrum
- R5.5 Ensure that Scotland's interests are reflected in Ofcom's Wholesale Broadband Access Review

Recommendation 6: Avoid market-distorting interventions in the 2B/3B+ markets

- R6.1 Refrain from offering 2B/3B+ subsidies to operators
- R6.2 Avoid offering retail 2B/3B+ services off the back of networks built for the public sector's own use
- R6.3 Avoid imposing compulsory duct/fibre/cabling requirements on property developers
- R6.4 Refrain from offering broadband subsidies to businesses or households in areas unable to obtain 2B or 3B+ services at this stage
- R6.5 Refrain from undertaking any high profile promotion of 2B/3B+ services at this stage

Recommendation 7: Ensure that Scotland's planning system takes competitive broadband availability into account

- R7.1 Ensure that Scotland-wide data on planned new housing/employment sites is made readily available to operators
- R7.2 Develop a Planning Advice Note regarding broadband availability considerations

Recommendation 8: On completion of the 'Pathfinder' procurements, determine the optimum scale and scope for future public sector broadband demand aggregation initiatives

Annex A: Consultees

We are very grateful to the following people, who have been consulted in the course of this study:

Contact	Position	Organisation
Ed Candy	Technology Director	3 UK
Artur Kocharyan	Product manager, SME Broadband Access	3Com
Jonathan Lambeth	Communications Director	AOL
Bastiaan de Vroogt	Marketing Director	Aramiska
Matt Locke	Head of Creative R&D	BBC
Antony Walker	Chief Executive Officer	Broadband Stakeholders Group
Stephen Nuttall	Business Development Director	BSkyB
Brendan Dick	General Manager, BT Scotland	BT
Graham Lamb	Head of Broadband Market Insight and Development	BT
James McClafferty	Senior Partnership manager	BT
Tom Saville	Industry Development Manager, Consult 21	BT
Ian Stirrat	General Manager, 21CN Programme Office	BT
Richard Wilson	Strategy Manager	Cable & Wireless
Gordon Thomson	General Manager, Scotland	Cisco
Mark Swarbrick	Deputy Director, e-business, broadband & digital content	DTI
Lucy Pioline	DG Information Society and Media	European Commission
Richard Bell	Marketing Director	Fujitsu Telecommunications
Stuart Robertson	Senior Telecoms Development Manager	Highlands & Islands Enterprise
Robert Spearpoint	Business Development Director	Homechoice TV
Dan Dahle	Senior Strategic Architect	Intel
Robert Condon	President	Libera
Nick Oulton	Senior Visiting Research Fellow, CEP	London School of Economics
Peter Key	Lead Researcher, Systems & Networks	Microsoft
Sharon Gillett	Executive Director, Internet & Telecoms Convergence	MIT
Tim Cull	Director, Telecommunications Policy	Motorola UK
Adrian Pike	Managing Director	Neos Networks
Bob Bryce	Director of Business development (N)	Networks by Wireless
Ron Macdonald	Principal Consultant, National Services	NHS Scotland
Raymond Purdon	Area Sales Director Scotland & Wales	NTL
Ken Leitch	Regional Operations Manager	O2
Clive Carter	Manager, strategy development	Ofcom
Pietro Crocioni	Senior Economist	Ofcom
Chinyelu Onwurah	Head of Telecoms Technology	Ofcom
Dougal Scott	Principal, Strategy Development	Ofcom
Tony Clayton	Director, Economic Analysis	Office for National Statistics
Malcolm Matson	President	OPLAN
Steve Gold	Global Account Director for BT	Oracle

Stuart Mitchell	Business Development Manager, Communications Industry	Oracle
Max Taylor	Head of 3G	Orange
Fraser Mackenzie	Project Manager	Pathfinder North
Derek Shaw	Project Manager	Pathfinder South
Graham Currier	Wireless Development Director	Pipex
Andrew Wilson	Group Business Development Manager	Sage
Eddie Duffy	Assessor, Renfrewshire Valuation Joint Board	Scottish Assessors Association
John Black	e-business team	Scottish Enterprise
Brian Hilferty	Scottish Borders Rural Broadband team	Scottish Enterprise Borders
Alan Cameron	Planning division	Scottish Executive
Raymond Elliot	Roads policy team	Scottish Executive
Lois Macfadyen	Head of e-Government and take-up team	Scottish Executive
Neil Macfarlane	Education Department, New Educational Developments	Scottish Executive
Brian O'Donnell	Transport strategy and policy team	Scottish Executive
Graeme Purves	Principal Planner, National Planning Framework	Scottish Executive
Laura Sexton	Local taxation team	Scottish Executive
David Beards	Senior Policy Officer	Scottish Funding Council
Malcolm Taylor	Policy Adviser	Telewest (adviser)
Martin Carberry	Head of Carrier Sales	Thus
Richard Sweet	Head of Government Affairs	Thus
Steve Horley	General Manager	Tiscali UK
Chris Stenning	Managing Director	UK Online
Mary O'Mahony	Professor of International Industrial Economics	University of Birmingham
Jon Crowcroft	Marconi Professor of Information Systems	University of Cambridge
Bart van Ark	Professor, Economic Dev't, Technological Change & Growth	University of Groningen
Phil Kirby	Director of Regulatory Affairs	Vodafone UK
Julian Barker	Director of Strategy and Planning	Wanadoo
Donnie Morrison	Connected Communities	Work Global

Annex B: Illustrative quotes from consultees

Coverage[43]

Topics	Sceptical	Neutral	Optimistic
8M ADSL	*"I expect 8Mbit ADSL services to be available in Scottish cities in 2006 but these services will not be made available throughout Scotland because the line lengths will render the technology inoperable."* *"It is unlikely that LLU activity will provide NGB services to rural Scotland in the near future."*	*"8Mbit/s services in Scottish cities should be available by the end of this year."* *"8Mbit/s services will grow and then become obsolete as that is as far as ADSL1 technology can go."*	*"Eventually 8Mbit/s service will be rolled out to all exchanges."*
Cable		*"Cable companies can offer downlink services of up to 30Mbit/s with their current architectures. Getting up to 50Mbit/s will probably involve getting fibre closer to the customer."*	*"Cable companies are interested in ADSL2+ and VDSL as delivery mechanisms. However, the coaxial cable used by cable is higher quality than these technologies. Electronics upgrades will allow speeds of up to 155Mbit/s without problems on cable."*
Satellite		*"There will always be a difference between the level of service between cities and rural areas. The scale/density characteristics of cities mean that it will always be more economic for wireline operators to offer services there. This means that there will always be a niche for satellite."*	*"Satellite services currently allow 2Mbit/s downlink with a 500K uplink. This will be extended soon using DVRCS which will be capable of 8Mbit/s down and 2Mbit/s uplink. SDBS2 will extend the downlink speed to 20Mbit/s and further developments are expected to offer 40Mbit/s downlink."*
ADSL2+	*"ADSL2+ causes problems by operating at the limits of what can currently be done. The number of faults increases dramatically and there are sensitivities to things such as internal wiring which make deployment problematic."* *"ADSL2+ services are merely a speed increment of DSL. VDSL looks more promising as a better uplink speed is possible allowing more symmetric-type services. Consumer generated video uploads will work better using VDSL."* *"The ADSL2+ products which are available on the market are not stable and it will be a couple of years before we will be likely to deploy the technology as the basis for new services."* *"As for rolling out throughout Scotland, there are some areas where limitations on backhaul capacity will prevent roll-out of higher bandwidth services."* *"We won't be investing in ADSL2+ services in the near future. Many ISPs are looking to consolidate and to make a profit on existing service offers, before ADSL2+ becomes relevant. Also, ISPs are as yet*	*"ADSL2+ will become fairly widely available but will not become the default service."* *"We are launching ADSL2+ services in October 2005. This will allow for speeds up to 24Mbit/s. It will be offered to customers on a best efforts basis where they will run the line as fast as it will go up to 24Mbit/s. Only very short loops will get 24Mbit/s. At distances of 2-3Km, 8 Mbit/s should be widely available."* *"21CN will need to be rolled out before ADSL2+ can be offered at all exchanges"*	*"ADSL2+ will eventually become the default access technology because that's what the manufacturers are pushing."*

[43] Note that these are paraphrased, rather than verbatim, quotes from our consultees. Comments have been anonymised; wherever a specific organisation/company name is mentioned, it is *not* referring to the consultee's organisation/company. The consultations were conducted in the latter part of 2005.

	unclear as to the distance from exchange implications for ADSL2+ - We would be wary of a mass market ADSL2+ advertising campaign, only to disappoint consumers living 3-4km away from exchanges unable to get faster connection speeds." *"ADSL2+ and VDSL are not yet on our radar– for the foreseeable future 8Mbit/s will be adequate to deliver the vast majority of applications/services. As yet, there is no single killer application which would necessitate vastly increased bandwidth speeds."*		
WiMAX	*"I am sceptical about WiMAX. I don't think it will compete with ADSL2+ where both are deployed. However, where WiMAX will be deployed and the services and access speeds which will be offered to customers are commercial decisions which I am not in a position to forecast now. No reason to believe that WiMAX will replace WiFi for in-building coverage or for hot-spot services either."* *"WiMAX is a technically clever broadband solution. However, it will struggle against established operators. In theory it is a good technology for rural areas. However, where they are already covered, the business case for WiMAX deployment will be severely undermined."* *"We have been trialling WiMAX as part of our portfolio of access solutions. It has faced propagation problems in rain and fog, though, which means that in some cases it is unsuitable to meet customer needs."* *"There is a lot of hype associated with WiMAX. The speeds available are not what were originally promised. The hardware is currently very expensive – therefore the scale of deployment will need to be very big to make it cost-competitive with other technologies. I do not see WiMAX being a significant player in the market until 2007 at the earliest. However, when available cheaply, it may make an interesting final drop technology from fibre nodes."* *"I am sceptical about WiMAX, because DSL is more and more capable, so the need for it is receding."* *"WiMAX will not be a competitor for ADSL services. The ADSL2+ and Wi-Fi hotspots network will be able to cover the vast majority of business/consumer needs. Someone will try to make a commercial go of WiMAX but it is unlikely they will succeed."* *"We have done WiMAX trials in the US which have been unconvincing."*	*"WiMAX is being pushed by Intel as their technology for 4G. At the moment it is difficult to say whether this is the radio technology that will make a difference for Scotland. There is no doubt that any longer term solution for Scotland's rural areas must include a radio access technology. Gigabit radio will be available in 10 years."* *"WiMAX meets the needs of business customers better than wireline solutions. I'm less sure if the economics of WiMAX stack up for consumer broadband."* *"I don't see WiMAX as a technology to in-fill in the UK where wireline solutions are uneconomic. The economies of density which govern wireline solutions apply to WiMAX solutions also, given that it's restricted in the power levels that can be used."* *"ADSL is an unsuitable technology for true broadband deployment. Wireless offering symmetric capacity is more suitable."* *"WiMAX is a rural area solution which will be under cut by legacy infrastructure in cities and towns."* *"We see WiMAX as a delivery mechanism for residential services and not suitable for delivery of business services. However, it may have applications for teleworking and branch office connectivity."* *"Wireless technologies have to be part of the mix to deliver high speed services to customers outside the range of VDSL. Spectrum will be a constraint and pressure needs to be put on regulators to make sufficient spectrum available."* *"WiMAX is an interesting emerging technology. It is symmetrical which is a plus particularly for business customers. It will work on a self-installed desk-mounted antenna at distances of up to 1km from the base station. However, at distances of greater than 1km then an externally-mounted antenna is required which will need a truck roll. This may kill the case for its deployment in places where it might be useful in Scotland."*	*"WiMAX will be important in my view. We have no plans to deploy it but we are aware that mobile companies are doing trials in cities. I see it a complement to wireline broadband rather than a competitor."* *"WiMAX will be an important technology for everyone. It will disrupt current markets and act as a tool for organisations seeking to service customers. It has considerable advantages in service to high density areas because of the ability to configure small cell sizes. It is also suitable for Greenfield deployment over low-density areas where is can serve as a combined voice, data and mobile network."* *"WiMAX may be important in Scottish rural areas. It will complement 3G and 2.5G services giving national mobile data services at a hierarchy of different speeds. I envisage a set of devices which will be wireless-technology-agnostic scanning the airwaves for the fastest connection over 2.5G, 3G, WLAN, WiMAX, etc offering seamless services at the best price in the office, at home or on the move."* *"WiMAX services will be launched to businesses in Glasgow and Edinburgh in 2006."* *"WiMAX has a huge weight of investment behind it. Things tend to happen when you have that."* *"WiMAX may well depend on what happens in China. Large deployment there could transform the unit costs."*
VDSL2	*"VDSL2 will require fibre to the cabinet and will most likely require a whole new cabinet. It will not be*	*"The cost of equipping a cabinet serving 200 customers in a village would be about the same as the cost of*	*"Fibre to the kerb will become more common though as BT and others take fibre to the street cabinet level in order to use shorter-*

	deployed until 2010 or so." *"I don't have a view on when VDSL2 will be rolled out in Scotland but I think that it is beyond the capability of the technology to roll out in rural areas of Scotland."* *"VDSL2 is not on the radar as yet for us. Such high speeds may be useful for business, but not for the consumer market. Consumers, rather than businesses, drive broadband markets through the volume of users – until consumers demand the sorts of speeds available with VDSL2, then the market will not provide."*	*equipping a cabinet serving 200 customers in a city."* *"The progress of DSL/VDSL is interesting. There are problems in the transition because of the need to operate DSLAMs in the street cabinets. There could be problems in actually doing this."*	*range higher speed technologies such as ADSL2+ and VDSL."*
FTTH	*"There will be issues with other operators (i.e BT) about sharing ducting."* *"The economic case for FTTH deployment has been investigated regularly and is always prohibitive from a cost/benefit point of view. For green field sites, the economics for fibre deployment are much more attractive."* *"FTTH is the logical end of the road for communications access. However, I do not see it being deployed widely in Scotland in the short to medium term."* *"Fibre to the home is not a likely contender in the foreseeable future. 20Mbit/s will deliver what most people require so why would they pay the extra cost to fund FTTH? The FTTH motel was tried and abandoned by Fastweb in Italy."* *"FTTH is completely unnecessary – a co-axial cable drop will be able to deliver the bandwidth that most customers will ever need."* *"Fibre to the home will never be needed. When fibre gets to 80,000 cabinets, few places will be more than 500m from an access point. Copper can give us everything we possibly want over that kind of distance."* *"Fibre is not likely as the business case is unlikely to stack up. For many customers copper can do everything that is really required."*	*"Ducting to new build houses from street cabinets will be useful."* *"Fibre to the home deployment is difficult to call. It is eminently possible that someone will have a go at doing it commercially by 2015 although it is difficult to forecast where with any confidence."* *"By 2015 the deployment of FTTH should be widespread to tower blocks, and new build developments will be served opportunistically by then too."* *"FTTH is intriguing. Some operators in the US are deploying heavily. In the UK copper will meet the needs for the foreseeable future. There may be a case for deployment on green field developments. However, there are safety implications for customers peering down a fibre with a laser at the other end!"*	*"Fibre will be used for accessing new build and multi-occupancy buildings by 2015."* *"Ducting should certainly be mandatory for new build housing – fibre is the ultimate communications access medium."* *"Fibre-to-the-home is being deployed experimentally at the moment. It will begin to make sense for new build soon to have fibre deployed as a matter of course."* *"FTTH already exists in significant numbers in Japan where there are two million fibre customers (about 10% of the broadband market). NTT fibre can be unbundled and this created an opportunity for Yahoo! to grow the market rapidly. FTTH trials are also underway in Korea. You can get 1Gbit/s access in Hong Kong. Currently 70% of FTTH is in Asia. However, it also exists in the USA."*
Mobile	*"3G availability will get better throughout Scotland but there will be gaps and even where it exists the bandwidths available may well be lower than in cities because the density of cells will be too low. Availability of 3G is becoming less of an issue as 2G technologies offer better and faster data services. In some respects 3G will be simply a bandwidth extension for 2G as far as users are concerned."* *"3G technology is not broadband technology. HSDPA will be very expensive and is just the extension of inadequate 3G technology."* *"There will be 80% coverage for 3G*	*"Further mobile technology developments will unfold – 4G, 5G etc will come. At some point in the technology evolution the focus on bandwidth will shift towards intelligence and usability as the bandwidths available are able to meet the needs of mobile customers."* *"As with other 3G operators, our strategy is to concentrate on coverage in major urban areas and along key transport routes."* *"The killer issue for getting 3G coverage out to a wider rural audience will be Ofcom's upcoming decision on spectrum review. 3G delivered over 2G spectrum in rural areas would mean that services could be pushed out faster and further. This would be*	*"80% population coverage of Scotland by 3G by 2007 will happen easily."* *"With HSDPA technology, 3G users will have a download speed of up to 2Mbit/s. The roll-out of HSDPA will be on a tiered basis, serving high demand areas first. We will start offering HSDPA sevices to consumers in key urban markets – in Scotland this is likely to be Edinburgh and Glasgow."* *"HSDPA services will be rolled out very quickly where levels of demand are high. 3G companies will eventually want to deliver a 'uniform customer experience' wherever users are located – however, as with 3G this will initially be confined to areas of high demand."* *"The issue of possible high levels of contention for HSDPA services will resolve itself. High contention is a 'nice problem to*

	by 2008. This will be the maximum extent of 3G's footprint and I don't expect 3G operators to be pressed by government to extend coverage any further. 3G operators will be focussing on deepening coverage in existing urban areas, rather than extending coverage beyond the 80% mark." *"Having achieved 80% coverage, mobile operators will go for a 'deep pan' and not 'thin and crispy' approach. This will mean maintaining and developing coverage in high demand areas, before expansion to rural hinterlands takes place. Ensuring consumers get continuous coverage between points will be of critical importance for 3G companies. The hand-up hand-down between 2G and 3G transmitters is not always seamless and there are significant battery drain implications of doing this."* *"I'm confident of hitting the 80% coverage target by 2007, but I'm not optimistic about the prospects for rolling out 3G to wider rural communities. The argument that 3G will be rolled out by stealth as phone companies update 2G masts with 3G kit doesn't wash. It's not commercially viable – why would companies take on the financial burden of changing SIM cards and subsidising new 3G phones for consumers in areas where demand for services is likely to be relatively low?"* *"It will be a long time before rural consumers get access to mobile 3G services. Without public sector intervention, universal 3G coverage is a long way off.*	*practical because of the relatively low user load on the system in rural areas."* *"As to whether HSDPA will genuinely be able to deliver 2-3 Mbit/s to users, this will be possible in urban areas, where 3G providers will invest heavily in meeting consumer demand. Users in rural areas may not be able to get 2Mbit/s, but the majority of internet use will not require 2Mbit/s speeds".* *"We don't anticipate significant competition from other mobile broadband offers like WiMAX or Wi-Fi. Only 12% of the population own a laptop – this factor alone will make generating a critical mass of mobile internet consumers very difficult."* *"The upcoming Spectrum Review, by changing the services that can be delivered over the 2G frequencies to include 3G, may be the solution to providing 3G services to rural communities."*	*have', indicative of high demand and a competitive pricing model. 3G companies will simply invest more in technology in areas of particularly high contention."* *"In time, 3G companies will roll out their services nationwide - and there may be scope in future for delivering 3G services over the 2G spectrum."*
21CN	*"BT's 21 CN is a core network technology. It will not change the access issues that exist in the more rural parts of Scotland."*	*"BTs 21CN will improve matters for broadband generally but it will reach the remote rural areas late in its roll-out. The backhaul issue will still be a major problem. There will also be issues such as the fact that O&M will always be more expensive in rural areas."* *"The launch of BT's 21CN will make matters more straightforward for operators and will make service delivery more cost effective – however, most users will not notice much of a difference."* *"The extent to which areas in rural Scotland will be able to receive NGB services will be dictated by how quickly BT rolls out its 21CN network."*	*"A key feature of the 21CN is that all services should be available everywhere so if backhaul needs to be upgraded to deliver services then it will be."* *"BT's 21CN is "spot-on" and will make a difference to rural areas in Scotland when it reaches the rural exchanges."* *"Contention will cease to be an issue for broadband when 21CN is introduced."*

Pricing and take-up

Topics	Sceptical	Neutral	Optimistic
Pricing		*"The price for the same service will remain the same between rural and urban areas. Availability will be where there is a difference between them."*	*"The premium which NGB will command over CGB may not be that great. We are already seeing operators competing on access speed rather than price. This may continue resulting*

		"As we move into the future I expect that NGB will co-exist with CGB for some time – how long will be a function of price differentials and how long the providers are willing to offer the older technology." *"There will always be a price premium for mobile broadband services above fixed broadband services."*	*in operators offering NGB access at little or even no premium over CGB. In fact NGB may be just a 'free' upgrade of CGB in many cases. Where there is a noticeable price premium for NGB then a significant proportion of customers will remain on CGB."* *"The price premium for NGB services will not be as much as the industry might like. The general existing level of monthly spend will not be exceeded greatly. NGB services will probably be tariffed at levels similar to premium broadband services at the moment."* *"I expect that in 2 years time my customers' entry levels will be 8Mbit/s with high end users on 24Mbit/s."* *"NGB will command a premium over CGB. It is likely that the entry point will migrate to the top CGB packages available today. We are looking at a cointinuously evolving market with ever higher speeds being offered for pretty much standard prices. NGB and CGB will co-exist for the foreseeable future giving consumers choice."* *"The opportunity to offer business services over NGB is fascinating. A service dimensioned for the consumer market has its peak usage in the evenings and weekends. This allows providers to offer fatter, less-contended pipes to business customers during the day. This then makes leased line replacement a real proposition (at least as far as Internet Access is concerned)."* *"There will be enough major players who will want to retain price equality, to ensure there would be no major price inequality between rural/urban customers."*
Take-up	*"There will be plenty of people using dial-up in 2010 – it meets the needs of many people and will continue to do so."* *"We have already learned from existing increases in access speeds, that customer usage patterns don't vary when their access speed is increased. There is a diminishing return on increasing access speeds."* *"Actually a key driver of current broadband is the fact that Internet usage does not tie up the telephone and that broadband access to instant messaging helps to reduce phone bills generated by teenagers telephoning each other."* *"We are now seeing a trend for multiple-DSL lines to be installed in small businesses. These multiple CGB lines won't be replaced with a single NGB access – businesses value the security of having multiple routes. The multiple CGB lines will be upgraded to multiple NGB lines when the time comes."* *"There may be a small improvement in quality and reliability as access speeds increase from 2Mbit/s to 10Mbit/s. Beyond this, there will be little additional benefit."*	*"Business will see less dramatic growth in traffic than consumer if widespread HDTV take-up becomes a feature of the market."* *"There is no single business application that will drive the need for connectivity of greater than 20Mbit/s. If it becomes widespread, then over time videoconferencing may take us there. In reality, it is combinations of services being used in parallel which will drive the need for NGB – for example multiple simultaneous voice channels could drive the need for higher uplink speeds."* *"Worrying about applications is a red herring. Let the people have raw communications power ! There's an analogy here with the questioning of people's need for computing power in the early days of the PC. The applications are as yet unforeseen and unplanned."* *"With the exception of HDTV there is no need for access speeds of 20Mbit/s. However, I do expect there to be a market for these faster services. Take as a comparison the PC market where hugely powerful computers are purchased by people doing a little light word-processing and email access. Eventually, consumers will understand the diminishing returns of increased speed and ISPs will then need to*	*"Roughly 100% of Internet connections will be broadband by 2010."* *"90% of internet connections will be broadband by 2010."* *"By 2010 dial up will be a minority activity (less than 5% if it exists at all)."* *"By 2010 I believe that take-up of broadband will be 100% where it is available."* *"By 2010, I expect virtually all Internet connections to be broadband – 2% still using dial-up would be a failure."* *"There are 8.9 million broadband customers now and we expect that number to rise to 18 million by the end of 2008."* *"It's really unknown what will drive SME demand for access at speeds of greater than 20Mbit/s. But businesses have shown an unlimited appetite for bandwidth in the past and we are confident that a technology push will be followed by a great deal of creativity and innovation. 2 years ago, 2Mbit/s access was the sort of connectivity required only by the larger businesses. Now everybody is getting it and there is demand for higher speeds."* *"I would hope we could get to 75% internet penetration of households."*

	"2Mbit/s is adequate for the time being for most smaller firms." *"The applications aren't in place to justify 8Mbit/s ADSL in the near future. We still have a hardcore of business on 512k for whom extra bandwidth will not be a key selling point – 8Mbit/s will not make it any quicker to buy a book on Amazon, for example."*	*compete on offering content."*	

Consumer applications and benefits

Topics	Sceptical	Neutral	Optimistic
Entertain-ment	*"Considering applications that will drive consumer demand for NGB, I don't see much that will. Even TV can be delivered comfortably in 1Mbit/s using MP4. 2Mbit/s will give a very clear picture. The issue for such services is not the access speeds but the contention."* *"For as long as I can remember, video-on-demand has been the killer application for broadband access. Distribution of DVDs by broadband at speeds achievable by consumers today is still expensive and time-consuming."* *"The cost of storage is falling more rapidly than the cost of bandwidth. This means that some very high density medium could be sent through the post which contains all of the new movie releases in a month with access to these movies controlled by transactions done over the net. If storage costs continue to decline faster than bandwidth cost this may be a more economic distribution method than distribution of the content over networks."* *"I am a little sceptical of the need for HDTV in the short to medium term because most users are happy with fairly low-quality video at the moment."* *"I view HDTV as a natural progression as more video is viewed over the Web – but its growth will be slow reflecting the high cost in terms of bits to transport."* *"Video will be important, but not as important as it will be in the USA because of the poor quality of American television both content-wise and in the technical delivery of pictures to homes."* *Video will not be as hungry on bandwidth as others forecast. Perfectly good HDTV is obtainable at 3Mbit/s with improved compression techniques. So a family of 5 would struggle to require more than 15Mbit/s downstream access to meet their entertainment needs."* *"Narrowband access speeds are all that is required for most games at the moment."*	*"Peer-to-peer file sharing is currently an enormous generator of broadband traffic. This is because of the distortions of 'all you can eat' broadband access pricing. There will be more migration to usage-based pricing of Internet traffic in future – most likely is a stepped approach where users will pay for bundles of Gbytes with their subscriptions, as mobile users on contracts usually pay for minutes now."* *"Video downloads will be the key consumer application in the future. We are only touching on the surface of IPTV. I'm seeing strong interest in Video on Demand. At the moment, that demand is catered for by 2Mbit/s connections. However, as more higher-speed connections become available, I expect that content will be generated for those connections which will increase demand for higher access speeds."* *"The applications that will drive demand for NGB will be about the delivery of content: local television, video on demand and local portals which make local news and information available."* *"Triple Play services such as those offered by CATV providers will require NGB. Also multiple voice over the Internet accesses. The current view is that a 10mbit/s connection will be needed to meet the needs of most households for these services."* *"Trading films and PVR content over the internet is still a relatively rare application because of the relatively low uplink speeds currently available. This will increase over time. The film industry will cope better with this than the music industry has with music sharing."* *"Narrowband access speeds are all that is required for most games at the moment. However, higher bandwidth will reduce the delay in downloading games which can be significant."* *"Private individuals already exchange large numbers of photos over the Internet. I expect NGB to see similar traffic in video."*	*"Nobody will watch TV or listen to radio as we currently understand them by then. All content will be pulled by the user rather than pushed by the provider. We are already seeing this with the growth of podcasting "* *"The so-called triple play of Internet, telephony and television will drive the demand for NGB broadband. Imagine a sky digital box with 100 times the power and functionality that it currently has and you are beginning to see what will be. We will move to a complete video-on-demand world with content released by producers for consumers to access at a time of their choosing. The world of broadcasting as we now know it will become a distant memory. It will not be long before all video entertainment will be high definition."* *"Video is the key offering which will drive demand for consumers. There will be a move away from broadcast to multi-casting and video-on-demand services."* *"The migration of access speeds from 10Mbit/s (today or soon) to 100Mbit/s (not as far as you might think) to 1Gbit/s which is conceivable in 10 years time will be a major change. When we get to access speeds of 1Gbit/s then the attraction of video on demand becomes very strong – a DVD comes almost as a packet (a single file-transfer burst) rather than a stream allowing the user to have instant gratification. However, just because technology can do this doesn't mean that it will be done that way."* *"Higher bandwidth applications include high quality video streaming which requires 6Mbit/s per channel. Multiple channels per household will require NGB. Also Distributed virtual reality will require approximately 6 high resolution screen images to be driven and will require roughly 100Mbit/s."* *"HDTV will eventually require a very high bandwidth to the home – HDTV requires 20Mbit/s and households could easily have three or four TVs going simultaneously. Such demand will require 100Mbit/s to the home."* *"When delivery of HDTV services becomes a reality it may well represent a step change in the industry. When the world moved from dial-up to broadband, the dominance of Freeserve was overthrown and subscription-*

	"In some ways the VoD model as the killer application for broadband is flawed as there is nothing urgent about film distribution. The average time between a film being released and being watched is of the order of days, weeks or even months. Therefore storage media through the post may well remain the most appropriate distribution mechanism." *"If you start thinking about delivering Manchester United TV in Manchester then DSL will not work because of contention."* *"HDTV won't be a key driver for NGB uptake – it's simply not on people's radars. TV per se will not be a big driver of NGB uptake: there are cheaper and simpler ways of offering choice and variability than via the web."* *"Hardware manufacturers are not geared up to developing TVs that receive inputs through DSL connections - at present it is very fiddly to connect a TV to receive a DSL input."* *"HDTV is less exciting in the UK than in some other markets. We already have one of the highest rates of digital TV penetration."* *"It will take a long time to develop networks capable of delivering a scaleable IP HDTV service that can compete with satellite HDTV."*	*"Pornography and gambling will simply migrate the existing business and exploit faster sites."* *"While storage costs have been falling, the ability of computers to write to hard disks has not been getting any faster. So far this has not been a problem as content cannot be delivered to PCs over public networks at speeds which disk drives cannot cope with. With access speeds in the 100s of Mbit/s, this will cease to be the case. This will create the need for fast memory buffers to store the data as it is received and allow it to trickle onto hard drives over longer time. The conventional situation that the communications speed is the bottleneck in communication will be shattered by high speed access."* *"We've seen a surprising amount of upstream activity. The majority of this is illegal file sharing, with a minority of consumers uploading photos/home movies."* *"The next major development will be customised web services, delivering user specific content e.g. RSS, Google Desktop – these developments will be about providing quality, but they will not necessarily be very bandwidth heavy."* *"To go mainstream, HDTV will need a critical mass of programmes to be developed for the format."* *"In the UK consumer market, where the BBC goes will be fundamental."*	*based players such as AOL became more significant players in the market. I have a gut-feeling that there could be a similar type of power shift when the market changes again. It may be that the Cable operators gain the upper hand because of their track record with Video."* *"The wow factor of HDTV will convince consumers to buy. Cathode ray tube TVs are slowly dying out, and there are very few mass producers remaining."* *"HDTV will be the main driver for consumer need of NGB and nothing short of 30Mbit/s will satisfy that need."* *"Higher bandwidth will reduce the delay in downloading games which can be significant."*
Video comms	*"Videoconferencing will never take off on a large scale."* *"Video conferencing will not take off – it has already been around for 10 years and people have still not bought into the concept."*	*"Video calls are unlikely to be a mass market application, at least until they become much easier to use."* *"Video calls are a possibility if real full motion video is involved. This will be hampered by the narrow bandwidths available for uplinks."*	*"Security services are another area where consumers will use a lot of bandwidth. Remote monitoring of houses and premises using webcams will be prevalent."* *"Video conferencing will have consumer applications such as family conversations and monitoring elderly relatives."* *"Streaming video cameras for monitoring homes will become more prevalent."*
Ecommerce and online spend	*"NGB availability will have little impact on the spread of ecommerce – the widespread availability of CGB was decisive in the spread of ecommerce."* *"Not very much content will be purchased from Scottish-based companies. Something of the order of 10% and most of this will be from Scottish-based retailers selling non-Scottish content."* *"Very little of the content bought will be 'Scottish' (less than 5%)."* *"The content provided online will be driven by global companies. Scottish companies may be able to provide some unique content, but they're unlikely to have a major impact against major players."* *"Trade in physical goods has been*	*"Ecommerce will continue to grow in use. This will have a strong influence on high streets which will become more like showrooms than places for transactions (which is already the case for some consumers)."* *"Ecommerce development will be enhanced by NGB but not because of the speed. Ubiquity will drive the real ecommerce revolution as online becomes the default way of transacting."* *"The average household will pay around £50 per month on broadband delivered content by 2010. About half of this will be substitution for CDs, DVDs and games on CD-ROM."* *"The amount that consumers pay for broadband delivered content will not change dramatically from that which is paid today (assuming they are paying fro TV services from Sky of Cable). On*	*"We will see a dramatic increase in the usage of ecommerce because of the increase in mobile broadband take-up. Ecommerce will become an activity for people wherever they happen to be, vastly increasing the opportunities for people to transact."* *"The introduction of NGB will have a dramatic effect on the take-up and utility of ecommerce. The revolution which CGB brought to certain markets such as books or flights will be extended into many other areas as richer communications will allow customers to do more to learn about products on-line. In the long run I expect that high street shops will become more like showrooms for feeling/touching specific types of product."* *"It would not be surprising if average monthly spend on broadband-delivered content were to be in the range $500 to $700."* *"European spend on digital content will grow very strongly. Average spend in the USA is*

	hugely affected by the Internet. Everything from travel to grocery shopping has felt the effect of the Internet. However, I do not expect the pace of this development to be significantly accelerated by NGB – CGB does the job perfectly well." *"Although broadband is not necessary for on-line shopping for physical goods and services, the response times given by broadband do allow shoppers to compare prices much more easily and make the whole shopping experience much more usable. The incremental benefit offered by NGB will be negligible, though."* *"Some types of shopping are much better done in person (clothes, fresh fruit and vegetables) and the social side of shopping should not be overlooked – a Saturday afternoon spent shopping is a social activity for many people."*	*average £50-£70 per month would seem likely."* *"The spend on broadband delivered content will be similar to that which exists today – there may be a small increase (say 10%) but nothing more dramatic than that."* *"Current consumer spend on content is around £30-£40 per month with a strong bias towards low-income households (cable and satellite subscriptions). This may increase as a % of household income but not by a great deal. However, taking into account substitution spend for music, films and games, it will rise rapidly to £50-£60 per month. I expect physical media products such as CDs, DVDs etc to disappear."*	*well ahead of Europe. My personal monthly expenditure on communications and content is over $300 per month."* *"Broadband has had a dramatic effect on the trade for physical goods and services. The main effect has been in the delivery of information to the customer allowing them to search out and identify the best deals. This effect will continue and NGB will facilitate more complex visioning such as clothes shopping. Most if not all of the independent high street retailers will disappear."* *"Ecommerce for physical goods and services will benefit enormously from NGB. Goods such as clothing which are now difficult to sell over the Internet will become easier. Fashion will benefit from being able to upload measurements and allow customers to visualise themselves in garments."* *"In the youth market, traditional spending patterns are changing, with young people buying fewer tangible goods (like trainers) and spending more on communication services. The growth in 3G and the internet will definitely take money off the high street."*
Mobile	*"About 50% of broadband accesses in 2010 will be wireless but a relatively small part of this will be on 3G/4G mobile networks (about 10-15%) – the rest being wireless access to fixed networks."*	*"In the nearer term, short video clips such as news snippets and comedy sketches will prove popular applications. All devices for viewing content will be general devices (specialist devices will be too expensive and inconvenient). Exchanging photos will grow and the uplink speed will become as important as the downlink speed."* *"Mobile broadband access will become more prevalent although there will be no bandwidth intensive services such as HDTV to mobile. In terms of broadband sessions, mobile will become much more important but obviously the proportion of traffic volumes will remain relatively small."* *"Looking at the balance between broadband use on fixed and mobile networks, there may be as much as a 50:50 split in terms of hours spent in front of screens but the traffic balance will be more than 99% generated by fixed networks."* *"More than 75% of broadband usage will be on fixed networks. Important mobile applications will be handhelds for internet access and email such as blackberry, video calling and video broadcast services for entertainment, news and specialist information."* *"Most broadband traffic for consumers will remain on fixed networks and will be based in the home. Cellular and WiMAX mobile coverage will be complementary to the fixed network."*	*"Mobile Internet access will become vitally important. The ability to do what people do on fixed broadband connections anywhere will arrive very soon. We will see the arrival of seamless 3G/Wlan integration. Hot spot growth will be very strong. It is likely that mobile will account for half of all broadband access in five years. Most of the growth coming up will be in mobile broadband access."* *"One of the key drivers for the take up of 3G and 3G HSDPA services will be mobile TV services."* *"Mobile TV will be one of the main consumer drivers for uptake of 3G services".* *"Other services that will become more popular include the downloading of magazines to mobile phones. Where previously a magazine may have cost £5, cutting out the printing and distribution costs, by delivering over the internet will reduce prices to £2 for the same content."*
IP telephony	*"TDM telephony is cheap and convenient and it will last longer than many are currently forecasting."* *"VOIP will serve a niche consumer market of people who have family or business contacts overseas – it will not be the mainstream telephone*	*"VoIP is still a bit technical for most consumers. It is still difficult to use and in many cases people cannot rely on the person they call being online. It will become more prevalent as time goes by and it becomes more ubiquitous and easy to use."*	*"Voice over the Internet is becoming more prevalent with Skype becoming more widely used.. If everyone began using Skype for all fixed voice communications, the Internet would cope with the traffic generated without really noticing the increase in traffic. There is little requirement for NGB for VOIP which works perfectly well under CGB."*

	technology."	*"NGB is not necessary for VoIP. Quality of service is a much more important issue and that is completely independent of access speed."* *"There may be a small improvement in quality and reliability as access speeds increase from 2Mbit/s to 10Mbit/s. Beyond this, there will be little additional benefit. Contention and usage caps will be more important in affecting VoIP than access speed."* *"VoIP traffic will overtake PSTN traffic in 2008. However, Skype will not be the dominant force – PC to PC communications is too unwieldy and dedicated handsets will continue to be the dominant means of accessing voice services."* *"VOIP will reduce customers expectations of what is reasonable to pay for a telephone call."*	*"Voice over IP will become very prevalent."* *"VoIP will become an important feature of communications."* *"Cheaper bandwidth will have an impact on VoIP prices and NGB will allow multiple simultaneous conversations."* *"VoIP will change the telecoms sector completely. In terms of cost it will be a fraction of the cost of providing voice over the PSTN."* *"Multiple simultaneous VoIP connections will become commonplace in households by 2010. This will require more uplink capacity than is currently provided. It will also require operators to prioritise voice traffic and to deliver low latency for those packets (< 50 milliseconds)."*

Business applications and benefits

Topics	Sceptical	Neutral	Optimistic
Overall impact	*"NGB will help businesses but it is not the only decisive factor. Skills and manpower availability are more important. There is no doubt that rural areas will lag what is available in the cities. However, for many businesses it may be that combining multiple 2Mbit/s links will deliver the connectivity that is required to many businesses."* *"The overall effect of NGB on the level of business in Scotland is difficult to say. If NGB in Scotland lags that elsewhere, then Scotland will definitely be disadvantaged. However, if Scotland holds its own against the rest to the UK/Europe then the effect will be difficult to predict and probably not as relevant as other issues such as tax and property prices."* *"There will only be modest benefits to having NGB for single site firms."* *"You don't actually find many firms deciding to leave an area because of the quality of the communications services available. It's more a people thing – especially the availability of skilled staff."*	*"One of the problems of selling to businesses is that broadband is regarded as a telecoms product rather than a potential revolution in the way business is approached. This constrains thinking on how broadband can be used and limits the realisation of its potential. As with consumers, businesses need to be educated in the use of broadband. This is particularly the case of SME's where there is less scope for monitoring and matching best practice. Communicating the message that using broadband can result in major time-saving is something which needs to be done much more than it is now."* *"It is a mistake to view NGB as a panacea which will solve the ills of Scottish business. Businesses who can produce good products and reliable services at the right price will succeed whether they have NGB or not. However, the availability of NGB helps them to do those things. It is a fundamental enabler like good roads and airports. (there is a minister for transport – why is there no minister for ICT?)"* *"There won't be big economic impacts from encouraging firms of fewer than 5 employees to take up broadband. They don't really have processes as such. It'll start to kick in at about the 10 employee level."*	*"Businesses will use NGB to reduce costs and to improve productivity. They will also face employee demand for better facilities to meet more demanding productivity requirements. Smaller businesses will be able to outsource context activities in the manner of large corporates allowing them to focus on their key strengths."*
IT systems and business processes	*"Self-publishing may grow as some people seek to have their own connected servers, but the difficulty of coping with security and denial-of-service attacks is likely to be a deterrent. Increased access speeds also increases sites vulnerability to denial of service attacks as more server capacity is eaten up with dealing with the spurious traffic."*	*"Business services which will drive take-up for NGB will include video-conferencing, VPN access, and remote backup (current speeds are too slow for remote backup). Remote working recreating the office desktop at home and on the move will be very important. Remote application access will also be important."*	*"Important business applications will be teleworking in the form of VPN access into corporate networks from domestic locations and ASP services as organisations take advantage of the scale and security offered by large server farms for web presence and data processing."* *"There will be more direct business to business IP communications without passing*

	"Email and web usage will be unlikely to be affected significantly by NGB." *"NGB will have no discernable effect on web access and email usage – the growth trend in their usage will continue as it currently grows."*	*"ASP type services would seem to be better served by NGB. However, a lot depends on regulation as the government seeks to regulate for business backups to be done remotely on economic security grounds."* *"NGB will increase email and web browsing as responsiveness increases and the size of files that can be shifted increases dramatically."* *"Larger SMEs will benefit from NGB even if they are single site. 2Mbit/s is adequate for the time being for most smaller firms. However, when ASP services are taken up widely by smaller firms they will require NGB too."* *"Webinars and training will be major applications."* *"NGB will increase and facilitate a trend towards centralisation of information systems which is happening anyway for good business reasons (duplication of information leads to errors and inconsistencies)."* *"Email use should change in that more people will post large files and email links to them rather than emailing large attachments. This will make email on small devices such as Blackberries easier to manage."*	*through the Internet – companies' relationships with customers and with their supply chain will become more automated and direct. ASP services will be widely adopted by smaller and smaller companies."* *"Inter-firm collaboration will be a major growth area. There is an increasing expectation that personnel from different companies can work together as if in a single organisation. Pharmaceutical firms are a particularly good example with employees working closely with the NDA, hospitals and doctors on clinical trials of new drugs."* *"Remote backup services will probably become more prevalent as businesses seek to exploit the security and economic advantages offered by large service providers. All other sorts of web services and distributed solutions will also grow."* *"For smaller businesses NGB will herald the eventual predominance of the ASP model with much data processing and web presence handled by external specialists rather than in-house. Large businesses are already using access speeds which we would classify as NGB even if the prices they pay are not 'affordable'. One effect for larger businesses with small offices (such as banks, building societies, retailers etc) will be to allow services which are currently limited to large headquarters and regional offices to be rolled out into the branch network."* *"NGB will affect businesses significantly in terms of outsourcing data processing and web services. Large data centres will become used by medium and small sized businesses able to use them effectively via NGB. The ASP business model will prosper. Disaster recovery and security will be greatly enhanced and small companies will have the kind of secure systems that large corporates have now."* *"ASP models will emerge for businesses as it becomes easier for small companies in particular to use the services of specialists for a whole range of business services."* *"NGB will allow businesses to centralise operations in the manner of old mainframe computers. This is a much more cost-effective model than managing thousands of individual PCs. Unlike before, NGB will allow users at the edge to enjoy the same level of service as users at the centre."* *"All of the systems that we provide to customers (technical web management, supply chain management, CRM and ERP) are enhanced by real-time connectivity. Instant updates are much more attractive than overnight or delayed updates. In addition better richer screens and presentation of information to users will enhance system effectiveness. This will apply in fixed and mobile communications."* *"SMEs will be able to access world class systems on a shared basis and will be freed from relying on small limited PC-based systems which they have to maintain themselves."* *"ASP offerings will help to ensure that smaller companies can get access to affordable high-*

			standard IT services allowing them to match the capability of larger companies." *"ASP services will require bandwidths of greater than 20Mbit/s. It will be important that the uplink is high bandwidth also because the communications required for these services is two way."*
Video comms	*"Video conferencing is something that there is limited demand for at the moment. There are problems with getting through firewalls etc that make it difficult to implement which may work against demand taking off. Not sure if there is a real need"* *"Video conferencing is too complicated to use and the prevalence of cameras is low. I do not see it becoming a major feature of the market."* *"There will be some substitution of travel for video conferencing, but nothing major. As a company we make very use of video conferencing despite having the facilities to do so."*	*"Video-conferencing will become more prevalent when it becomes easy to use. Improved voice quality is of greater value than video – in systems where voice and video quality can be traded, users invariably choose improved sound over higher quality vision."* *"Videoconferencing will grow but quality VC remains expensive because of the high prices of codecs – it is this rather than bandwidth which is holding back the use of videoconferencing."* *"Video conferencing as a business application has some way to go. I have encountered the Video-Wall that operated between MIT and the MIT Media Lab in Dublin and found the interaction rich and satisfying. If that kind of service were reproducible then Video Conferencing will become a strong driver of traffic."* *"Video-conferencing may become important in the future but it needs to become easier to use."* *"I'm unsure about the role of video conferencing. I'll be watching with interest to see how Skype Video take-up develops."* *"Video-conferencing is an unknown as yet – if it is done right then it will be successful – if not then it will remain a niche activity."*	*"Email and web usage will increase with NGB. Already within our company they have been forced to increase maximum attachment sizes from 2Mbyte to 20Mbyte as it was inhibiting the exchange of emails with video attachments."* *"Communications between firms will also become more sophisticated and in the longer term video calling will become widely used."* *"Video conferencing will grow as will increased video surveillance of business premises and of private dwellings."* *"Video conferencing will increase as the cost of travel increases (as fuel prices rise). We already use video conferencing extensively internally and with decent screen resolution and sound quality, the interaction is extremely rich."* *"Video conferencing will start to take-off for businesses – stimulated by growth in consumer use of MSN video instant messaging etc."* *"Videoconferencing will take off – especially given the fuel price increases."*
IP telephony	*"Most users will remain ignorant of whether their calls are VoIP or not. An interesting question is whether businesses will migrate voice to IP telephony solutions or move to mobile for voice entirely."*	*"VoIP for business customers will be very different from consumer VoIP. This will mainly be carrier-grade VoIP where providers have their own platforms (such as Broadsoft) and class 5 switches. These will be used to offer centrex or hosted PBX services. Where there are a number of simultaneous users, the access link will need to be symmetrical."*	*"For businesses the case for VoIP is compelling. Replacing voice and data networks with a single IP network which can integrate voice and data applications is hugely attractive."* *"VoIP is already the dominant technology for corporate voice. 70% of new voice systems being installed in corporates use IP handsets. The only reason that smaller business systems are not similarly IP-based is that the OEMs haven't yet developed the smaller scale products for this market. This will soon change. VoIP call volumes will overtake traditional telephony in 18 to 24 months."* *"VoIP is an enormous business opportunity for us. We benefit from VoIP in two ways. The first is that we sell systems to the telcos to equip their own infrastructure to offer VoIP. The second is that there is fantastic scope for integrating Voice into the systems we provide to our customers. Integrating Voice into their call-centre systems, supply chain and procurement systems is increasing the effectiveness of those systems enormously."* *"Business VoIP is a done deal. Nobody buys PSTN PBX any more."*

Collabor-ation			*"Inter-firm electronic communications is becoming more and more important. Much inter-company administration will become highly automated."* *"Single site firms will benefit from NGB in that their interface to the rest of the world will be better and capable of more. This will be very important for composite businesses (businesses which come together in groups to deliver projects). Composite businesses will become more and more prevalent with time. Most small businesses will be involved in composite project activity at least some of time."* *"Single site businesses will benefit from NGB by using centrally supported applications, backup and disaster-recovery services and extranets to allow collaborative working with suppliers and customers. Such collaboration between groups of companies will become very common."* *"Single site businesses will benefit from NGB because of faster access to the web and to ASP-type services. However, multi-site businesses will enjoy all of these benefits plus better intra-organisation communication."* *"Collaborative working is increasingly important both within organisations with geographic spread and between organisations. We are an intensive user and creator of systems to support collaborative working. NGB will help to smooth out the differences between large and small companies and between the core of large companies and their edge (up to and including employees homes). This will reduce the effect of having to cater for a 'lowest common denominator' in terms of connectivity (although mobility still presents challenges)."*
Mobile	*"Fixed broadband access will have an advantage while the cost of fixed bandwidth is considerably cheaper than mobile data bandwidth. Wireless access is improving the mobile access as long as the user is not mobile while using the service. Mobility over a wide area and while on the move will continue to be price/bandwidth constrained for some time yet. Therefore services actually being used while mobile will tend to be less bandwidth intensive and have immediacy such as news, sport, transactional interactions, email access, voicemail access."* *"Seamless broadband is not really a technical issue. It would be simple to implement but rather expensive to use under current circumstances. The economic barriers to seamless service will remain significant for the foreseeable future."*	*"Mobile broadband for business users is not about speed of access but ease of use – decent email access will bet a key requirement of mobile broadband users."* *"Most business broadband will remain from fixed sites but it will vary between different types of business. Some organisations with large mobile workforces (AA/RAC spring to mind) will have a much higher level of mobile broadband usage than average."*	*"Business adoption of mobile broadband will be even greater than consumer takeup. Productivity demands will require constant connectivity."* *"It is likely that mobile will account for half of all broadband access in five years. Most of the growth coming up will be in mobile broadband access."* *"In the world of business communications, mobile accesses will represent a higher proportion of broadband accesses than in the consumer world – about 50% of total broadband accesses. I am constantly being asked for mobile services from my customers and these represent a very high, and growing, proportion of our traffic at the moment."* *"Seamless communications will be a reality by 2010."* *"Seamless broadband offerings should be emerging soon and should be widespread by 2010. Shoud real seamlessness fail to materialise before 2014, then the productivity gains required to maintain our standard of living will not be realised and that would be very serious."*

Social impact

Topics	Sceptical	Neutral	Optimistic
Transport & teleworking	*"The effect on transport is relatively small if any. There is journey substitution for sure but increased economic activity because of broadband may generate more journeys to substitute for this effect."* *"I've not noticed a great impact on travel as a result of broadband."* *"There has not been a huge effect on transport. I don't expect this to change with NGB – most people need to go to an office and work together."* *"Ecommerce has had an enormous impact and has generated huge business for logistics companies such as Federal Express."* *"The effect of broadband on teleworking has been noticeable but not large. The business world is generally unsuited to such radical change – bosses want to see their people working."* *"There has not been a major impact on transport."* *"I'm not convinced that higher speeds will be enough, alone, to effect a change in work habits. The majority of people who do some work at home already have CGB which is sufficient for their needs – extra bandwidth may only be of relevance to home workers in sectors such as graphic design/architecture."* *"If broadband enabled the economy to become richer many people would buy more cars, and the number of cars per household would increase. If congestion on the roads started to decrease, people would simply come off the trains and buses and get back into their cars. There is a matrix of second order effects that make the outcomes difficult to predict."* *"Most managers are in 'command and control' mode. There would need to be a change in how managers assess their employees – moving to assessing them on their outputs rather than their time in the office."*	*"A major area for businesses in the future will be support of teleworkers."* *"CGB has had an effect on home working but not as much as we might have expected. NGB may increase home working but it is difficult to say."* *"There has been some effect on transport usage as a result of teleworking. Full-time or substantial teleworking is still relatively rare (although common in our company) but we have observed a lengthening of peak rush hours as people use their ability to work from home to avoid peak travel times."* *"CGB has led to a lot more home working (as in working at home part of the time). It is now possible for most people to work at home as effectively as if they were in their office. This has many advantages and some disadvantages as team interaction is compromised."* *"There are likely to be personal issues that make teleworking more attractive for certain demographic groups – like people with young families who want to spend more time with their children."* *"The effect of teleworking on congestion is inconclusive. Travel demand generally is clearly increasing, and passenger number on buses and trains are going up after a dip following Hatfield and several driver strikes. However, it could help to redistribute patterns of travel away from peak periods."* *"In some cases cutting travel costs may be an incentive for commuters to telework. However season tickets for trains will not cover, say, three days a week and there is currently no incentive for more sophisticated ticketing arrangements from trains and buses. Having said that, bus passes are getting increasingly sophisticated."*	*"Yes, the effect of broadband on teleworking must be appreciable. It is surprising that there doesn't seem to be much evidence to back up my personal experience."* *"The social impact of broadband in terms of working patterns has been enormous. Much more homeworking is going on although there is little documentary evidence. People are free to relocate to places huge distances from their actual place of employment. People are able to use summer houses much more intensively than in the past because of broadband."* *"Teleworking is definitely a strong feature of life in some sectors. It will probably increase as a result of NGB."* *"Individuals will demand the flexibility to work from home even more than they do now. This will drive the facilities for sophisticated business applications to be made available in the home."* *"CGB has led to more home working and NGBB will accelerate this trend. Decent up-link speeds will help home workers enormously. There also must have been an effect on travel in terms of substitution but I don't have any numbers to support this view."* *"CGB has made an impact on home working and NGB will enhance this effect. There is a lot more dipping into accounts in the evenings and at weekends to check emails."* *"A lot of people are mobile workers now – it makes a great deal of sense for them to work from home. CGB has allowed this to happen. Also a lot of people work from home part time or do bits of work in the evenings or weekends. NGB will increase this tendency."* *"Teleworking is a real feature of society now and the introduction of NGB will keep the growth going. There may be some profound effects on transport in the future – if people cease travelling to work, will that remove the need to have a car at all? The outcome will depend on how public transport rises to meet the challenge of widespread use of shared transport (ubiquity of routes being the most dramatic need)."* *"CGB has led to a big increase to formal and informal working from home. NGB will help because it will facilitate the recreation of the office working environment at home."*
eGovern-ment	*"Broadband has encouraged the use of e-Government services. However, the usability and sophistication of many e-Government sites leaves a lot to be desired. Improving the sites would have a more profound effect than increasing the access speeds. Also, e-government providers have a lot to learn from the banking sector on security – the level of security used for some services (VAT returns*	*"E-Government has been problematic. The public sector has vocally embraced e-Government and broadband but in fact it has been very slow to change. Next generation broadband will help as attitudes change to improve e-Government."* *"E-Government will happen irrespective of NGB deployment – there is an*	*"There have been some notable successes – tax returns online are becoming widely used now and many local government sites are effective. NGB will also help with e-learning allowing more high-resolution content to be accessed by schools and students."* *"There is a marked improvement in e-government websites. The public service is lagging but getting better. Lots of local*

	for example) is way out of proportion with the risks involved." *"There is a lot of talk in Government circles about e-Government. However, the realisation is often poor or non-existent."* *"E-Government is developing but probably in the wrong direction. The public service target driven approach is completely wrong. E-government implementation should be customer driven and not target driven."* *"The impact of NGB on E-Government will be minor – it's unclear how NGB would add to what is already available."*	*ideological commitment to it and it will happen – it will be essential to meet the public service job cuts the government talks about."* *"E-Government should grow strongly. However, there are examples of how to approach innovation from the private sector, particularly banking who used the opportunities offered by telephone banking and the Internet to change fundamentally the way they offer services to customers. The government should use the technology as part of a review of how it delivers services rather than simply automating what it does now."* *"E-Government is growing strongly as a business for us. It is still patchy with some authorities moving ahead and some failing to embrace technology as a driver of efficiency and improved service."* *"There are structural and procurement issues which need to be ironed out if e-government is to be effective. Structurally, there needs to be re-engineering of processes. Procurement-wise there needs to be much better control of contractors and what they deliver."* *"The level of e-Government activity varies between LAs. Areas like West Lothian lead the way in Scotland."*	*authorities are looking to develop their own networks and to self-provide services and in some cases to offer commercial services also."* *"E-Government is beginning to move – I've just renewed my vehicle tax online. The trend towards developing e-citizen portals seems to be a step in the right direction."* *"E-Government is definitely growing – as an individual, I go online wherever possible to interact with government. A lot can be learnt from e-Government services in the Baltic states, where they have started from a clean slate."*
Health	*"There are liability issues regarding the use of video communications for remote consultations."*	*"If bandwidth was a lot cheaper then many more health applications could be extended to smaller sites."* *"3G could be useful for midwives and GPs, for example."*	*"We will see whole cities covered with wireless LAN. Applications such as allowing an ambulance to forward an x-ray of a patient ion the way to the hospital will drive local authorities to deliver ubiquitous WLAN coverage."* *"There are many possible health and social benefits from broadband deployment including remote consultation and diagnosis, monitoring of the elderly and the infirm, and keeping extended families in regular contact."* *"A particularly strong application is keeping in contact with elderly relatives using video. Something which would integrate a monitoring service into something as easy to use as a TV would be enormously popular with families with elderly relatives."* *"Thin client architectures are starting to be piloted for GPs. I'd expect GP bandwidths to be in the order of 10Mbit/s by 2010.""*
Education	*"Education institutions typically use just 10% of their capacity."* *"There tends to be strong cultural opposition to using technology in educational institutions."* *"Schools tend to be varied reactions to anything involving mobile phones, due to health concerns."*	*"Korea made great inroads into broadband usage by training 27,000 teachers in how to use broadband to improve the education they give to the children. This has resulted in greatly more use of IT and communications in schools and educational institutions."* *"E-Learning is a very strong growth area. But it is being led by industry and not education. Many large corporations conduct large amounts of their training and personal development through e-Learning systems. This trend is moving away from interaction with software on a CD-Rom, towards server-based systems some of which allow for interaction with an instructor where appropriate. NGB will allow a lot of*	*"e-Learning is well advanced in Scotland."* *"E-Learning is extremely important. There are so many ways in which electronic content can enrich the learning of students. Kids are creative and if the system allows that creativity to be exploited then it will be."* *"E-Learning will benefit from NGB. At the moment the experience of sitting behind a screen is less rich than interaction with a teacher. NGB will help to change that."* *"Higher and further education connectivity and usage of bandwidth has grown faster in Scotland than elsewhere in the UK."*

		training to be done in the home." *"Colleges want to support more professional development programmes, and these would lend themselves to more video streaming of lectures, and the provision of courses online."* *"Video conferencing may not work for big groups. It's more likely to be used in smaller groups, like rural schools and special groups."* *"You could see applications like alerts to students' phones. They won't be particularly bandwidth hungry though."*	*"Big investments have been made in e-science, to support applications like network testing for the gaming industry, particle physics and parallel computing. If these areas take off they will require a lot of bandwidth."* *"We'll see schools' MIS systems shifting away from locally based systems to centrally managed hosted databases, accessed via the web."* *"Video conferencing will be really important for the more remote and rural schools. They need to look at all of their equipment, and not just the bandwidth though. For example, are their cameras up to scratch ?"* *"By 2010, if they can afford it, most big secondaries will be looking at 100Mbit/s."*
Housing		*"Given the speed requirements, the digital divide will open into a yawning chasm with those within range of such services enjoying enormous benefits and those not able to access the services subject to a whole raft of disadvantages and probably lower house values. The problem is that the proportion of the population that is on the wrong side of the chasm will increase as the range limitations of the higher speed technologies are approached. It's similar to the house price implications of living close to a station with good rail connections to London (or not)."*	
Digital inclusion and user generated content	*"Pornography and gambling are already booming – the issue here is how to protect the vulnerable (such as children and the addicted). This is a particular concern with the increased Internet access from mobiles and playstations (which the kids know more about than the adults who allegedly control their access to material.)"*	*"We expect there to be about 7 million households left without internet access. A key issue for the future will be to try to get as many as possible of the 7 million households online, in order to prevent a digital divide."*	*"User generated content is emerging as an important driver of traffic. This will drive the requirement for better uplink speeds in the domestic market. The ability to exchange information freely will have the effect of strengthening local communities as they focus on locally generated content rather than what is pumped at them by broadcasters."* *"Flexible teleworking approaches help to include the disabled and the disadvantaged and to assist them to fulfil their potential."* *"Community portals will be important to unite virtual and geographic communities."* *"Consumer generated content from pictures and video to file sharing will become greatly more important over the coming years."* *"NGB will help to cement geographic communities as well as virtual communities. Local football teams and theatre groups can record and post material for the wider community to enjoy. This will be a great source for rich content."* *"Consumer-generated content is becoming very prevalent – witness the volume of material on Google Video."* *"Broadband can have a real impact in keeping families and communities together."* *"VoD is a way of getting previously 'unreachable' communities to have access to the internet and digital services."* *"For us, getting the 20-30% of people who still do not have any form of internet connection into their home is the most important broadband connectivity issue. Triple bundle services will be a means of bringing broadband type services to the large majority of homes."*

			"Upwards of 90% of the population owns a mobile handset. Handsets are cheap, with much of the initial adoption costs absorbed by phone companies. There is genuine scope for 3G services to have a significant impact on 'bridging the digital divide'. Only 50% of the population have a computer in their homes and the barriers to internet adoption are potentially much higher using a computer than over a telephone." *"In Tower Hamlets, an estate was wired up and had its own video streamed TV channel. A full time cameraman went around interviewing residents and videoing the communal areas of the estate – many of which were in disrepair. Over time, this led to greater community interaction and meetings with the council to improve the worst areas of the estate."*

Annex C: Summaries of selected previous broadband impact study methodologies

Gartner, 'The Payoff of Ubiquitous Broadband Deployment', July 2002

C.1 Gartner notes that data from the International Telecommunications Union (ITU) suggests a broad correlation between GDP per capita and telephone penetration. They use a similar assumption for a correlation between GDP per capita and broadband penetration, to create a model that assesses the impact of ubiquitous broadband in the United States over a ten year period.

C.2 A 'correlation slope' is defined between GDP per capita and broadband penetration. This is developed by taking separate forecasts of the rise in GDP per capita in the US during the next 10 years and relating these to a widely accepted view of achieving a broadband penetration level of 20% over the same period.

C.3 The study contends that a penetration of 50% would be possible by 2010, should regulatory and financing conditions prove favourable and encourage early implementation. Gartner estimates that this higher level of broadband penetration would lead to US GDP per capita reaching c. $47,000 by 2010 (as opposed to c. $43,000 under a 20% penetration scenario).

C.4 On this basis, Gartner estimates an incremental $5.5 trillion GDP over a 10 year period (c. $500 billion p.a.), and an incremental 13 million jobs, associated with the higher penetration level.

C.5 Gartner also assesses the relative impact on the various broad industry sectors. Each sector is given a relative score according to the proposed effect of broadband in that particular sector. Industries such as mining are given lower scores compared to, for example, finance, where it is thought that broadband would have a much greater impact. Employment growth factors are then applied to the various sectors, according to these relative scores, in order to derive a distribution of the $5.5 trillion across the broad industry sectors.

Criterion Economics, 'The Effects of Ubiquitous Broadband Adoption on Investment, Jobs and the U.S. Economy', September 2003

C.6 In this report Criterion considers both GDP effects and consumer surplus effects of ubiquitous broadband deployment in the US.

GDP

C.7 The report uses output multipliers from the Bureau of Economic Analysis (2.969 for telephone and telegraph apparatus, and 2.8984 for cable and other pay television) to conclude that a $1 increase in the output of telecommunications equipment providers will increase GDP in the US by an average of $2.82.

C.8 Criterion base their analysis on a forecast of 65% Current Generation Broadband (CGB) penetration by 2010, and 95% by 2021. Under this adoption rate, they estimate that cable and DSL operators will invest c. $64 billion in residential CGB through to 2021. The total increased GDP through the multiplier effect of CGB investment is therefore found to be c. $180 billion between 2003 and 2021 – an average of $9.5 billion p.a.

C.9 Criterion then consider the effects of investment in Next Generation Broadband (NGB) technologies, such as FTTH and VDSL. They forecast an adoption rate of 7% by 2010 and 42% by 2021 for these services, and estimate that the average annual investment is c. 50% higher for NGB than for CGB. After allowing for substitution of some CGB take-up by NGB, they forecast that the total investment rises to $146 billion over the period to 2021 (up from $64 billion for CGB only), and that the total GDP impact rises to $414 billion (up from $180 billion for CGB only).

C.10 Under a more rapid adoption scenario (95% CGB penetration by 2013), Criterion estimate a cumulative GDP impact, due to operator investments, of $465 billion over the period 2003-2013 (i.e. an average of c. $47 billion p.a.).

C.11 Finally, Criterion predict a further annual $67 billion in annual GDP, due to broadband stimulating a 10% increase in capital investment in a variety of (broadband-using) industries.

Consumer Surplus

C.12 The effect of broadband adoption on consumer surplus is also estimated. The authors assume that demand for broadband is linear with an elasticity of -1.0 to -1.5. The demand curve is shifted outward, with a constant slope, as penetration levels increase to 95%; a constant price of $40 per month is assumed. This results in a projected consumer surplus rising to $234 billion to $351 billion per year. Criterion estimate an additional $20 billion p.a. consumer surplus associated with broadband-stimulated purchases of household computers and networked equipment.

CEBR, 'The Economic Impact of a Competitive Market for Broadband', November 2003

C.13 CEBR translates the benefits of broadband into inputs to UKMOD, their UK macroeconomic model, in order to understand the potential impact on the UK economy. The benefits of broadband are modelled as the difference between the economic forecast including the potential gains from broadband and a hypothetical base case where it is assumed that broadband does not exist.

C.14 Three inputs are considered:

- An increase in productivity due to broadband.
  - In CEBR's 'cautious' scenario they assume that communications technologies account for 16% of ICT capital deepening, which in turn accounts for 0.65 percentage points p.a. growth in productivity. Applying estimates for broadband's share of communication technologies, the cautious approach assumes an annual broadband contribution to productivity growth rising to 0.04 percentage points by 2010.
  - In an 'inclusive' scenario – which CEBR considers to be more likely – they recognise that communications technologies enable complementary ICT capital deepening (they assume 25% of ICT capital deepening), and also account for some of the growth in Total Factor Productivity (they assume a share equal to communications technologies' share of capital deepening growth). This results in the broadband contribution to productivity growth rising to 0.22 percentage points by 2010.
- A reduction in the cost of internet connectivity as broadband cost savings are passed on to users – assuming that this reduces the cost of doing business and the cost of living. At its fastest, the quality adjusted price of broadband is modelled to fall at 1.8% per quarter.
- An increase in business investment – for the roll out of broadband.

C.15 Applying these inputs to their macroeconomic model, CEBR finds that the impact of broadband is 0.5% to 2.5% of GDP by 2015, corresponding to £4.9 billion to £21.9 billion (at 2000 prices).

ACIL Tasman, 'Economic Impacts of Broadband Adoption in Victoria', June 2004

C.16 Tasman develops a business-as-usual (BAU) model for the economy of the State of Victoria in Australia, based upon the following key assumptions:

- Victorian economic growth is assumed to be c. 3.4% per year over the BAU period to 2015.
- Productivity growth rates attributable to broadband are estimated for each sector of the economy, informed by Tasman's review of the literature.
  - These range from an average annual productivity shock of 0.06 percentage points p.a. for primary agriculture to a shock of 0.47 percentage points p.a. for the communications sector.
  - The productivity shocks are distributed over time, by applying Tasman's forecast broadband take-up curves – each sector is placed on one of three take-up curves: 'early', 'mid' or 'late', to describe their likely pattern of adoption. This results in the overall (sector weighted) broadband productivity shock rising to 0.36 percentage points p.a. in 2008 – with an average of 0.23 percentage points p.a. over the modelling period.

C.17 Based on these assumptions the model assesses the extent to which Victorian economic growth prospects depend on broadband over the period, by comparing the BAU case versus a reference case in which the productivity effects due to broadband are excluded.

C.18 In their 'conservative' BAU case, employment growth is fixed. In the 'less conservative' case the Victorian unemployment rate is allowed to adjust in response to changing wages.

C.19 Their findings are that broadband will contribute an average of 0.47 to 0.82 percentage points p.a. to Victorian economic growth over the period, with the impact peaking at AUS$1.5 billion to AUS$2.5 billion in 2008.

Annex D: Case studies illustrating broadband benefits to businesses

Table D-1 Qualitative case study examples of broadband benefits [sources: various]

SIC grouping	Case study sector and source	Broadband benefits
AB	Agriculture [source: actnow]	Broadband has enabled Folly Farm to carry out the task of cattle passport applications over the web much faster than with the old dial-up internet connection; this now takes as little as ten minutes. The broadband connection has made the purchase of supplies cheaper because the company is now able to purchase products from the cheapest supplier wherever that may be in the country. It also allows them to access information on new product developments to the latest milk quota prices. The farm's increased use of email as a result of broadband has also meant that less time is wasted trying to phone contacts, when an email can be dispatched to await a reply. The farm has also found broadband invaluable in helping them find out about new sources for the rare breeds of dairy and beef herds they keep on the farm.
CD	Manufacturing [source: Yorkshire Forward]	Cambrai Aircraft Covers has benefited hugely from the installation of broadband. It enabled the company to take charge of its own website, keeping it up to date and responding to client emails within the hour, as well as processing orders entirely online. All order forms are now downloadable and it has made the company's presence in Europe even stronger, doing away with the language barrier frequently created by telephone conversations. The company now deals with clients all over the world and attributes this to the stronger market presence broadband has afforded them.
EFI	Construction [source: DTI]	The Benson Group Ltd was in need of an online communication solution to support its rapid growth. Online facilities were needed to provide ways of communication between its several offices at various locations and its head office. A virtual private network (VPN) was introduced to provide this communication system, which enables remote access for up to 250- employees at each office site and allows secure broadband connections to be accessed at each site. Crucial to Benson's day to day operational effectiveness is the maintenance of a database which contains information on all customers as well as tenders won and lost. As the database has grown, broadband has become essential to be able to synchronise work effectively across offices. Without broadband, effective access to this database at a local level would not be possible. This saves time and money that would otherwise be spent manually collating the information from each office for use in management information. Broadband has also made customer service more efficient, providing a fast response to all queries. Furthermore, with broadband, on-site construction teams are now able to receive architects' drawings on-site and online, which enables them to make any necessary amendments to the drawings and respond immediately on line and on-site - providing major benefits in terms of turnaround times.
G	Retail [source: Scottish Enterprise]	Broadband enabled Blooming Britain to cope better with busy periods. Files containing customer orders can be downloaded within minutes of the order, and email enquiries from customers can be dealt with several times quicker than using the previous dial-up connection. They can now check websites instantaneously - essential for tasks such as checking the Consignia website for postcodes (before broadband, they waited up to 3 minutes to access this information). Previously, Blooming Britain's dial-up costs were c. £500 per month; with broadband, costs are c. £30 per month to network eight computers through a broadband connection.
H	Hotels [source: Yorkshire Forward]	The Carlton Lodge Hotel saw immediate benefits from the installation of broadband. The immediate benefits of speed and always being able to be online saved a great deal of time, More important was the newfound capacity to search the web for the most up-to-date legal and financial legislation pertinent to the hotel trade, particularly important with the introduction of the new licensing bill. Being online constantly also allows the company to easily seek out the best deals with suppliers. The company are also able to now send out bulk emails, including sending out a customer newsletter. An added benefit is that the company has through its broadband connection has access to the latest info on developments regarding technology and training for the hotel industry.

JK	Real estate [source: actnow]	May Whetter & Grose have been astounded by the difference the installation of broadband has made to the efficiency of their business. They frequently need to send photographs of properties to printers, and with broadband they arrive in an instant; also, they now tend to use email instead of writing a letter or telephoning, which makes the process of contacting clients quicker. They also believe that the increased speed of communication with clients – especially when it comes to sending complex documents - creates a positive impression amongst customers and may give them a market 'edge'. The company can now get full value from the internet through it being available al the time, without tying up the phone lines. The company also finds that it can access its website a lot faster and it is easier to upload new info to the site. It is also invaluable when it comes to looking a t relevant website while talking to someone on the phone, something they could not do before. The next development will be to introduce video conferencing, which is expected to make the business even more effective and competitive.
O	Other community services	Citizens Advice In Northern Ireland uses broadband to provide its offices with internet access, so that staff can find funding applications and other information sources easily and efficiently. It also uses broadband in order to create a virtual private network for its internal databases, which include case recording, information databases and a range of other corporate services. Broadband has allowed Citizens Advice to change the traditional model of service delivery whereby clients had to queue to see a qualified adviser; now this skill base is available through email advice provision. It has also led to the creation of a paperless working environment and the training of all staff in IT.

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