Sonas Innovation

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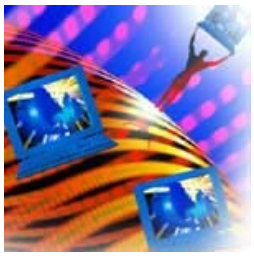

Ireland's Broadband Future

Telecommunications Working Group

Information Society Commission

29 October, 2003

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Acknowledgements

Sonas Innovation would like to thank the following people for their time and cooperation in making valuable contributions to the project and the production of this report:

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Liz Battersby, St Cuthbert's School
Keith Bohanna , Product Inform
Ed Brophy, NTL
Derek Buchanan, Champion Sports
Joe Butler, Intel
Michael Byrne, Netsource
Vint Cerf, MCI
Paul Conway, ComReg
Enda Cronelly, Daughters of Charity
Frank Cronin, Setanta
Christine Eckersly of Southern Health Board
Brian Fitzsimmons, ESB Telecom
Adrian Devitt, Forfas
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Tim Duggan, Department of Finance
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Prof Jane Grimson, TCD
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Brian Higton of Cygnet Solutions Ltd,
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Kathy Lester, AAMC, Maryland, USA
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Doug Reed, McKinsey (ex FCC)
Nana Luke, Bealtaine
Tom McFadden, Portmarnock N.S.
Orla Sheridan, Microsoft
Brian Moran, Chorus
Dr Phil Nolan, Eircom
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Ursula O'Sullivan, SHB
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Joe Macri, Microsoft
Alan Leahy, Hoki
Siobhan Masterson, IBEC
Patrick Vankwikelberge, ST Microelectronics
Carlo Ottaviani,, ST Microelectronics

We would like to pay a special thanks to the members of the Telecommunications Working Group of the Information Society Commission, under the Chair of Dr Patricia O'Hara, and to Aedan Hall and Tony Downes, in the Department of An Taoiseach, for their guidance and support throughout the project.

Sonas Innovation would like to recognise the work of Iarla Flynn as co-author on this report. Inputs by Ben Hurley on telecommunications technology and design input by Philip Lynch of Pixel Soup are appreciated.

Executive Summary

For the Information Society Commission, the overall aim of this project was to highlight some key issues in relation to the provision and availability of broadband communications infrastructure. The terms of reference for the project were as follows:

1. Having regard to the objectives in the New Connections Action Plan, prepare a short appraisal of the adequacy of broadband infrastructure in Ireland at present
2. Identify the short and medium term capacity requirements arising and the most appropriate broadband technologies to address these
3. Prepare a selection of case studies capturing user experience in Ireland and elsewhere

Our aims and objectives in this report are to:

- Investigate the importance of broadband for Ireland's future economic development [Section 2]
- Analyse broadband availability and take-up in Ireland today [Section 3]
- Show in practical terms how the take up and usage of broadband can develop in Ireland in the medium to long term [Sections 4 and 5]
- Inform and support recommendations to Government by the Information Society Commission on broadband policy development [Section 6]

A detailed analysis of the factors shaping the market for supply of broadband services or the development of recommendations in this regard are not within the scope of this report.

What is Broadband?

Broadband services are communications services which provide users with high speed and always-on connections to access the internet and transfer data. Broadband services can be delivered in a variety of means to end users. For example, existing telephone and cable TV networks can be upgraded to support these services.

There has been much debate about the speed of broadband services. A simple way of considering broadband speeds is to compare them with what was, or is, on offer to users who do not have access to broadband. Most dial-up internet services use a modem which gives a maximum data speed of 64kbps (64,000 bits of information per second) and an average somewhere around 40kbps. Most entry level broadband services offer a download speed **ten** times as fast.

In technical terms, 'Broadband' is a high speed and always-on communication service**.** The two main technical characteristics are as follows:

- speed - this describes how much information can be transferred over the connection each second. We believe that a speed of 256kbps is the minimum level at which a service can be considered to be a 'broadband' service.
- 'Always-On' - this means that the link does not require time or technical skill to make ready. It is as easy to use as turning on a television.

However, a technical definition alone is not sufficient. In its true sense, a "broadband" service is a service which must be available at a reasonable cost to consumers. Bringing the various elements together - we define a broadband service as an always-on communications service offering a minimum speed of 256kbps at a reasonable cost.

Why does broadband matter?

We move on to address a fundamental question - '*Why Does Broadband Matter?*'. Our purpose is to address the concern amongst many policy markers and industry players that much of the broadband agenda is built on technology hype. We examine issues in relation to the potential economic impact of broadband in Ireland.

The Irish economy has seen significant structural change in recent decades. High-tech manufacturing has been the driving force behind Irish economic growth for over 30 years. This trend became much more pronounced during the 1990s. Services became an increasingly important source of economic growth in the 1990s and this coincided with a rapid increase in service exports.

While the success of the economy in recent times has been widely heralded, there is a need for every aspect of Government policy to maintain an absolute focus on ensuring that relative productivity increases in Ireland to ensure future economic success. Competitiveness is a key metric governing whether this will continue. For a small open economy such as Ireland the gains from improved productivity, if there is an improvement in relative competitiveness, are potentially far greater than the rise in productivity would initially suggest. However, the reverse is also true. A fall in competitiveness, such as might be experienced by relatively slow access to broadband, has implications for the standard of living well in excess of what measures of productivity might suggest.

The role of broadband technology in boosting competitiveness and economic activity has been emphasised by many State bodies - including Forfas and the National Competitiveness Council. The evidence from the research indicates that the potential productivity improvements from broadband are considerable.

We estimate that broadband deployment could result in net employment creation in the region of 85,000 jobs in Ireland over the first 10 years of its widespread adoption by business over and above what might be created by the economy. A conservative valuation of this employment is €851m per annum - which may be a prize or penalty for the Irish economy.

Research undertaken, principally in the US, has been drawn on to provide indicative estimates of consumer spending from broadband related purchases. These estimates suggest that annual consumer expenditure on access to broadband services, TV and movies, education, and telemedicine would reach €400 million within a few years. When online shopping and other potential revenue sources are included, consumer expenditure using broadband could be 3 times this figure - €1.2bn.

A different approach to estimating the value of broadband focuses directly on consumer welfare rather then the products that might be consumed. This approach draws on projections of broadband take-up set out in Section 4 of the main report. If it is assumed that broadband access will reach 90% of households in 20 years, consumer surplus with a discounted present value of €1.3bn or about 1.2% of Irish GNP is estimated. However, access in areas of low population density may be slower to develop. If take-up in rural areas is only 50% in 20 years, then this estimate could fall by 26% to €0.96bn.

There is obvious potential for the development of new services and new methods of delivery of Government services. In areas such as telemedicine efficiencies have been researched and measured. It has been estimated that an investment of €18 billion in ICT in medicine delivery in the US would yield savings of greater than €120 billion for the healthcare industry over a six year period[1]. This saving would represent about 1.5% of the estimates US annual expenditure on healthcare of US$1,300 billion. While it is clearly difficult to extrapolate from this, a similar percentage cost saving in Ireland would reduce public expenditure on health, which is currently running at close to €9 billion per annum in total, by close to €150 million in 2004.

However, this cost saving would be only a small part of the potential gains since overall efficiency, the quality of service and delivery in rural areas would also improve.

Where are we now?

Our main focus in this section is to present a short appraisal of the availability of broadband in Ireland today.

Despite flat-rate narrowband internet access services only becoming available in Ireland recently, of the order of 40% of Irish homes use the internet today. Given this and a number of other factors, we conclude that SMEs and residential consumers are likely to be eager users of broadband in the right circumstances.

Similar to many other EU countries, Ireland currently has a variety of network platforms providing broadband services nationally.

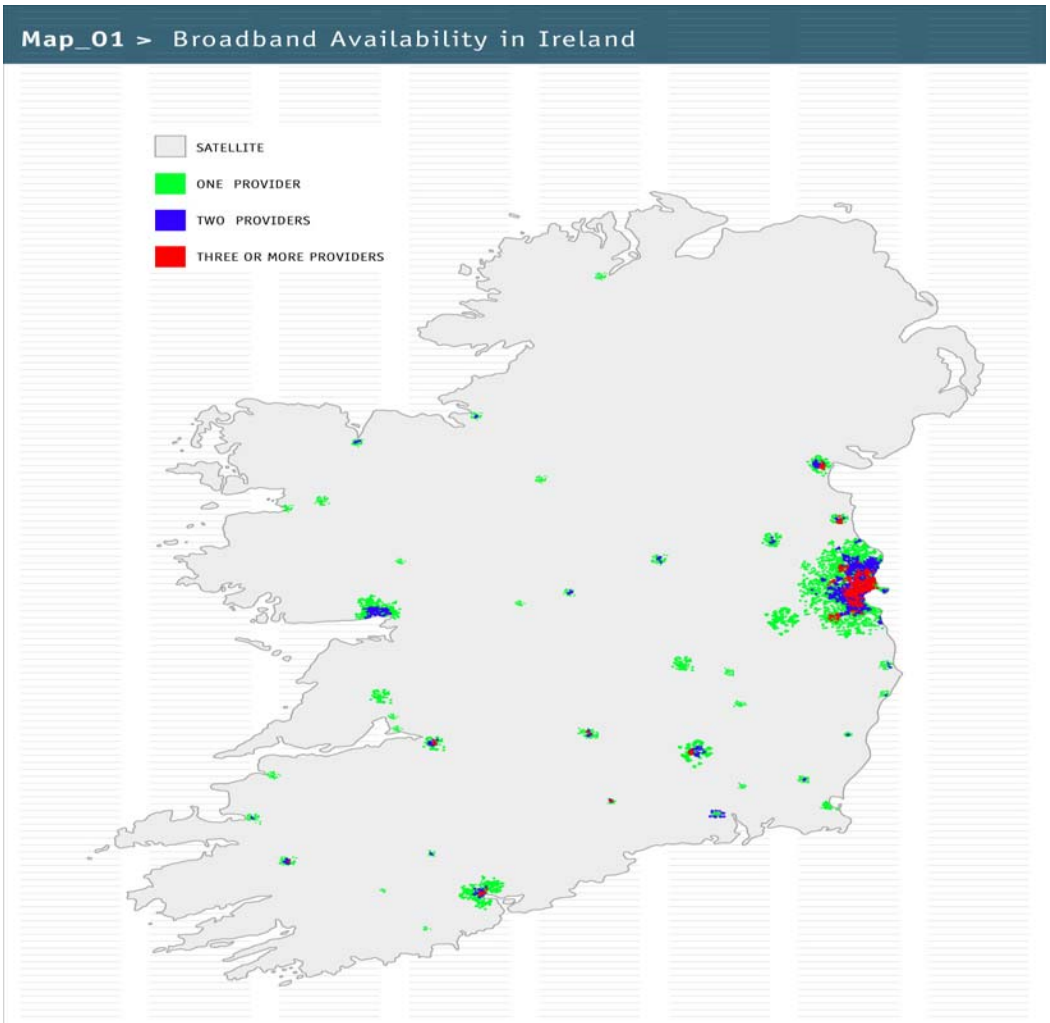
1. Fixed-line telephone network - Traditional telephone lines can be upgraded to support broadband services – known as digital subscriber line (or DSL) services. DSL services are generally aimed at both small businesses and households. Prices for DSL currently start from around €55 per month. Eircom aims to have 1m lines (out of a total of 1.6m) DSL enabled by end 2003.
2. Wireless Networks - These 'wireless' broadband services are generally aimed at business users and are typically available in the centre of large cities. It remains to be seen what impact they will have in Ireland. In Ireland today there are a number of operators providing wireless broadband services to over 5,000 users.
3. Cable TV Networks - Cable TV networks can be upgraded to support broadband services via cable modems - with services aimed at households and small businesses. In Ireland

[1] "Building a Positive, Competitive Broadband Agenda." www.positivelybroadband.org , ITAA, 2001

the number of cable modem customers are an order of magnitude lower than other countries. For example, in the UK 5% of TV households have broadband as against 0.35% of households in Ireland.

4. Satellite - a number of providers offer these services throughout Europe and into Britain. Ireland is also covered by these services. Satellite services tend to be focused on the higher end of the market. The principal advantage of satellite is that the same choice of services are available in rural areas as in cities.

The telephone network and cable TV networks provide by far the most likely platforms for significant supply of broadband. To date in Ireland, very little investment has taken place in cable TV networks. As a result the dynamic of network-based competition for broadband, which drives take-up in many EU States, is almost completely absent in Ireland. Thus, the imperative on the fixed incumbent to invest in broadband upgrades, and to drive consumers to take up DSL services, is significantly reduced.



Having presented the availability of services across various platforms, we make a number of observations about broadband availability and choice:

- service availability follows population density
- large parts of the country do not have access to any terrestrial broadband service
- choice of service provider is generally very limited

When added to the analysis of potential future take-up of broadband (in Sections 4 and 5) and the potential economic value of broadband (in Section 2), current levels of supply point to evidence of a market failure in broadband - where supply is failing to meet a latent demand. The supply market, as evidenced by the step change seen in price levels and take-up elsewhere, is characterised by significant economies of scale to suppliers as usage increases. These would allow for significant price decreases, however, these decreases will only arise where demand grows by large amounts. The development of the Irish industry to date suggests that this may be an appropriate analysis since it explains why charges are high and take-up is low even in areas where the technology is available, but there has been little evidence of new market entrants emerging.

A second market failure arises due to social benefits that will arise but will not accrue to private developers since they cannot be charged for. Many of these social benefits can be described in terms of a more inclusive society that overcomes the current problems of social and regional imbalance.

We conclude that these market failures are very unlikely to be addressed by the industry in the medium term. Ultimately, it falls to Government to try and resolve the situation.

The Government's primary target for the sector is to see the widespread availability of affordable, always-on broadband within three years. Specifically, they wish to see Ireland within the top decile of OECD countries for broadband connectivity by 2005. The table below provides figures for how Ireland's broadband take-up compares against a number of similar sized EU states.

Ireland's Broadband Penetration Compared with Other EU Countries

Country	DSL lines	Other broadband	As a % of population	EU ranking	Growth in the last 6 months
Ireland	5370	4100	0.25	14	47%
Belgium	627 970	417 897	10.19	2	19%
Denmark	389 805	168 795	10.44	1	24%
Finland	280 000	63 950	6.64	5	25%
Sweden	591 695	299 685	10	3	36%
EU average			4.65		36%

Source: EU Commission Broadband Access in the EU (as at July 2003)

Based on an analysis of comparative data for a number of EU states, we draw the following conclusions:

- Ireland currently ranks second last in the EU for broadband penetration
- Our % growth rate in the last 6 months is above the EU average but will not lead to Ireland closing the gap on its EU counterparts in the short to medium term

To assess more accurately the task that Ireland faces in meeting the Government's target by March 2005, we have projected an EU best broadband penetration of 12% by 2005. To hit this target Ireland will need over 450,000 broadband users - an almost fifty-fold increase from current levels.

As set out above, the current circumstances in the sector point strongly to a market failure in the supply of broadband. This holds out the prospect of a significant level of unsatisfied demand in the medium/long term. Unless this situation is addressed, the Government's target for 2005 will not be achieved.

The research undertaken in preparing this report has uncovered a number of areas where data deficiencies may inhibit the measurement of the roll-out and economic impact of ICT and broadband in Ireland. A preliminary set of (consumer, business, and strcutral) indicators has been identified for Ireland, mainly based on work done in the US. Some of the indicators identified may be usefully compared with competitor economies while others would require time series analysis. These indicators should be treated as preliminary and further research would be required to finalise the indicators in advance of evaluation.

How many Broadband users will there be?

To answer this question we will build evidence of underlying trends to generate a projection of the number of broadband users in Ireland over 20 years. Our analysis assumes that broadband be freely available at an economic price.

At the heart of the question as to how pervasive would broadband be in society, is the extent to which user behaviour changes as a result of adoption of technology. Users derive more value and need from ICT with maturity of usage. Use of ICT in the home is an evolutionary process. Users become more accustomed to the technology and can put it to more effective uses with familiarity. An ICT and broadband user will have higher communications requirements over time, and will become more dependent on broadband. An evolutionary pattern for broadband adoption also exists for the business user.

Any new technology introduced in a society will go through a process of adoption over time. Those segments, or groupings of people, more disposed to adopt and use the technology adopt earlier. There are many other experiences of technology adoption which can inform likely adoption of broadband. Devices including the mobile phone, the VCR, the colour TV, and the CD player have all undergone a process of adoption over time. The pattern where technologies form an "S curve" in the early to middle stages of adoption is well accepted by technology business and by academia.[2]

[2] Frank Bass – Diffusion Model

Broadband has been available in other developed countries for some years before it was introduced in Ireland, so these adoption experiences will inform the view for adoption in Ireland. Research by McKinsey shows that "At the current pace of growth, broadband will achieve 25 percent penetration in the United States within 6 years of its commercial launch. PCs reached this level in 15 years, mobile telephones in 13, and the World Wide Web in 7."[3]

We conclude this section by drawing together the various strands presented and the Model for Estimating Consumer Surplus (see Section 2). Two scenarios of broadband take up are presented.

The first projection assumes a penetration rate of 90% (or 1.2m) households is achieved in 2024. This gives the take-up and penetration levels set out in the table below:

Summary of Adoption Projection

Year	Number of connections	Household Penetration (%)
2007	117,000	9%
2012	417,000	32%
2017	951,000	72%
2022	1,200,000	90%

The second projection of household uptake recognises that there are issues related to accessibility in areas of low population density. The assumptions here are that while penetration in towns rises to about 40% in the first 10 years and 90% in the following 10 from a base of 5% in the first year i.e. at the same rate as was assumed for all households in the first calculation, it reaches only 10% of rural households in the first 10 years and 50% after 20 years from a base of 1% in the first year. This gives the number of household connections as shown in the table below:

Summary of Adoption Projection with Rural Adjustment

Year	Number of urban households	Number of Rural Households	Overall Household Penetration (%)
2007	69,000	14,000	7%
2012	246,000	50,000	23%
2017	561,000	110,000	51%
2022	714,000	239,000	72%

How Much Broadband is Needed?

In this section developments in a number of key sectors (e.g. education and healthcare) are analysed to show how broadband availability can lead to new ways of performing essential functions. We also consider the longer term trends of the evolution of IT and

[3] "Making sense of Broadband", McKinsey Quarterly, June 2003

communications technology since the 1980s. We conclude with a projection of the bandwidth to be used by a typical Irish consumer over the next 20 years.

The Irish Government has identified, in the "New Connections" document, an objective of 5 Mbps to the home in the 2012 – 2017 timeframe.

In Section 4, the evolution of user needs is examined. This describes how it takes time to initiate use of a technology, experiment with it, adapt its capabilities to benefit specific uses, discover new ways to do current tasks, and employ the technology to enable completely new uses (sometimes referred to as "applications"). Analysis of some key application areas will further illustrate this. Chosen areas are:

1. Education - Increasingly the educational system will involve technology in its core activities. As learning is an information-based activity, the effective harnessing of ICT can deliver much improved pedagogical results.
2. Health - Centralised medical records, collaboration between medical teams, ongoing professional updates and learning, remote access to medical results and records, and a consistent view of the patient, whatever part of the system he or she engages with, are all possible. Broadband could mean easier and more efficient access to a higher quality health service.
3. Communications - People today are avid users of technology to aid communications. Society now expects instant, and quality communications. Broadband will allow for a myriad of new uses. Sharing home videos with friends and family via broadband could be one such example.
4. Teleworking - Broadband can allow for much greater flexibility and productivity. Research in Europe projects that the number of teleworkers will rise from 4.5 million in 2000 to 17.5 million in 2010. [4]
5. Entertainment - Entertainment uses are often the first to exploit new technology. Gaming has reached a high level of popularity in Ireland, with statistics showing that the country is second only to Japan in the penetration of Playstation devices. Entertainment has already proven to be one of the first application areas to drive broadband take-up.

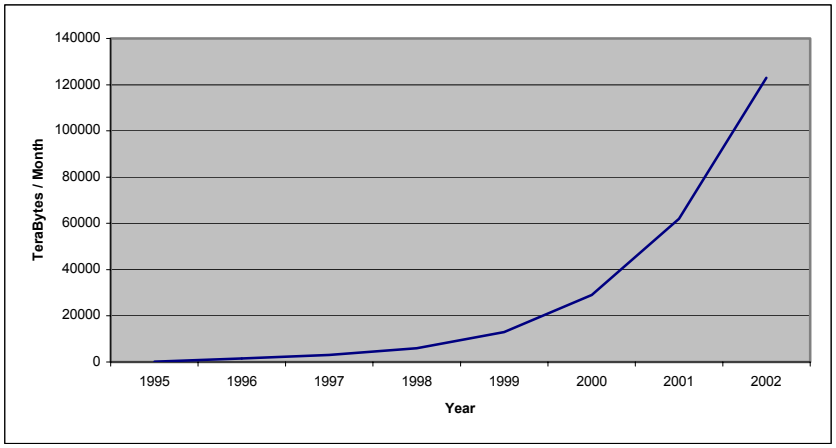
There are a number of broadband trends which will inform the analysis of how much broadband users will need in Ireland. The core trends relied upon are described here.

- Increased Broadband Users Drive More Broadband Use - A significant driver behind the amount of broadband consumed is the number of users on the network. As there are more users, there is more utility in interaction between each other.
- Increase in Devices on the Internet - The number of devices on the Internet not only reflects the number of users, but also the number of destinations to go to online, and associated services to consumers.
- Overall Traffic Trends - Traffic on core Internet backbones has continued to grow over recent years. This traffic is directly related to the amount of broadband each user

[4] EU Emergence Project, May 2000

on the Internet now needs and will require in the future. Research referred to indicates that Internet traffic is likely to double every year.

Traffic on Internet Backbones in the US



Legend: Traffic in 2002 is 123,000 TeraBytes. This approximates network transfer of contents of 250 Million CDs.

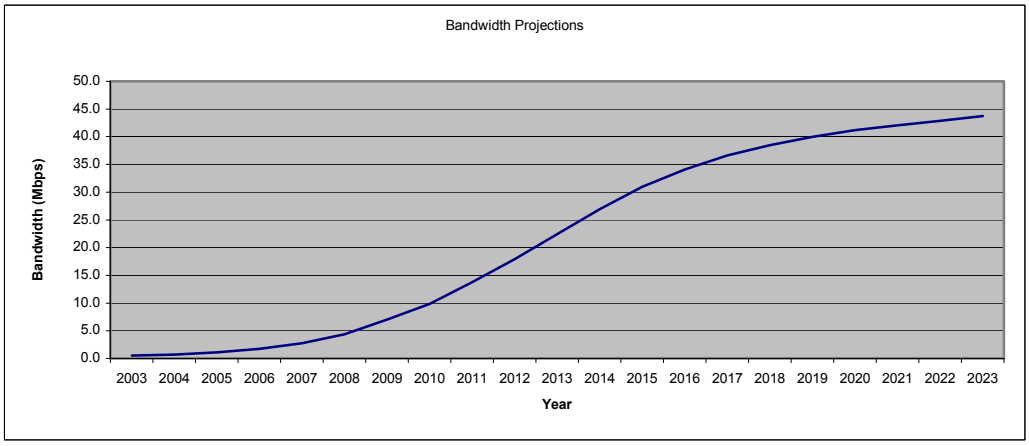
Source: "Internet traffic growth: Sources and implications", Andrew M. Odlyzko, University of Minnesota, Minneapolis – Draft

- Applications Getting 'Fat' - In recent years, the proliferation of multimedia content on the web, along with the file-sharing phenomenon, has driven growth in traffic needs to new levels.

In our view, the evolution of technology leads to a requirement for more and more broadband. In each of the application areas identified above (e.g. health or education), the more users become familiar with, and gain utility from, broadband, the more information is required to serve that need. Similarly, the more the users are capable of utilising ICT and broadband, the more feasible it is to provide services over broadband. The network effects of more users accelerate adoption once a critical mass is attained.

We conclude this section by drawing together the various strands presented in the report to make the following projection:

Projection of bandwidth used by an Irish consumer



In summary, this graph projects the broadband usage levels set out in the table below

Year	Bandwidth Usage
2005	1Mbps
2010	7 Mbps
2015	28 Mbps
2020	40 Mbps

The simple message emerging from this research is that when broadband is made available to users, they have an intrinsic capability to utilise it and require more.

Recommendations

The following recommendations stem from the research conducted for the compilation of this Report. This research served to inform and support the following recommendations to Government by the Information Society Commission:

Recommendation 1 - Increase Government Role in Broadband Market
The analysis outlined in this report shows that conditions for market failure exist. However, there are clear economic benefits to stimulation of a thriving market. Potential demand is high for the take-up of broadband services. Research indicates that a Government role is justified and essential where climate for private investment is furthered.

A: Set ongoing broadband targets
B: Ensure supply-side is focussed on end user
C: Structure the market for competition

Recommendation 2 - Government should lead by example
The Irish Government should position itself in the top decile of the OECD in effective use of ICT. This will span activities from procurement to automation of internal processes.

A: Position ICT as key enabler for each public service
B: Accelerate rate of transformation of Government business
C: Mainstream broadband as a utility infrastructure
D: Adopt a strategy for disadvantaged areas

Recommendation 3 - Measure the effects of ICT in Irish society
We found that our standing relative to other countries will lead to disproportionate gains or losses. An approach outlined in the report, section titled “Monitoring the Information Society” or similar should be adopted. This will allow for clear appraisal of the success or otherwise of initiatives to improve Ireland’s standing.

1 Introduction

This report focuses on the potential future take-up and usage of broadband services by consumers in Ireland. It sets out an economic analysis of the importance of widespread take up of broadband and assesses current availability of service.

Aims and Objectives of this Report

For the Information Society Commission, the overall aim of this project was to highlight some key issues in relation to the provision and availability of broadband communications infrastructure in Ireland. The terms of reference for the project were as follows:

1. Having regard to the policy objectives in the New Connections Action Plan, prepare a short appraisal of the adequacy of broadband infrastructure in Ireland at present

2. identify the short and medium term capacity requirements arising and the most appropriate broadband technologies to address these

3. prepare a selection of case studies capturing user experience in Ireland and elsewhere

Our aims and objectives in this report are to:

- Investigate the importance of broadband for Ireland's future economic development [Section 2]
- Analyse broadband availability and take-up in Ireland today [Section 3]
- Show in practical terms how the take up and usage of broadband can develop in Ireland in the medium to long term [Sections 4 and 5]
- Inform and support recommendations to Government by the Information Society Commission on broadband policy development [Section 6]

A detailed analysis of the factors shaping the market for supply of broadband services or the development of recommendations in this regard are not within the scope of this report.

The report is structured to meet the objectives listed above and addresses the key themes as a series of questions. Our first task is to set out a clear definition of broadband (Section 1).

The first question addressed is - '*Why Does Broadband Matter?*' (Section 2). The purpose of this section is to address the fundamental concern amongst many policy markers and industry players that much of the broadband agenda is built on technology hype. This section examines issues in relation to the potential economic impacts of broadband in Ireland. These are covered under three broad headings: the impact on Ireland's productive potential, the impact on consumers, and the impact on Government policy.

The current level of broadband availability and take-up is assessed in the next section - '*Where Are We Now*?' (Section 3). While a brief review of narrowband internet services and international broadband capacity is included here, our focus is on national broadband networks and services. We compare the technical capabilities and current roll-out of competing platforms. A brief analysis of the market structure for broadband supply is undertaken and a set of

indicators is proposed for more accurately measuring the development of the Information Society. We conclude by assessing Ireland's current performance against the Government's targets for the sector.

The following two sections have a future-based focus and seek to chart how broadband can develop in Ireland in the medium to long term.

Section 4 addresses the question '*How Many Broadband Users Will There Be*?' We analyse how changes in user behaviour result from the acquisition of new ICT technologies. We draw on technology adoption patterns for similar types of services and conclude with two projections of the number of broadband users in Ireland over the next 20 years.

Section 5 asks '*How Much Broadband is Needed*?'. Developments in a number of key sectors (e.g. education, healthcare, and communications) are analysed to show how broadband availability can lead to new ways of performing essential functions. We also consider the longer term trends of the evolution of IT and communications technology since the 1980s. Drawing on international trends for bandwidth usage, we conclude with a projection of the bandwidth to be used by a typical Irish consumer over the next 20 years.

The final section brings the key conclusions together and puts forward a set of recommendations for consideration by the Information Society Commission (Section 6).

What is Broadband?

Broadband services are communications services which provide users with high speed and always-on connections to access the internet and transfer data. Broadband services can be delivered in a variety of means to end users. Existing telephone and cable TV networks can be upgraded to support these services. At the same time a range of new delivery platforms are coming on stream to provide users with the prospect of even greater choice.

There has been much debate about the speed of broadband services. A simple way of considering broadband speeds is to compare them with what was, or is, on offer to users who do not have access to broadband. Most dial-up internet services use a modem which gives a maximum data speed of 56kbps (56,000 bits of information per second) and an average somewhere around 40kbps. Most entry level broadband services offer a download speed **ten** times as fast.

The price of broadband services is also an important characteristic. In the following paragraphs we argue that significant reductions in the retail price of broadband services has been a key factor driving their take-up. For example, today consumers in Ireland can use a broadband service for less than €60 per month. As recently as 18 months ago broadband type services would have cost six times as much.

In technical terms, '**Broadband' is a high speed and always-on communication service.** The two main technical characteristics are as follows:

- speed - this describes how much information can be transferred over the connection each second. It can vary from 256 kbps to 10 Mbps (10m bits of information per

second) and above. We believe that a speed of 256kbps is the minimum level at which a service can be considered to be a 'broadband' service. This threshold is acknowledged by international authorities (for example, see Paltridge, OECD 2001). The actual speed of a broadband service is determined by the needs of the user and the capability of the underlying network.

- 'Always-On' - this means that the link does not require time or technical skill to make ready. It is as easy to use as turning on a television.

While the preceding text addressed technical characteristics, we believe that a purely technical definition of broadband does not capture its essence. The issue of cost must be taken into account.

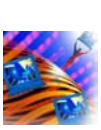
High capacity communications connections (technically equivalent to broadband) have been available for many years, following the development of digital technologies in the 1980s. Ireland's national telephone network has been fully digitalised for almost ten years. Today high capacity connections are available to every single business and home in Ireland - in the form of leased lines on the eircom network. The key factor inhibiting take up of these services on a mass scale is their cost - the cheapest 256kbps leased line service available from eircom today costs over €1900 to connect and €375 per month in rental - excluding VAT. Research from ComReg shows that at these price levels consumers in Ireland will not take up service in large numbers.[5]

In parallel with the digitalisation of networks a number of other developments (such as the development of the internet, falling technology costs, and liberalisation of telecomms markets) have together contributed to create the circumstances where high capacity communications services can now potentially address a wider market. Today broadband services are available to consumers in Europe at prices which make mass take up possible. For example, in our case study on 'Broadband Availability for Teleworker in Sweden' we feature a 2.5Mbps broadband service available for €25 per month.

We conclude our definition of broadband by stating that a technical definition alone is not sufficient. In its true sense, a "broadband" service is a service which must be available at a reasonable cost to consumers. Obviously, the definition of "reasonable cost" will vary from person to person, however, the ComReg research referred to above concludes that a price of €30/€40 (incl VAT) per month is required to ensure significant take-up in Ireland.

Bringing the various elements together - **we define a broadband service as a communications service offering a minimum speed of 256kbps, always on functionality, at a reasonable cost.**

[5] "Consumer demand for Broadband in Ireland" ComReg/MRBI, September 2002



Case Study – Transcription services from County Donegal

Celtic Transcripts is based in Derrybeg in Northwest Donegal and provides transcription services to the medical sector in the US.

Founded in 2002, the Company currently employs 50 people full-time. Expansion plans are well advanced to provide services to legal firms as well as breaking into the Irish and UK markets.

The Company provides digital dictaphones and computer software to GPs and other medical practitioners. Instead of making detailed written or typed notes of patient interactions, the doctor simply records the details onto the dictaphone and downloads the data onto Celtic's website. The information is returned, normally within 24 hours, as carefully written-up patient records.

Donal Doherty, MD of the Company describes the benefits their activities have for their clients,

"Results to date have been impressive with some doctors able to double the numbers of patients they can treat by offloading large parts of their administration work to Celtic Transcripts. A Northern Ireland based clinic was able to save 85% of their admin costs through using the service".

By the very nature of its business, Celtic needs to transfer large quantities of data to and from clients each day. The average client transfer is 10MB per day – transfer of voice records being very bandwidth intensive. *(MB – MegaByte. 1 million bytes, where 1 byte = 8 bits of information)*

Up until recently, the Company was forced to rely on 4 ISDN lines (phone lines offering up to 128kbps) for all their communications needs. Because of their remote location, the entire telecommunications cabling in their area had to be upgraded to allow for ISDN service.

This process took five months to complete. Communications costs were hitting €2000 per month.

Recently, the Company managed to upgrade their service to a 2Mbps connection based on satellite technology. The service, from Digiweb, costs €160 per month. While the broadband satellite service marks a huge step forward, some technical issues remain. Because of the nature of satellite signals, Celtic were forced to move their IT server to the US to safeguard client data. The locating of the server outside Ireland limits the type of services which can be provided to clients. Celtic wants to locate the server in their Derrybeg HQ.

Donal thinks that their best option would be to get a flexible broadband service on the fixed network. DSL (broadband service via the telephone network) is not available in Derrybeg and the alternative is to get a leased line from Eircom. The cost for this service is estimated at €50,000 per annum. By contrast a similar service in the Dublin area would cost half as much. The same service in Northern Ireland would be even cheaper.

The Company has ambitious plans for growth expecting to employ 150 people by 2006. The Company's plan to have 800 clients by 2005 would entail a requirement for 8GB of data transfers each day. This kind of data download would take around 11 hours each day to download using their current 2Mbps connection.

The need for significant expansion in bandwidth is clear. The Company's requirements for the future are for a 50Mbps connection, supporting a local web-based server available 24 hours per day.

Key findings

1. The demand for new information and communications services globally creates opportunities for companies throughout Ireland to build international markets.
2. New generation high speed services, such as DSL and satellite broadband, are essential to allow Irish companies to compete with their international competitors.

2 Why does broadband matter?

Much has been written about the information technology revolution and its economic impact. On some issues, there is certainty: information technology has become ubiquitous in modern economies, the importance of knowledge as a key wealth creating resource continues to grow, and connectivity creates a whole new dimension for the use and development of technology and knowledge. Opinions differ, and it is clear that there is considerable uncertainty, regarding the ultimate effect of the growth of information technology and its use on the structure and performance of economic activity.

In this section we set an economic context for the evaluation of communications and broadband policy in Ireland. A number of areas are investigated where economic competitiveness would be affected by the extent of broadband usage.

We review the changes that are sweeping the economy today and review Ireland's competitiveness. The impact of Information and Communications Technologies (ICT) in the structuring and performance of an economy is assessed. Estimates are made regarding potential to increase competitiveness and some calculations are made of national economic value of consumption of broadband.

Structural Shift in the Economy

In addition to undergoing a period of rapid growth over the past decade, the Irish economy also underwent considerable structural change. This change was not unique to this period but has been ongoing for a number of decades. What was different during the high growth period was not just the pace and clear direction of the change but also that gains in output and employment were far greater than the losses that occurred in sectors from which the economy was changing. Table 2.1 shows the output growth of the various broad sectors of the economy in each 5-year period since 1971. In effect, these numbers can be interpreted as the contribution of each sector of the economy to Ireland's Gross Domestic Product (GDP) growth in each period.

Table 2-1 Annual Growth in GDP by Sector (%)

	1971-1999	1985-1990	1990-1995	1995-1999
Agriculture	0.3	0.3	0.3	0.1
Building and Construction	0.3	0.1	0.3	0.6
High-tech Manufacturing	3.1	4.1	2.9	7.4
Traditional Manufacturing	0.7	0.5	0.8	0.7
Market Services	1.9	1.8	2.1	3.5

Source: Slevin (2002)[6]

[6] "Is there a New Economy in Ireland?" Slevin, G, Central Bank of Ireland Technical Paper 3/RT/02, 2002

Table 2.2 shows the changes in manufacturing output in the high growth period comparing activity in traditional industry, food processing and high tech sectors. The potential for the output of high tech sectors where affiliates of foreign owner Multi-National Corporations (MNCs) dominate to be distorted by transfer pricing has been widely commented on and, as a result, any output based data on the Irish economy – including labour productivity – must be handled with caution. However, given that Gross National Product (GNP) – which nets out the impact of MNC profits – grew by 54% in real terms in this period, it is clear that the high tech sector provided the source of growth with the traditional and food processing sectors growing only slowly. This is reflected in the second half of this table where the output of high tech manufacturing increased from 55.9% of the total to 69.8% in just 5 years.

Table 2-2 Gross Output by Sector

	1995	1996	1997	1998	1999	2000
(€billion)						
Traditional	8.3	8.5	9.0	9.2	9.5	9.9
Food Processing	10.8	10.9	11.0	11.8	12.4	12.9
High Technology	24.2	27.2	33.5	41.2	47.3	52.7
(% of total)						
Traditional	19.1	18.2	16.8	14.7	13.8	13.1
Food Processing	24.9	23.4	20.6	19.0	17.9	17.1
High Technology	55.9	58.4	62.6	66.3	68.4	69.8

Source: National Competitiveness Council (2002)

Further evidence of the growing importance of the high tech sector of the economy is provided in Table 2.3 which shows employment in these main sectors in this period. This shows that while employment in the traditional manufacturing and food processing sectors was almost static, employment in high tech manufacturing grew by almost 30,000 or 26.7%.

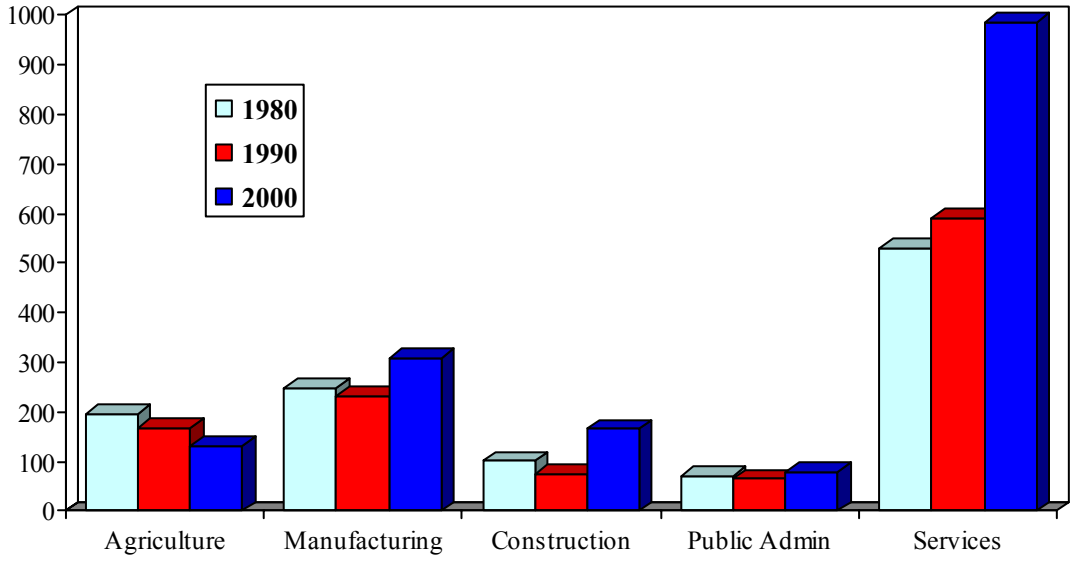
Table 2-3 Employment by Sector (000s)

	1995	1996	1997	1998	1999	2000
Traditional	81	81	83	82	83	81
Food Processing	40	41	41	41	42	42
High Technology	105	110	122	126	129	133

Source: National Competitiveness Council (2002)

However, this strong performance in manufacturing needs to be placed in the context of a longer term trend of change in the economy that is shown in Figure 2.1. Although employment was rising in high tech manufacturing, the trend for the whole economy has been strongly towards employment creation in services. Along with the performance of these high tech industries this change is a major element of the evolution of the Irish economy in recent years.

Figure 2-1 Numbers Employed by Broad Sector



When these measures are combined the result is a rapid rise in productivity in the high tech sector with much lower, although generally positive, rises in productivity in the traditional and food processing sectors.

It has been proven that high-tech manufacturing has been the driving force behind Irish economic growth for a prolonged period – see Appendix 1. This is the case in almost every 5-year period between 1971 and 1999. In addition, this trend became much more pronounced during the 1990s. A second important point is that services became an increasingly important source of economic growth in the 1990s and this coincided with a rapid increase in service exports.

Imperative to Sustain Productivity Growth

The focus in Ireland has generally been on the importance of broadband in preserving Ireland's relative productivity in the face of other economies. This contrasts somewhat with many countries where the focus has been on the role of broadband interconnectivity on improving the overall productive capacity of the economy and reflects the importance that is attached to international competitiveness in Ireland. There is good reason to conclude that the Irish focus on the impact of broadband on competitiveness rather than productivity is the correct approach given the extreme openness of the economy, the reliance on fairly mobile capital and the continuing pace of structural change in the Irish economy. In a world of mobile capital and competing locations, even a marginal advantage can lead to a large gain in terms of the location of production i.e. a 'winner takes all' type of situation.

Foundations of Competitiveness

According to Porter (2001) competitiveness must not be analysed as a zero-sum game between economies in which the more competitive nations gain additional market share at the expense of others[7]. Lower wages, which would lead to a gain in competitiveness in terms of the market share view, do not necessarily lead to a gain in welfare and will not ultimately lead to sustainable competitive gain in the absence of gains in the underlying value-adding potential of the economy. Rather, competitiveness is built on productivity where an improvement can lead to an increase in the standard of living in all countries. This has two further implications. First, while macroeconomic balance is required it is not sufficient and microeconomic policies hold the key to developing competitiveness. Second, the crucial role of productivity means that the entire economy matters in determining the standard of living and not just the internationally traded sectors. As a result Porter concludes that competitiveness depends on productivity which is determined by microeconomic performance in two interrelated areas:

1. the sophistication with which companies in the country compete; and
2. the quality of the business environment.

These insights are reflected in many areas of economic policy in Ireland in recent years. MacSharry and White relate the difficulties that were experienced in the 1980s when initiatives to attract foreign investment to Ireland, no matter how consistent internally, were constantly undermined by the adverse macroeconomic imbalances being experienced[8]. By the mid-1990s, these problems were considerably eased and attention could increasingly focus on the microeconomic foundations of the economy. Since then, while the low interest rate environment and the effective devaluation of the currency in the advent of EMU (Economic and Monetary Union) provided a boost to the economy, the boost was to an already booming economy. The policy foundations of this were located in incomes policy, taxation policy, competition policy, re-regulation and a whole range of initiatives in the

[7] "Enhancing the Microeconomic Foundations of Prosperity: the Current Competitiveness Index", *WEF Global Competitiveness Report 2001-2002*, Michael Porter, 2001

[8] "The Making of the Celtic Tiger", MacSharry, R. and P. White, 2000

general area of industrial policy. These interventions are almost wholly concerned with the effective working of markets or with improving market incentives. As such, they are microeconomic, meaning that the key elements of national economic policy in Ireland over the past decade have been microeconomic with macroeconomic policy mostly limited to avoiding excessive exchequer deficits once the decision to join EMU had been made.

Viewed in this light, the principal economic metrics related to the Irish economy over the past decade – high growth, falling and then low unemployment, a strong balance of payments, etc. – are outcomes of an economy that has undergone a competitive improvement and not the result of macroeconomic policy intervention beyond the role of policy in the avoidance of harmful imbalances. This analysis effectively reverses the idea that as the macro economy improves the microeconomic functioning of the economy follows and is very much in keeping with Porter's finding that microeconomic conditions in an economy have a causal relationship with the level of GDP and with changes in the level of incomes. As a result, microeconomic reform is at least as important as macroeconomic reform in determining performance and, as economies converge in terms of macroeconomic policy and performance, microeconomic polices probably become the key arena in which governments can affect performance.

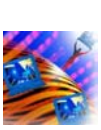
Disproportionate Impact of Falling Behind

This characterisation of the Irish economy must not be interpreted as concluding that the challenges have all been met. Not only are there still weakness in the functioning of many markets but a new set of challenges, of which the growing importance of the knowledge economy is among the greatest, need to be met. Furthermore, there are two additional vital issues to be considered.

While it is true that productivity must be seen as the determinant of competitiveness, the fact remains that an economy's sustained competitiveness is determined by its productivity gains relative to its trading partners. Thus, while competitiveness is not a zero-sum game in the aggregate, national competitiveness is still related to market share.

Second, even if a simple relationship between productivity and competitiveness is assumed in terms of causation, this does not imply that the gains from improved competitiveness are similar to those from productivity gains. To see this, assume that all economies in the EU experience a 1% improvement in productivity. Productivity has improved and the standard of living will rise, but relative competitiveness has not changed. Change the assumption so that one country with an open economy experiences a 2% increase in productivity. In this case, the potential is that the standard of living in that country will rise by far in excess of the productivity gain since it has now also had a relative improvement in competitiveness.

For a small open economy such as Ireland, trading on world markets, this means that the welfare gains from improved productivity, if there is an improvement in competitiveness relative to its trading partners, are potentially far greater than the rise in productivity would initially suggest. However, the reverse is also true. A fall in competitiveness such as might be experienced by relatively slow or inadequate access to broadband has implications for the standard of living well in excess of what measures of productivity might suggest.



Regional Imbalances

As the Irish economy has grown in recent years, regional imbalances have become ever more obvious. Unless developed in an optimal manner, broadband could make this situation worse by providing superior access in leading, generally urban regions. Furthermore, research shows that the benefits of connectivity may be difficult to predict since network effects mean that the past can be a poor indicator of the future. However, if appropriate investment is undertaken, broadband holds the potential to overcome a number of the problems that have been associated with unbalanced regional growth.

While the magnitude of the potential benefits of a better distribution of economic activity is difficult to access, it is known that investment in upgraded infrastructure is required if they are to be realised. A number of alternatives are possible including enhanced transport and utility infrastructure in rural areas. The question then is to identify the most cost effective. The available data shows clearly that, where connectivity is important, by far the most cost effective infrastructure is ICT related. Thus, it can be stated with certainty that while broadband infrastructure is expensive and return on investment is strictly long term, it is far less expensive by a factor of 10 and more, in the case of most relevant alternatives, when compared to other infrastructure costs such as roads, water and electricity. Broadband may eventually diffuse through the economy, even in the absence of state involvement. Therefore, the real issue is the fact that policy initiatives will speed up the process.

The problem with including these issues in any assessment of the benefits of broadband is that, although they are important, there are no effective methodologies for the measurement of these dynamic effects. Indeed, instances of the successful application of weights to recognise the different marginal utilities of income in areas with contrasting economic performance are rare, even where the dynamic network effects are not recognised. The result is that the CBA (cost benefit analysis) approach will underestimate the potential benefits of broadband in terms of its long term impact on the spatial distribution of production and households in Ireland.[9]

The idea that there is an optimal spatial distribution for economic activity and household formation in Ireland has been implicitly accepted in both the NDP and the National Spatial Strategy, although the current distribution diverges considerably from this optimal. The argument being made here is that the attainment of this optimal would be made more feasible by the availability of broadband in currently lagging regions. Similar arguments lead to conclusions in relation to the distribution of income that promote the idea that there are economic gains – in excess of the welfare benefits of reducing poverty – that arise from promoting greater social inclusion.

While increasing attention has been paid to achieving regional objectives in Ireland and in Irish economic policy, the evidence of the past decade is that, apart from the important

[9] It is expected that broadband will promote teleworking and therefore allow for more flexible living and working patterns. This has definite benefits but these are fully included in the consumer surplus approach above. The effects being discussed here arise from externalities that can be harnessed to alter the spatial distribution away from congested areas through enhancing the competitiveness of non-urban areas.

contribution made in this area through the reduction in unemployment, the development of the economy has not improved the distribution of income in the manner that might have been hoped. Just as the leading regions have gained most from growth, the stronger income groups have gained from rising prosperity. However, many of the benefits of balanced regional development and enhanced social inclusion are not marketed. These include issues such as a greater choice of where to live, less lost commuting time, lower congestion in the Dublin region and the welfare gains of participation in economic activity. As a result, their evaluation is very difficult but clearly positive in terms of economic welfare.

Case Study – Sligo firm loses out on mobile investment

Stiefel is a privately-owned multinational pharmaceutical firm. Sligo is the main manufacturing plant for Europe and the Middle East. The plant produces a range of pharmacy and cosmetic products. Stiefel has operations across Europe and the US.

The Sligo operation uses a leased line to support communications with the other Steifel plants. Research, test data and orders are sent between the different plants. Voice over IP is used to get cheaper phone calls. The leased line in Sligo service is slow and very expensive, costing nearly €20,000 per annum.

Recently Steifel upgraded their leased line service to 512K. DSL is now available locally, however, the firm is tied into a contract for the leased line for a further period. The leased line costs over 10 times the price of an equivalent DSL service.

The high cost of communications services has had a negative impact on Stiefel's Irish operations.

The Sligo plant was previously home to the IT servers which supported the Europe-wide ordering and financial communications system. The cost of maintaining this service in Ireland was a key factor in the decision to move it to the UK early this year. The UK equivalent broadband service was estimated at ten times cheaper. Jobs have been lost as a result of this move and Ireland's status as the key IT site in Europe for Stiefel has been undermined.

Recently, Stiefel was considering where to base its IT systems for storing and analysing test data from all labs worldwide. A 2Mbps broadband service would have been needed to support this service. Ireland was not actively considered because the cost of telecomms services here was far too high. The facility is now based in the US.

Key Findings

- Jobs and investment has been lost through not having broadband infrastructure in place
- Broadband costs in Ireland are far higher than other corporate locations

The Importance of Broadband

The importance of broadband for productivity and competitiveness has received most attention in Ireland, particularly given its importance in open economies and has been identified and integrated into policy objectives at both the EU and the national level.

Following on from the initial eEurope 2002 Plan, the Commission has produced an action plan, *eEurope 2005*. The aims of this plan are that by 2005, Europe should have widespread availability of broadband access at competitive prices and a secure information infrastructure to ensure modern online public services and a dynamic e-business environment.

The focus on identifying the impact of broadband in Ireland has correctly been on the impact on competitiveness rather than productivity. *Forfás* placed the economic role of broadband technology in context: [10]

> The ability to create, distribute and exploit knowledge and information is the main source of competitive advantage, wealth creation and improvements in quality of life … World class broadband telecommunications infrastructure and services are essential to the development of a knowledge-based economy.

This reflects the earlier assessment by the *National Competitiveness Council* that 'broadband services are now key determinants of competitiveness'.[11] Placing a valuation on these benefits requires that some estimate is available of the extent to which broadband will improve competitiveness, the effect that this will have on the level of production in the economy and the impact of this growth on welfare. In other words, to what extent would broadband improve competitiveness and in what way would increased competitiveness translate into increased output and incomes?

ICT Can Enhance Productivity

Research indicates that technology investment alone does not create increased productivity. The simple insertion of ICT into existing work practices will not deliver the expected increases in productivity but that where ICT allows for new ways of working to emerge, major gains can be made[12]. US studies at sectoral levels have concluded that experience was varied with different sectors performing much better than others[13]. Among the best performers were the ICT producing sectors, such as semiconductors and telecoms, which accounted for only 8% of US GDP but 36% of productivity growth between 1993 and 2000.

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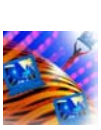
[10] "Broadband Investment in Ireland: Review of Progress and Key Policy Requirements", Forfás, 2002

[11] "Statement on Telecommunication: a key factor in electronic commerce and competitiveness.", National Competitiveness Council, 1998

[12] "Beyond Computation: Information Technology, Organizational Transformation and Business Performance" Journal of Economic Perspectives, Volume 14 (4), Brynjolsson E. and L. Hitt, 2000

[13] "US Productivity Growth 1995-2000: Understanding the Contribution of Information Technology Relative to Other Factors", McKinsey Global Institute, 2001



The research found that although most sectors of the US economy experienced positive productivity growth, the change was concentrated in only six sectors of the economy – semi-conductors, wholesaling, securities, retailing, computer manufacturing and telecoms – and that ICT was only one of several factors that contributed to the growth of productivity in these sectors. Other important factors included capital availability and cost, process innovations, new products and changes in the regulatory environment, as well as the impact of demand in a booming economy. In addition, behind many of these lie further influences such as the motivation to gain efficiencies that is provided by the tightening labour market that was experienced in this period.

Given this finding, follow-up research addressed the question of how ICT affected productivity in these sectors and the conditions under which this positive impact might be maximised[14]. The main finding of this work was that the relationship between ICT and productivity is complex and varied, not only between sectors, but within industries also. In summary, the findings suggest that it is not the nature of the technology that is employed that matters, nor the sectors in which it can be used – although important fundamental influencing factors will be present in some sectors only at a particular point in time – but the way in which the ICT and processes within the industry are managed that is the crucial determinant of the productivity gains that are experienced.

In summary, these findings mean that ICT is only one contributor to performance, albeit an essential ingredient and its payoff will be positive and sustainable only when the investment is tailored to needs. This means that the focus of attention to realise a productivity improvement must not be on the technology but its use. Otherwise, the investment will become just another cost item.

Parallel with Other Historical Innovations

The facts in relation to the growth of ICT are astounding when placed in the historical context of previous economic revolutions such as the agriculture and industrial revolutions up to the 19th century and the communications revolution in the 20th century. By the late 1950s it has been estimated that there were in the region of 2,000 computers in the world processing perhaps 10,000 instructions per second i.e. the power to compute up to a total of 2 million instructions per second globally. It has been estimated that by 2001 there were probably about 300 million computers in the world with an average computing speed in the region of about 267 million instructions per second[15]. This gives a 40 billion-fold increase in the world's raw automated computing power in a little over 40 years or continuous annual compound growth of about 84% per annum.

This contrasts with the agricultural revolution that was such a vital prerequisite for the birth of industrialisation in Britain and which provided annual food output growth of about 1.5%

[14] "How IT Enables Productivity Growth", McKinsey & Co., 2002

[15] "A Historical Perspective on the New Economy" Paper presented to New Economy Conference, Montreal, DeLong, B., June 2001

in the 18th century. At the height of the industrial revolution the main industrial sectors of Britain were growing at a rate of about 5% per annum while the golden era of industrial development in the US in the late 19th and early 20th century saw industrial output growing at about 10% per annum. Each period of economic development had far-reaching impacts in terms of the structure and performance of the major economies but, just as importantly, they also resulted in great and unforeseen changes in living standards and social organisation in the countries involved.

It is immediately obvious from this overview that the rate of change and growth has resulted in the knowledge that the economy is changing but uncertainty about what will result and how the change can be both managed and harnessed for the good of societies.

Increase in Economic Activity

The economic activities enabled by broadband can increase the value of jobs in Ireland. This has become widely articulated as a key goal of policy. There is a direct and indirect economic impact of this increase, and values for the likely impact will be investigated here.

Research suggests that there may be considerable scope for improvement in Ireland's telecommunications infrastructure with associated improvements in economic competitiveness[16]. In an assessment of the state of development of broadband in Ireland in 1998 and of the potential gains from new infrastructure, *Forfás* found that investment in broadband would lead to considerable economic gains for Ireland[17]. This report found that there was a large and widening gap between the facilities that were available in Ireland and those provided in a range of other countries, many of which are competitors with Ireland for trade and inward investment. The analysis concluded that a failure to do this would result in job creation in manufacturing and trading forms falling 25,000 short of the targets that had been set for 2010. This shortfall would arise due to the loss of competitiveness in industry and would be only part of the lost opportunities for Ireland. The Forfás work estimated elasticities for the major variables and found that broadband investment of £200 million (€254 million) along the lines discussed in the report would increase Irish GDP by $4 billion (€5 billion) per annum and create an additional 35,000 net new jobs by 2010. Furthermore, given the direct contribution that access to enhanced telecommunications can make to economic welfare and its role in promoting more balanced economic development, as recognised in the *National Development Plan 2000-2006*, there would be additional gains through these developments.

The *National Competitiveness Council* (NCC) has argued that broadband access is vital to improving productivity in Ireland and would also contribute significantly to reducing costs in production[18]. Although adoption of new ebusiness technologies by companies in Ireland, including SMEs, is high, the availability of broadband needs to be accelerated from its

[16] "National Investment Priorities for 2000-2006" ESRI Policy Research Series No. 33, March 1999
[17] "Broadband Telecommunications Investment in Ireland", Forfás, 1998
[18] "Statement on Telecommunication, eBusiness and the Information Society" National Competitiveness Council, 2000

current growth if the 'always-on' technologies that will be required in the future for these companies to compete are to be available.

Connectivity is a key requirement in promoting the development of the new economy and the fact that ICT may have counted for about 65% of the growth in labour productivity in the US in the late 20th century has been put down in considerable measure to the development of connectivity in this period[19]. The *Brookings Institute* has estimated annual savings from connectivity at over $370 billion for the US in 2005[20]. In other research, over 90% of respondents reported that the gains resulting from increased productivity exceeded the cost of the DSL service[21]. This research also showed that 76% of respondents found improvements in productivity and 70% found improvements in customer relations when broadband services were introduced. Other benefits have also been found as a result of greater use of teleworking including higher employee satisfaction and productivity. This also gives rise to potential savings in terms of travel time and costs and reduced congestion. These have been estimated at $23 billion per annum for the US.

In summary, research indicates that there are positive impacts on productivity and competitiveness as a result of access to broadband and that this level on inter-connectivity is necessary for the productive capability of earlier ICT technologies to be realised due to the time and cost savings that are available in the deployment of these technologies.

[19] "The Resurgence of Growth in the Late 1990s: Is Information Technology the Story?" Journal of Economic Perspectives, Volume 14 (4), Oliner, S. and D. Sichel, 2000

[20] "Net Impact Report" in association with the University of California-Berkeley and Momentum Resources Group, Brookings Institute, 2002

[21] Research undertaken in the US by the Yankee Group published at www.sbc.com

Broadband and Employment Creation

The main areas of benefit that will arise are increased incomes and increased tax revenues that arise in Ireland as a result of increased production based on the improvement in competitiveness.

Although its relatively low dependence on international trade means that the US is not a good comparator for Ireland, research there indicates some parameters for assessing the extent to which competitiveness gains are important[22]. It has been estimated that a full rapid roll-out of broadband would create in the region of 1.1 million permanent jobs in the US. These arise from productivity gains and higher consumer demand. Gains from competitiveness would add to this in the Irish case. The same research also showed that there are a number of aspects to the competitiveness issue. Non-access to broadband does not only lead to a competitive loss relative to others but that it will lead to absolute losses as well. This arises since download times on the internet for non-users are increasing considerably by as much as 50% in the past two years as content providers design increasingly complex sites and systems. This means that there is a good reason why businesses, even if relatively sheltered from competition, need access to broadband.

Indirect effects of investment have accounted for an important part of the benefits that have been identified in many CBAs in Ireland, particularly prior to the mid-1990s. However, although the net benefit of these impacts in a full-employment economy will be reduced they remain particularly important in this project. There are two reasons for this. First, the reduction in unemployment does not mean that the knock-on effects of any investment are reduced, it just means that the net benefits of this are lower. This should be accounted for by using an appropriate shadow price for labour, probably in the region of 90 to 100% of the wage rate unless the impact is felt in a lagging region. Second, an important issue is that indirect effects of investment in advanced technology are thought to be much greater than for the economy in general. This arises because of its productivity impact in sectors other than ICT where the technologies are used and applied. This raises an important issue. The main effect of broadband will not be an increase in the number of jobs but an increase in the value of the employment that is available. In many respects this equates to the objective of improved competitiveness in the future: it allows for higher value added employment rather than aiming at increased employment. It is important that the opportunity cost of labour that should be used – that is, the shadow wage – should be based on the value of employment in the absence of broadband. This provides an argument that the shadow wage of 'new' employment should be below the wage rate, even in an environment of full employment. The new employment might not be additional jobs, but they are higher value jobs replacing what previously existed.

International research suggests however that the impact of investment in ICT is much more extensive than for the economy in general. Pociask reports that ICT multiplier effects are greater than for investment in general with the multiplier effect of the introduction of

[22] "Building a Nationwide Broadband Network: Speeding Job Growth." TeleNomic Research, Va., Pociask, B., 2002

Microsoft software being estimated at 6.7. This is extremely high but is indicative of the productivity impacts that are possible. However, the multiplier effect of broadband is likely to be lower because while its potential applications are very wide it is not as fundamental a technology as a basic operating system. It does appear likely that a multiplier in the region of 4 may be appropriate. In other words, 4 indirect jobs would be created for every 1 job created directly in the investment in broadband. Once again, it is worth noting that in the labour market that exists in Ireland, this should not be interpreted as 4 additional jobs, but that additional value equivalent to what would be created through 4 additional jobs will be created indirectly in the economy for every direct job created through enhanced productivity as a result of the availability of broadband. This is a total effect, the net benefits being found by the subtraction of the shadow wage, in this case, the value of the current employment of these people in lower value added activities.

The factors from this research are applied to employment in Ireland and are represented in Table 2-4:

Table 2-4 Broadband and Employment Creation

Industry	Employment Growth in US due to Broadband (% p.a.)	Employment in Ireland (000s)	**Potential Job Growth in 10 Years**
Manufacturing	1.2	215.8	**27,300**
Healthcare	1.1	32.5	**3,800**
Finance & Business	1.5	113.9	**18,300**
Hotels & Restaurants	0.9	46.9	**4,400**
Other Services	0.9	159.9	**15,000**
Wholesale & Retail	1.2	128.6	**16,300**
Total:		697.6	**85,100**

Note: Employment estimates for Ireland are based on the CSO's *Quarterly National Household Survey*, Seasonally Adjusted Series for February 2003

The table shows net employment creation of just over 85,000 could result in the first 10 years of broadband adoption if Ireland progressed along the lines of the US. In fact, the structure of the Irish economy, in particular its openness means that the potential may be greater. The US economy is effectively limited in productive capacity by the size of the US market with exports playing a relatively small role. However, there is not such constraint in Ireland since most manufacturing is destined for export to a global market that is effectively unlimited, provided Ireland is competitive. Thus, the potential in manufacturing is probably greater, and subsequent demand would push up employment creation in the supporting service sectors.

However, this approach, while producing some indicative estimates, includes productivity gains only. It is therefore appropriate for the US but not for Ireland. If competitiveness is introduced then the gains could be a lot greater but two important issues arise. The first is that in assessing the gains from competitiveness it is important to remember that the concept has a meaningful interpretation only in relation to some other benchmark. The impact of this is that the gains in competitiveness from broadband – assuming that our competitors develop

broadband at least as quickly as Ireland (which is probable) – are better expressed as the avoidance of losses. In other words, once the gains from productivity are included, if all countries develop broadband at the same rate, there are no further actual gains to be included. However, if one lags the others then redistribution takes place whereby the lagging economy suffers losses that are redistributed as gains to competitors. Furthermore, this will probably not amount to a zero sum and the overall balance will show a loss due to a weak member of the trading system.

The second issue is that the impact of competitiveness on the economy is very volatile with respect to measurement. Indeed, for a technology such as broadband, even a relatively small deficiency could have a large impact on the competitiveness of the economy. This is distinct from productivity since it needs to include the impact that international competitiveness has on the underlying structure. As a result, predicting gains on the basis of the existing economy is unlikely to produce reliable estimates.

It is difficult to quantify exactly the differential value of this employment. However, an estimate will be instructive to put the value of this prize, or indeed penalty into context. It could be estimated that should there be a €10,000 differential in annual salary in the value of this employment, then there is a direct value of €851m annually to the economy.

Broadband and Consumer Spending

In this sub section we examine the potential impact of broadband on the standard of living of Irish residents. The approach taken in this report is based on identifying the consumer surplus that would be associated with access to broadband. Consumer surplus is an old idea in economics but can be confusing. Put simply, it can be thought of as a measure of the effect on the standard of living of a consumer from being able to spend income on a product - compared to a situation where the income was available but the product was not. It depends on the observation that if the welfare received by a consumer from a purchase was measured fully by the price of the item bought then there would be no reason for the consumer to undertake the transaction. If the consumer decides to go ahead with the transaction then it can be concluded that the welfare received from the product or service exceeds its price.

Broadband technology will undoubtedly add to the wealth creating potential of the economy, even if this ultimately only amounts to preserving Ireland's relative standing with other countries who invest in the technology, and a lot of attention has focused on this issue in Ireland and abroad. However, it is ultimately the extent to which broadband affects the consumption possibilities of Irish residents that leads to increases in welfare[23].

[23] Consumption here is broadly defined and should not be read as relating to expenditure on material goods and services only. An example would be greater choice regarding where to live and still remain part of a particular community through online communication.

This is in keeping with Porter's argument that competitiveness based on achieving lower wages where labour productivity does not increase is unsustainable, although the underlying argument is different. The approach adopted in the EU indicates that this point is accepted and considerable emphasis is being placed on the use of broadband technologies in enhancing the quality of life of EU citizens in addition to the competitive gains that the technology offers to producers. This is also more inclusive than a focus that emphasises the impact on productive capacity only.

The economic benefits that would accrue to consumers as a result of household broadband access arise from a number of sources, including:

- home retail shopping for goods and services;
- the ability to access digital entertainment;
- reductions in commuting costs and the revenues associated with teleworking;
- increased ability to access telephony and communications services;
- enhanced community strength;
- access to government; and
- savings and revenues associated with telemedicine and distance education.

However, consumers do not perceive the opportunities that are available since they expect a gradual development of the technology rather than the step-change that broadband would induce. Therefore, there may be many new uses in the future that are currently unforeseen that will be stimulated by the advent of broadband. We examine this issue in greater detail in Section 5. This is supportive of the conclusion that the use of broadband, and therefore the benefits that will accrue, will be supply driven and will not arise for as long as investment takes place only in response to observed demand. However, it is also possible to argue that consumer demand will be important in the development of consumer products and that the extent of the benefits that arise will depend not just on the potential that is created through incentivising infrastructure and creating an amenable competitive industry but also on the ability of consumers to adapt and avail of the new opportunities that arise. In a sense this argument reflects the earlier point regarding the productivity effects of ICT where the ability of people to utilise the technologies and adapt systems and structures determined the payoff.

It is unlikely that the prospect of higher speed internet access will be sufficient to encourage consumers to pay for broadband access. As a result, the greater variety of services that will be available on broadband when compared to the alternative technologies provides the key to understanding the potential value of this business to consumers. Research indicates that consumers would be willing to pay for online entertainment services provided they were of the quality of delivery that is promised by broadband access[24]. This work estimated that entertainment services in the US would have market revenue of about €6.6 billion per annum currently. Furthermore, the number of consumers willing to pay for education online was nearly as great although revenue here would be lower at about €3 billion.

[24] "Customers at the Gate: Mounting Demand for Broadband-enabled Services", Sage Research, 2002

Other research in the US has produced a range of values for a number of consumer markets. These estimates are summarised in Table 2.5[25]. As well as indicating potential magnitudes these estimates also provide an indication of the uncertainty that surrounds the commercial potential of broadband. This table also contains derived estimates of the potential of the Irish market[26]. These are based simply on the US estimates rescaled to the smaller size of the Irish market and lower GDP per capita in Ireland in purchasing power parity[27]. They are clearly subject to errors of magnitude.

Table 2-5 Annual Broadband Consumer Revenue Estimates

Product Category	Year	US Value Range (US$ billion)	**Rescaled to Ireland (€ million)**
Access revenue	2004	7.9 - 31.2	**83.5 – 330**
IT Equipment	By 2011	110	**1,163**
Residential Gateways	2006	5 - 24	**53 - 254**
TV and movies	2005	0.3 – 3.9	**3.2 – 41**
TV and Movies	2010	5.5	**58.1**
Continuing education		3.0	**31.7**
Telemedicine		2.6 - 20	**27.5 – 211**
Telephony		1.9 – 51	**20 – 540**
Unified messaging	2005	1.0 – 2.1	**10.6 – 22.2**
Telecommuting		1.0	**10.6**
Online gaming	2005	1.2 – 2.8	**12.7 – 29.6**
Shopping		74.0	**782**
Streaming	2005	7.5	**79.3**
Advertising	2005	3.1 - 3.5	**32.8 – 37**

Source: eMarketer (2002)

Since these estimates are derived from a wide variety of sources it is to be expected that there would be considerable variation in underlying methodologies and also the possibility that similar activities could be included under different product categories in different studies. As a result, the rows of this table are not additive in the sense of providing an indication of the potential consumer market. However, some are clearly distinct.

Taking mid-point values for Ireland, these estimates suggest that annual consumer expenditure on access to broadband services, TV and movies, education, telemedicine and online gaming would reach €400 million within a few years. When online shopping and other potential revenue sources are included, consumer expenditure using broadband could be 3 times this figure. Forecasts indicate that private consumer expenditure in Ireland in 2003 will be in the region of €63 billion in total[28]. This suggests that consumer expenditure utilising broadband services would be in the region of 2% of total consumer expenditure

[25] The work from which these estimates are derived has been undertaken by a wide variety of researchers in commercial organisations and academia. This table is based on a review of this work contained in eMarketer (2002) The Benefits of Broadband. Many of the estimates assume that about 50% of the population will have broadband access within a fairly short period i.e. by 2005/6, although this assumption also varies.

[26] A €/US$ exchange rate of parity is used in producing the Irish values.

[27] According to The Economist World in Figures 2003, Irish GDP per capita in 2002 was approximately 75% of the US value when measured in terms of purchasing power parity.

[28] ESRI (2003) Quarterly Economic Commentary, July

with a few years i.e. when potential access reaches about 50% of the population. This does not include expenditure on equipment to support operating platforms.

While these extrapolations provide indicative estimates, the fact is that uncertainty over uses that consumers and producers of consumer products will find for broadband makes the prior estimation of the benefits of access particularly difficult from a socio-economic point of view, just as it introduces additional risk for potential investors in the private sector. As a result, while the analysis could try to predict what services consumers will buy, this approach is very speculative. An alternative approach is to concentrate on estimating consumers' willingness to spend in acquiring broadband access for whatever purposes as an indication of the value that may be extracted. The model for the evaluation of consumer benefits therefore concentrates not on the direct impact of broadband on consumers' decisions but on the change in consumer welfare that would result from its availability.

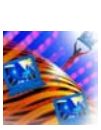
The concept of consumer surplus is discussed in Appendix 2 to the report[29]. The concentration on consumer welfare in general rather than expenditure on individual goods and services may appear at first to be a sharp deviation from the usual approach to economic appraisal as used, for example, in undertaking cost benefit analysis. In fact this is not the case but is a return to the basic methodologies that underlie such procedures and recognises the fact that the nature of the expenditure that will take place is unknown. Importantly, this approach is perhaps more appropriate for a general analysis of the impact because actual instances of investment and consumer expenditure are not being specified but a general development of the integration of a new technology into the economy. Only as specific costs and benefits become clearer in the future would it be valid to implement precise CBA techniques[30].

In the case of typical broadband services, consumers either subscribe to the service, or they do not. As the uses of broadband multiply, the value to subscribers, as defined under the consumer surplus approach, rises far above the monthly subscription price. Placing a value on potential consumer surplus requires a number of assumptions regarding the likely rate of consumer penetration and the price that consumers will be willing to pay to be connected. These are detailed in Appendix 2.

The calculation shows that achieving a rate of penetration of 90% in 20 years would give rise to consumer surplus with a present value of $1.3 billion. This is approximately equal to about 1.2% of GNP at present. In other words, the development of broadband along these lines increases economic welfare by approximately 1.2% of GNP as a result of increased consumer surplus.

[29] For a full understanding of the discussion, the appendix should be read in conjunction with this section. However, it can be omitted for brevity.

[30] Research in the US shows that this approach, based explicitly on measuring consumer welfare, may be more appropriate for appraising the benefits to households of broadband access than an alternative that attempts to predict the future uses of the technology. See Crandall, R. and C. Jackson (2001) *The $500 Billion Opportunity: The Potential Economic Benefit of Widespread Diffusion of Broadband Internet Access*, Criterion Economics. In the analysis, this consumer welfare approach actually found estimates of benefits for the US that were very close to what was obtained by placing valuations on a speculative basket of possible future services that consumers might purchase.



However, there are issues related to accessibility in areas of low population density that will affect household uptake. To accommodate this it is assumed that penetration in towns rises to about 40% in the first 10 years and 90% in the following 10 years from a base of 5% in the first year, but reaches only 10% of rural households in the first 10 years and 50% after 20 years from a base of 1% in the first year. This lower penetration of rural households reduces the present value of consumer surplus over 20 years to €0.96 billion or 0.9% of current GNP. This estimate is about 26% below the previous estimate based on a total take-up is 90% of all households and arises as a result of the additional costs to be addressed in providing broadband in areas of low population density.

Broadband and Public Services

There is obvious potential for the development of new services and new methods of delivery of Government services. One of the greatest problems with providing projections in this area is that the actual range of potential consumer uses of broadband and the business models that will be used to supply these markets remains very unclear. However, in areas such as telemedicine efficiencies have been researched and measured.

It has been estimated that an investment of €18 billion in ICT in medicine delivery in the US would yield savings of greater than €120 billion for the healthcare industry over a six year period[31]. This saving would represent about 1.5% of the estimates US annual expenditure on healthcare of US$1,300 billion. While it is clearly difficult to extrapolate from this, a similar percentage cost saving in Ireland would reduce public expenditure on health, which is currently running at close to €9 billion per annum in total, by close to €150 million in 2004. However, this cost saving would be only a small part of the potential gains since overall efficiency, the quality of service and delivery in rural areas would also improve. These represent clear benefits over and above any savings.

Increased efficiencies would accrue to many other areas within Government. Full exploitation of these efficiencies requires a complete deployment of ICT including access to broadband technologies. Increased efficiency would be the first step along transformational change, allowing for increased effectiveness such that the quality of services delivered to citizens would improve.

Case Study – Southern Health Board improves service with broadband

The Southern Health Board (SHB) provides health and social services to the people of Cork and Kerry.

In September 2001 the SHB launched a new strategy (Health eSHB) aimed at harnessing new technologies to improve health care in the Cork/Kerry region. This strategy focuses on

The system also supports communication between hospitals and GPs by a secure link to ensure that results of tests and other important information can be provided to GPs rapidly.

Laptops with a satellite link allow for instant contact with any part of the Health Board and can

[31] "Building a Positive, Competitive Broadband Agenda." www.positivelybroadband.org , ITAA, 2001

harnessing ICT to implement new models for healthcare delivery across three broad areas: ➢ Improve access to specialist medical expertise and the delivery of care in the most appropriate setting. ➢ Improve communications between the disparate healthcare communities. ➢ Provide self-service or home-based services & information to patients via the Internet or other means. Examples are typically administrative in nature, e.g. appointments or payments. New communications technology has allowed community-based staff, such as public health nurses, to make more effective use of house calls to elderly people or those in remote areas.	help ensure that the patient's records can be kept up to date easily. For example, it ensures that patients in remote areas do not have to travel for test results. Administration contact with the Health Board can also be handled directly from the patient's home meaning less paperwork for staff. The feedback from health professionals using the system is very positive. According to Claire Barrett, public health nurse, "The new system allows me to access full information on each patient irrespective of location. If necessary I can take test results or photos and scan them through to the hospital so they can be assessed straight away."

Conclusions

The Irish economy has seen significant structural change in recent decades. High-tech manufacturing has been the driving force behind Irish economic growth for over 30 years. This trend became much more pronounced during the 1990s. Services became an increasingly important source of economic growth in the 1990s and this coincided with a rapid increase in service exports.

While the success of the economy in recent times has been widely heralded, there is a need for every aspect of Government policy to maintain absolute focus on ensuring that relative productivity increases in Ireland to ensure future economic success. Competitiveness is a key metric governing whether this will continue. For a small open economy such as Ireland, trading on world markets, this means that the gains from improved productivity, if there is an improvement in competitiveness relative to its trading partners, are potentially far greater than the rise in productivity would initially suggest. However, the reverse is also true. A fall in competitiveness, such as might be experienced by relatively slow or inadequate access to broadband, has implications for the standard of living well in excess of what measures of productivity might suggest.

Productivity growth is the essential requirement for competitiveness. Research has shown that it is vital that investment at the firm level is accompanied by process innovations and that the technology employed must be appropriate to needs. As such, investment in IT is only one element in achieving productivity growth. This requirement is reflected at national level in the need to ensure that macroeconomic imbalances are avoided, that appropriate microeconomic initiatives are introduced in a range of areas and that the structure of the economy is such that the potential of technological progress can be realised. There is reason to believe that Ireland is in such a situation suggesting that there are potentially large gains but that the potential losses from falling behind are also considerable.

The role of broadband technology in boosting competitiveness and economic activity has been emphasised by many State bodies - including Forfas and the National Competitiveness Council. The evidence indicates that the potential productivity improvements from broadband are considerable.

It is estimated that broadband could result in net employment creation in the region of 85,000 jobs in Ireland over the first 10 years of its widespread adoption by business over and above what might be created by the economy. A conservative valuation of this employment would be €851m annually - representing a prize or penalty for the Irish economy.

Research undertaken, principally in the US, has been drawn on to provide indicative estimates of consumer spending from broadband related purchases. These estimates suggest that annual consumer expenditure on access to broadband services, TV and movies, education, telemedicine and online gaming would reach €400 million within a few years. When online shopping and other potential revenue sources are included, consumer expenditure using broadband could be 3 times this figure. This means that consumer expenditure utilising broadband services would be in the region of 2% of total consumer expenditure with a few years.

A different approach focuses directly on consumer welfare rather then the products that might be consumed. If it is assumed that broadband access will reach 90% of households in 20 years and available data for willingness to pay are used then consumer surplus with a discounted present value of €1.3 billion or about 1.2% of Irish GNP is estimated. However, access in areas of low population density may be slower to develop. If take-up in rural areas is only 50% in 20 years then this estimate could fall by 26% to €0.96 billion or 0.9% of current GNP.

There is obvious potential for the development of new services and new methods of delivery of Government services. In areas such as telemedicine efficiencies have been researched and measured. It has been estimated that an investment of €18 billion in ICT in medicine delivery in the US would yield savings of greater than €120 billion for the healthcare industry over a six year period[32]. This saving would represent about 1.5% of the estimates US annual expenditure on healthcare of US$1,300 billion. While it is clearly difficult to extrapolate from this, a similar percentage cost saving in Ireland would reduce public expenditure on health, which is currently running at close to €9 billion per annum in total, by close to €150 million in 2004.

However, this cost saving would be only a small part of the potential gains since overall efficiency, the quality of service and delivery in rural areas would also improve. These represent clear benefits over and above any savings. Increased efficiencies would accrue to many other areas within Government. Full exploitation of these efficiencies requires a complete deployment of ICT including access to broadband technologies. Increased efficiency would be the first step along transformational change, allowing for increased effectiveness such that the quality of services delivered to citizens would improve.

[32] "Building a Positive, Competitive Broadband Agenda." www.positivelybroadband.org , ITAA, 2001

3 Where are we now?

In this section we present a short appraisal of the availability of broadband in Ireland today. The underlying data to support this analysis was gathered in extensive interviews with a variety of industry players. We present the information in table format and as a map to ensure a clear understanding of the overall situation is arrived at.

Our assessment of broadband availability is set against the definition of broadband established in Section 1 (Introduction).

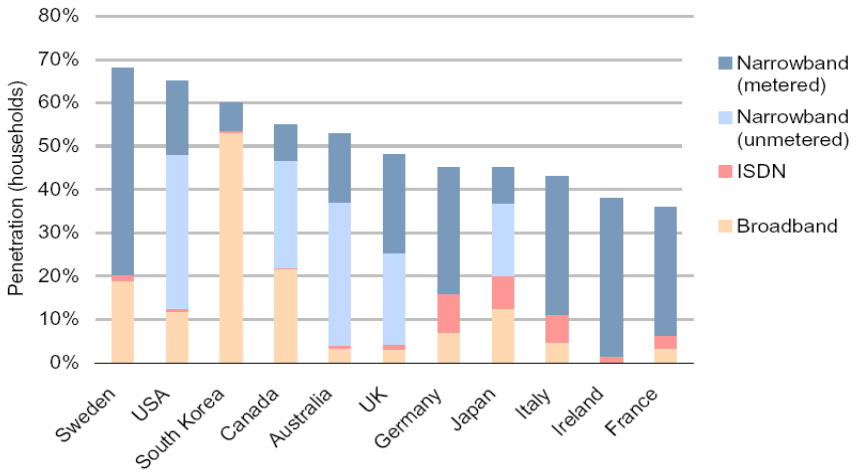
Given the level of take-up of broadband, we ask if the market for supply of broadband is demonstrating characteristics of a market failure. We review Government targets regarding goals for development of broadband in Ireland. We compare Ireland's current broadband performance with that of other EU countries and draw conclusions about the likelihood of meeting the Government's targets. We conclude by suggesting a methodology for measuring progress in the future.

From narrowband to broadband

Before fully considering the availability of broadband in Ireland, we will start by focusing briefly on the uptake of basic or narrowband internet services.

Ireland is a leader in a number of indicators in terms of demand for information services. The country's consumption of gaming, news, mobile telephony, and video entertainment is in the leading group of OECD countries. Despite flat-rate narrowband internet access services only becoming available in Ireland recently, our overall usage of internet access is at a reasonable level. Of the order of 40% of Irish homes use the internet today.[33] This is illustrated in Figure 3.1:

Figure 3-1 Ireland's Internet Access Market



Source: Broadband Stakeholder Group (UK) Second Annual Report, November 2002; Analysys.

[33] "Consumer TrendWatch" Amarach Consulting for Comreg, February 2003

Irish consumers also illustrate a positive attitude towards taking up broadband services. A recent survey found 46% of home users and over 50% of SMEs "fairly" or "very" likely to subscribe to a broadband service.[34]

Our conclusion is that SMEs and residential consumers are likely to be eager users of broadband in the right circumstances.

However, making the move from narrowband to broadband requires more than a general interest in usage of new technologies. The presence of a number of other factors is required, including:

- investment by operators to upgrade networks to broadband capability
- the presence of market or other forces to bring prices to levels that will attract consumers

Broadband Availability in Ireland

A key element of the Terms of Reference of this project is to assess the current availability of broadband infrastructure and services in Ireland. The following pages address this issue.

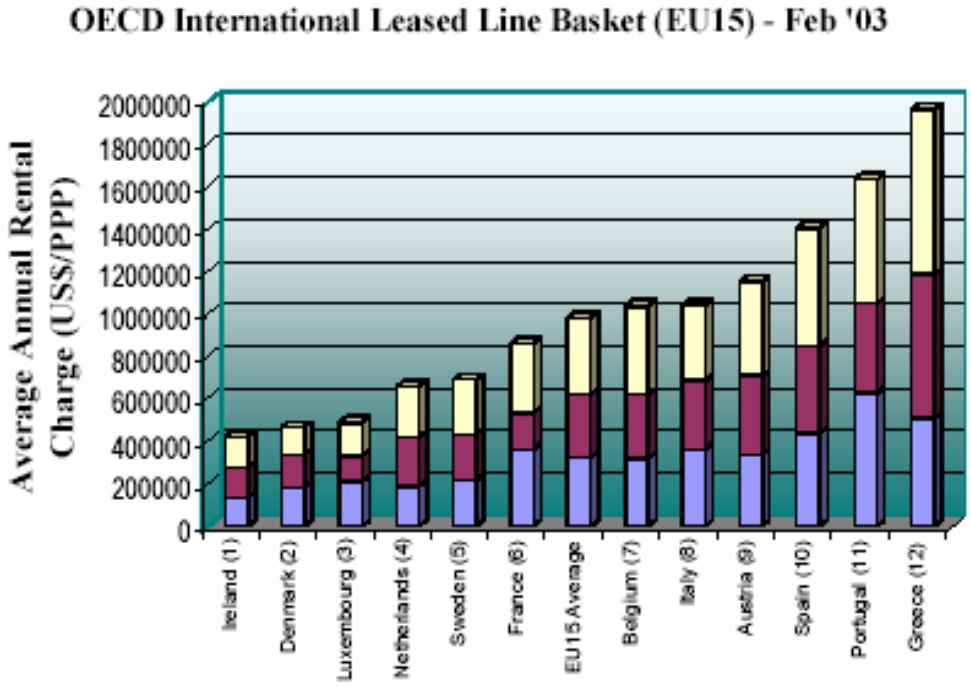
Our focus is on national broadband, however, we commence here by briefly addressing the availability and pricing of international broadband services. Ireland compares well with other countries regarding availability and pricing of very high capacity international broadband services.

In recent years we have seen several major international communications cables established in Ireland by companies such as NTL, Global Crossing, Network 360 (now Hibernia), and Esat BT. All of these cables connect into network nodes in the Dublin area, and there is a high number of competitors who control broadband infrastructure and offer services out of Dublin. The presence of over 10 major carrier hotels or co-location facilities in the Dublin area underlines this point.

The price levels for high capacity international links reflect the impact of competition between the various suppliers. The following chart shows that Ireland is the best in the EU for international broadband pricing:

[34] Consumer Demand for Broadband in Ireland, ComReg/MRBI September 2002

Figure 3-2 Ireland International Broadband Standing



Source: Comreg.

However, investigation of broadband services available outside of the large international nodes in Dublin tells a very different story. This is confirmed by our appraisal of national availability levels in the following pages. It is also backed up by the views of a range of experts and users who made contributions to this study. For example, according to Pat Shanahan of the Atlantic Technology Alliance "o*utside of Dublin there is a very much a monopoly structure (even if there is more than one provider) in the availability of broadband*".

Case Study – Business Disadvantaged in County Clare

Bealtaine is a company involved in training, research, and language translation - based in Scariff, Co. Clare. The company has a full time staff of seven and makes use of a network of over 200 expert translators and other IT specialists from all around the world.

While most of the overseas international translators that Bealtaine uses have high speed communications services, the company itself has a very limited set of options. The cost of internet access is currently running at €250 per month.

This is now becoming a critical business issue, Having a broadband service would have a huge impact on Bealtaine's operations. Receipt of and responses to customer emails, which often contain large files, would be accelerated. Management of teams of international teleworkers would become much more efficient.

Recently Bealtaine were considering getting a new software package from Canada which would have allowed them to communicate with and manage their teams more effectively. This system would support on-line team meetings with video conferencing. However, the Company could not run the demonstration because their download speed was too slow.

"Large emails can take hours to download slowing down work in the office. This is a central part of our business", says Nana Luke of Bealtaine.	Bealtaine are actively looking at upgrading their service. Satellite is one option. They have received a quote for a 2Mbps satellite connection which would cost €699 per month on top of an installation fee.

Key Findings

- Narrowband internet access imposes very high costs and restricts some important business communications activity
- Bealtaine's rural location places them at a disadvantage for the availability of broadband services

Which Platforms Are Providing Broadband Services?

In the following paragraphs we compare the different platforms or networks currently providing broadband services in Ireland. As indicated at the start of this Section we do not give serious consideration to platforms/services which do not meet the terms of our basic definition of broadband.

1. Fixed-line telephone network

Traditional telephone lines can be upgraded to support broadband services – known as digital subscriber line (or DSL) services. DSL services are generally available to any phone user within 3km of the local exchange. However, due to the poor condition of some telephone lines, not all consumers living within the 3km range will be able to receive service.

DSL services are generally aimed at both small businesses and households and in Ireland currently offers services from 512kbps up to 2Mbps. Prices for DSL currently start from around €55 per month, in addition to connection fees and charges for modems. Eircom recently announced a special offer for new connections based on a free modem and E0 connection charge.

In Ireland, eircom owns the national fixed network and has been upgrading exchanges to support DSL services over the last two years. Eircom aims to have 1m lines (out of a total of 1.6m) DSL enabled by end 2003. Other operators can provide DSL services to end users over the eircom network and a number of companies currently provide services in this manner.

Figures from ComReg show that that there are now over 7,000 DSL broadband users in Ireland[35].

Throughout the EU, the network of the incumbent fixed-line telephone operator is the primary means of delivering high speed services. Today the EU has over 11m DSL lines

[35] ComReg Quarterly Key Data, September 2003

in operation. This represents 6% of the total telephone lines in the EU. In Ireland DSL lines account for less than 0.7% of the national total.

2. Wireless Networks

Developments in technology have allowed new high capacity services carried over radio signals to emerge. These 'wireless' broadband services are generally aimed at business users and are typically available in the centre of large cities. These services have had a considerable impact in some countries but have not achieved mass availability or take-up. It remains to be seen what impact they will have in Ireland in the medium to long term.

In Ireland there are a number of operators providing wireless broadband services to over 5,000 users. Key players include Leap, Irish Broadband and Digiweb.

Prices are generally similar to those pertaining for DSL services, however, in recent months some prices for wireless broadband have been positioned at a discount. For example, Irish Broadband offers a 512Kbps service for residential users for €30 (incl VAT) per month.

Standards are emerging which may allow much higher speed services over wireless.[36] New interactive uses of radio frequencies allowing for 'intelligent' radio devices may allow for more efficient use of the scarce spectrum resource and faster lower cost services.

ComReg has been to the fore in seeking to license new operators for wireless broadband and a recent competition for local licences received 128 applications.[37] Government funding has also been provided for a number of pilot programmes for innovative wireless services.

3. Cable TV Networks

There are almost 500,000 homes connected to cable TV in Ireland. This is amongst the higher penetrations levels in the EU. Cable TV networks can be upgraded to support broadband services via cable modems - with services aimed at households and small businesses.

In the EU almost 4m cable TV customers have been upgraded to broadband services. In many countries (e.g. the UK, Belgium, Denmark, Sweden, Netherlands and Austria) the number of cable modem customers is around the same or greater than the number of DSL users. Cable modem services provide by far the strongest competition to DSL services.

In Ireland the number of cable modem customers are an order of magnitude lower than other countries. For example, in the UK there are 1 million cable modem users (5% of

[36] Source: Intel announcement wireless 802.16 standard may allow for 70Mbps access with a range of 30 miles, April 2003
[37] ComReg statement of 16 September, 2003 (PR 160903)

households).[38] There are around 3,000 cable modem users in Ireland (0.35% of households) today. [16]

Significant capital expenditure is required to upgrade most cable TV infrastructure to broadband functionality, although many areas, with newer housing, can be upgraded for considerably less. To date in Ireland, very little upgrading has been completed. This lack of investment is due to a variety of factors but its impact is clear. The dynamic of network-based competition for broadband, which drives take-up in many EU States, is almost completely absent in Ireland. As a result, the imperative on the fixed incumbent to invest in broadband upgrades, and to drive consumers to take up DSL services, is significantly reduced.

4. Satellite

Broadcast Satellite service providers have about 280,000 TV customers in Ireland. [16] Interactive satellite services have also advanced to allow providers to deliver broadband services. Currently, a number of providers offer services throughout Europe and into Britain. Ireland is also covered by these services. Satellite services tend to be focused on the higher end of the market.

The principal advantage of satellite as a means of delivering services is that it does not need any local network. This means that the same choice of services are available in rural areas as in cities. Currently customer numbers are less than 1,000.

It is important to note that there are some technical questions regarding whether Satellite will have the capacity to provide a mass market service. Satellite broadband services typically serve businesses users.

5. Fibre

Fibre networks are in use in Ireland for highly trafficked links. These include international trunk links and national backbones. Local fibre links are typically only in place to business parks, large businesses and high density city centre locations. Fibre will typically be deployed for links of speeds between 2 Mbps and 10 Gbps (one Gbps = one thousand Mbps). Fibre (or its copper hybrid, VDSL) is not available to the mass market in Ireland today. This type of network almost exclusively serves large businesses.

[38] Broadband Stakeholders Group, Second Annual Report and Strategic Recommendations, November 2002

Where is Broadband Available?

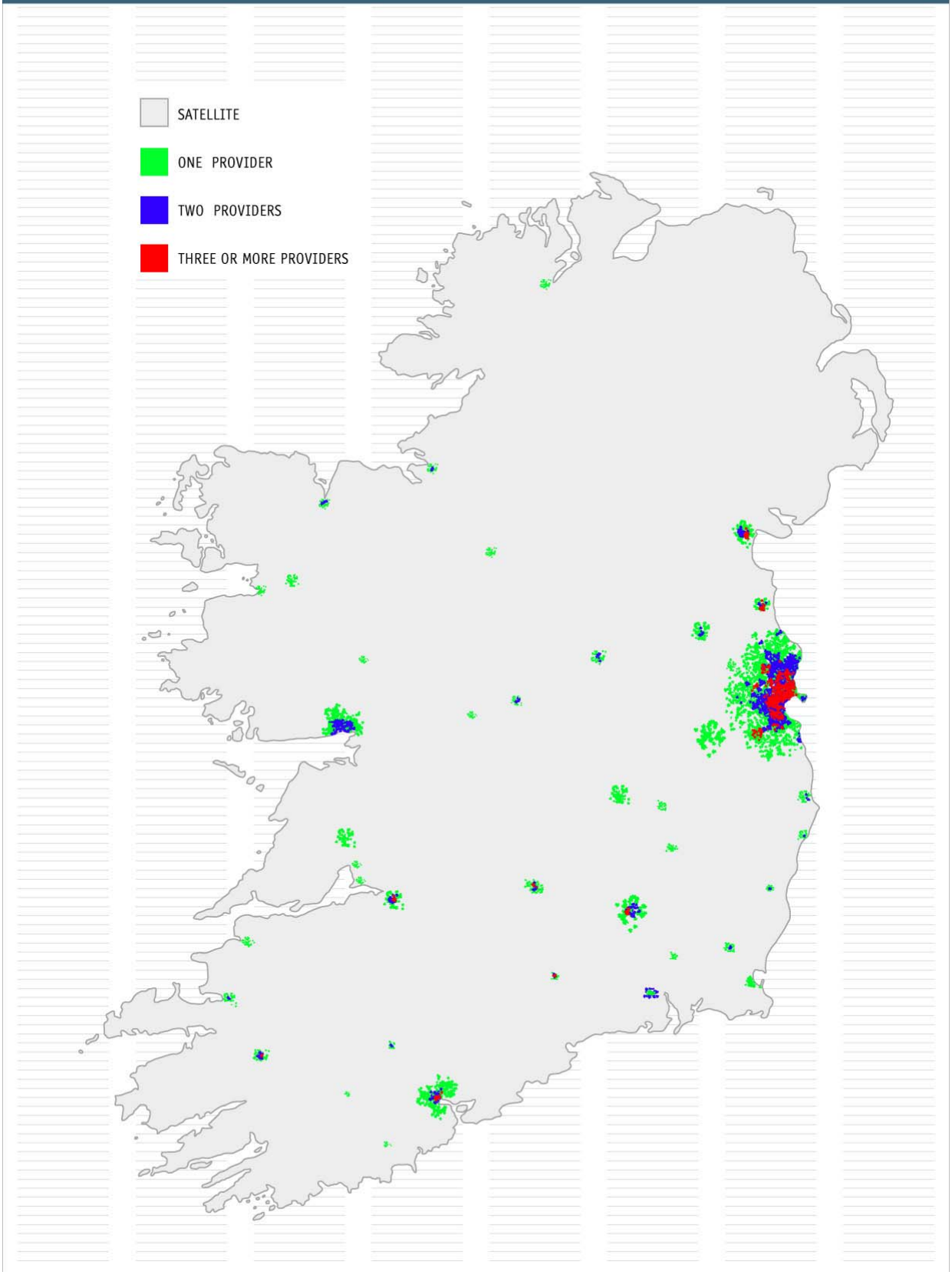
The following table lists the cities and towns where broadband services are available in Ireland. The main providers for each service are identified.

Figure 3-3 Locations of current broadband availability

Service provided via	Main providers	Location Available
DSL on eircom's network	Eircom Resellers of eircom wholesale services	Dublin, Cork, Limerick, Galway, Drogheda, Dundalk, Monaghan, Wicklow, Arklow, Greystones, Portlaoise, Naas, Lexilip, Celbridge, Maynooth, Carlow, Athy, Waterford, Wexford, Enniscorthy, Gorey, New Ross, Kilkenny, Clonmel, Mallow, Bandon, Macroom, Killarney, Tralee, Listowel, Shannon, Ennis, Newmarket, Westport, Castlebar, Ballina, Athlone, Mullingar, Sligo, Letterkenny, Carrick-on-Shannon, Navan, Ashbourne
DSL via Local Loop Unbundling of eircom exchanges	Esat BT	Centre of Dublin, centre of Cork, Limerick, Galway, Greystones, Wicklow, Arlow, Kilkenny, Gorey, Enniscorthy, Waterford, Mallow, Tralee, Killarney, Thurles, Clonmel, Navan, Drogheda, Athlone, Mullingar, Ballinalsoe, Ballina, Sligo
Cable modems on cable TV networks	NTL Chorus	Tallaght, Lucan, Kilkenny, Clonmel, Thurles
Broadband wireless	Leap Irish Broadband Digiweb	Centre of Dublin, Cork, Limerick, Dundalk and Drogheda
Satellite	Digiweb Aramiska	Nationwide

This information is also represented on a map (see overleaf). In the map the network information is overlaid to give an illustration of areas where consumers have a choice of providers. Satellite services are available in all parts of Ireland. The choice of terrestrial broadband providers (i.e. DSL, cable modem, or wireless) is represented in green for one provider, blue for two and red where three providers offer service in a geographic area.

Map_01 > Broadband Availability in Ireland



Market Structure and Market Failure

We can make a number of observations about broadband availability and choice from the preceding table and map:

- service availability closely follows population density
- large parts of the country do not have access to any terrestrial broadband service
- choice of service provider is, in most areas, very limited

The preceding analysis of the market for supply of broadband in Ireland leads on to consideration of whether there is evidence of market failure and what role, if any, the State should take in addressing this situation.

The arguments presented in the previous Section (Section 2) conclude that the development of broadband in Ireland will provide a more competitive environment for business and will provide enhanced welfare for consumers. The following Sections (4 and 5) show that take-up and usage of broadband in the future should be significant. Given this, it is reasonable to ask why the State should be involved in developing a broadband policy, particularly since this is likely to involve public expenditure. The widely accepted conclusion is that, ultimately, the development and delivery of broadband services and content is a matter for the private sector.

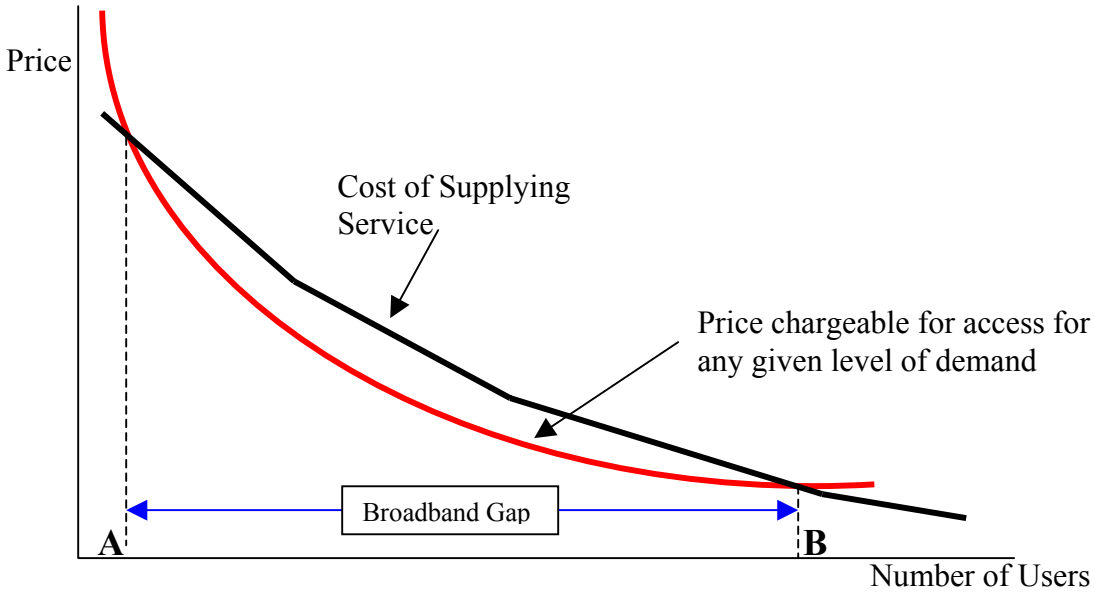
However, while the industry will be dominated by private commercial firms, although they will operate in a regulated environment for the foreseeable future, this does not mean that an economic role for the public sector is negated. Rather, closer examination shows that, as a result of some important market failures, a rationale for the state to adopt a leading role can be identified.

Two quite separate sources of market failure can be identified that need to be addressed if investment in broadband provision is to be adequate.

The first arises from the existence of considerable economies of scale to services providers that mean that the price of access to the broadband infrastructure can fall considerably as take-up increases. This is a desirable situation but the economies of scale may be so large that the infrastructure approximates the characteristics of a public good and the growth may not come about. However, users may not perceive the full potential uses of broadband until they have started to use it. In other words, access costs need to fall first to stimulate uptake, but will not do so until uptake is sufficient to allow for the economies of scale to arise.

The relationship between price and the growth of usage of broadband that would lead to the adoption of a sub-optimal equilibrium that would inhibit growth. This is illustrated in Figure 3.4 overleaf:

Figure 3-4 Price and Cost of Access to Broadband



Source: Based on Forfás (2002)

This figure shows the cost of providing access to each user falls considerably as the number of users increases but, over a certain level of demand, the price at which suppliers would be willing to supply services is too high for potential customers. This leads to a broadband gap where, essentially, the private sector is unwilling to invest to supply services and the sector does not grow. Below output level A, larger firms for whom broadband access is mandatory, would be willing to pay the high prices implied by output A, but their number is limited. Small commercial users and domestic consumers are excluded due to the high cost of access.

At output level B and above, the cost to the supplier and therefore the price at which the service is supplied, is at or below the price level required to stimulate demand, and growth occurs. Indeed, there is the possibility of considerable profit for suppliers who can attain sufficient economies of scale to force down costs to these levels. The problem however, is that there are clearly high risks involved in creating the infrastructure required to bring about this situation. The existence of the broadband gap means that an equilibrium is reached so that the supplier charges a high price that is sufficient to cover costs but that limits demand to output A.

The development of the Irish industry to date suggests that this may be an appropriate analysis since it explains why charges are high and take-up is low even in areas where the technology is available, but there has been little evidence of new market entrants emerging.

In Ireland a number of factors have conspired to limit the amount of investment in existing networks. Late liberalisation of the telecomms sector (in December 1998) followed by the impact of the rapid contraction in the communications industry gave Ireland a narrow window during which major investment could realistically take place. The impact of these

two factors is seen particularly in the very limited roll-out of cable modem services nationally.

This minimal availability of cable modem services has had a significant negative impact on the availability and pricing of DSL services:

- late launch of DSL - broadband services via DSL became available in Ireland in May 2002, some 3 years behind other OECD countries
- high price levels - up until very recently prices for DSL services were at exceptionally high levels. Even given recent reductions, they are still well above those available in many other EU countries.

The second market failure arises due to social benefits that will arise but will not accrue to private developers since they cannot be charged for. Many of these social benefits can be described in terms of a more inclusive society that overcomes the current problems of social and regional imbalance. Overcoming the imbalance that has emerged has been given prominence in Irish economic policy in recent years in under the regional and social inclusion programmes contained in the *National Development Plan* and in the *National Spatial Strategy*, but there is a widespread acceptance that the general thrust of Irish economic development over the past decade has tended to magnify rather than reduce the imbalances that exist. The development of broadband access in Ireland to date has further promoted these undesirable trends. This means that while a more rapid roll-out of access to broadband may be required from the point of view of maintaining Ireland's international competitiveness, from the point of view of maximising the national benefits of having access to these technologies, a different regional and social structure of the roll-out is required. However, above output level B costs will increase due to the need to provide access in areas of lower population density.

We conclude that this analysis provides a rationale for public intervention in developing broadband. The role of Government is addressed in the following pages.

Case Study – Dublin commute forced by lack of broadband

Mission Critical is based in Clontarf, Dublin and has a small office in Kells, Co. Meath. The company provides remote IT and data security services to a wide range of customers. Services include security updates for clients, (anti-virus or anti-spam) scans of IT systems, security audits and instant messaging. Interactive support is provided between 8am and 6pm, and email and remote support is available around the clock.

Quality of service is a key aspect of Mission Critical's offerings. In order to give customers peace of mind they provide a guaranteed Service Level Agreement. The Company guarantees that

Service options are much more limited in Kells. The Company currently uses ISDN lines. DSL is available in Navan but Kells is outside the range of coverage for that service. Major difficulties have been encountered in doing business in Kells. According to John Thewlis, CEO, "The problem arises when you go outside the M50. While our Dublin office is well served we have had serious trouble getting services in Kells. It took us 3 years to get two ISDN lines installed".

The impact is very tangible on the company and its employees. John outlines, "Because of the poor communications service at our Kells office, two staff

their network will be available at least 99.9% of the time. In the event of failing to meet this promise, they provide a money-back guarantee. Clearly, reliable and cost effective communications services are fundamentally important to Mission Critical's business. In the past, monthly narrowband communications bills were about €2000. The company wanted to move to a fixed price service. They have now achieved that for the Dublin office – with both an ADSL link and a wireless broadband connection.	members, who had been based in Kells, now have to commute to work in Dublin each day". Even Mission Critical's current service choice in Dublin compares poorly to international equivalents. The Company has a partner firm in Spain and a recent comparison of the cost of communications services found Spain to be 37% cheaper than in Ireland. ADSL is available in Barcelona for E20 per month – half the price of the Irish equivalent.

Key Findings

- Lack of broadband in outlying areas has a direct effect in the centralisation of business to the larger urban centres
- Broadband may yield significant economic savings in reduced reliance on transport infrastructure
- The cost and inconvenience of doing business without broadband has a negative effect on business competitiveness
- Even with recently reduced broadband prices in Ireland, other countries are more competitive

Government Targets For Broadband Roll-Out

The Government's overall objectives for the development of broadband telecommunications infrastructure are set out in the 'New Connections' document, published in March 2002. In terms of specific targets regarding availability of services, the report (in Section 1.3) states that:

> *Government wants to see the widespread availability of open-access, affordable, always-on broadband infrastructure and services for businesses and citizens throughout the State within three years, on the basis of utilisation of a range of existing technologies and broadband speeds appropriate to specific categories of service and customers. We wish to see Ireland within the top decile of OECD countries for broadband connectivity within three years.*

The New Connections document also sets a target for household usage of broadband at 5Mb in the 2012/2017 timeframe. We analyse this target in detail in Section 5.

At this time we cannot definitively judge the performance of the sector against the Government's roll-out target. However, we can comment on how much progress has been made to date and whether it seems likely that this target will be met.

As the key target of Government is based on reaching a particular comparative position internationally, we believe the best approach here is to compare our broadband take-up with that of other EU and OECD countries.

South Korea is the world leader in broadband take-up. Penetration is projected to reach 12m users by the end of 2003 - representing 25% of the population.[39] DSL accounts for 55% of the total supply market, with cable modems holding 34%. Currently, over 200,000 customers have availed of new very high capacity 20 Mbps DSL services.[40]

The table below provides figures for how Ireland's broadband take-up compares against a number of similar sized EU states.

Table 3-1 Ireland's Broadband Penetration Compared with Other EU Countries

Country	DSL lines	Other broadband	As a % of population	EU ranking	Growth in the last 6 months
Ireland	5370	4100	0.25	14	47%
Austria	207 850	330 000	6.62	6	32%
Belgium	627 970	417 897	10.19	2	19%
Denmark	389 805	168 795	10.44	1	24%
Finland	280 000	63 950	6.64	5	25%
Sweden	591 695	299 685	10	3	36%
EU average			4.65		36%

Source: EU Commission Broadband Access in the EU (as at July 2003)

The following points should be noted from this table and an analysis of related data:

- Ireland currently ranks second last in the EU for broadband penetration
- While we have enjoyed a large growth rate over the last 6 to 12 months, this must be judged against the very low level from which we were at recently - e.g. 1300 connections in July 2002
- Our growth rate in the last 6 months is above the EU average but will not lead to Ireland closing the gap on its EU counterparts in the short to medium term
- For Ireland to reach the current (July 2003) EU average penetration level, we would need to grow our broadband numbers to over 175,000 - or by 1760%
- For Ireland to reach the current (July 2003) EU best penetration level, we would need to grow our broadband numbers to over 375,000 - or a forty fold increase

However, it must be acknowledged that the level of broadband penetration throughout the EU and internationally is likely to grow rapidly over the next few years. To assess more accurately the task that Ireland faces in meeting the Government's target by March 2005, we have projected broadband penetration in the EU over the next two years. Using the figures in the table above as a base, we use a very conservative growth rate of 10% for all countries. The result is that the EU best for broadband penetration is around 12%.

[39] Point Topic (April 2003)
[40] Dotecon (October 2003)

To hit the Government's target, we estimate that Ireland will need over 450,000 broadband users in 2005 and will need to grow its user numbers almost fifty-fold from current levels.

In this section we use the number of broadband users as the main unit of measurement and comparison. In our analysis of the future usage of broadband (in Section 5) and the economic impact of that take up (in Section 2) we use number of households as the key unit.

As set out above, the current circumstances in the communications sector point strongly to a market failure in the supply of broadband. Given the potential for user uptake (see Sections 4 and 5), this holds out the prospect of a significant level of unsatisfied demand in the medium/long term. Unless this situation is addressed the Government's target for 2005 will not be achieved. Our conclusion is that a clear imperative exists for the State taking a direct role in the communications sector. In the final section of this report (Section 6) we will set out a number of recommendations for appropriate action by the Government.

Monitoring the Information Society

The research undertaken in preparing this report has uncovered a number of areas where data deficiencies may inhibit the measurement of the roll-out and economic impact of ICT and broadband in Ireland. As a result, it is important that the impact of this technology and, indeed, the development of the information economy in general is monitored. Among the areas where information is deficient are:

- Lack of clarity regarding the potential uptake and usage of broadband by consumers;
- Restricted information on the likely price of access and the structure of service supply to consumers;
- Lack of information on the likely investment response of the private sector to initiatives by the public sector;
- Uncertainty regarding uptake by industry and producers;
- Willingness of suppliers to pay for access and price elasticities;
- Metrics regarding the impact of broadband on competitiveness and economic measures such as employment, productivity, investment, regional location of production and entrepreneurship.

In the context of developing broadband, it is clearly important that the response of the sector to policy interventions is monitored and that there is good information on the development of the sector and its economic contribution. While accepting that some of the deficiencies will only be addressed as the development progresses, lack of data inevitably inhibits economic valuation.

One way that is being developed to get around this is to develop indicators of developments in the economy. One example is the new economy index for US states[41]. This approach surveys 21 indicators that are deemed to be related to the growth of the information economy. These are divided into 5 categories:

1. Knowledge jobs:
2. Globalisation:
3. Economic dynamism and competition:
4. The transformation to a digital economy:
5. Technological innovation capacity:

Even a cursory glance at this list indicates that the focus is much wider than just technology and its application. The clear message is that policy to develop IT and its application in the economy should not be seen as a separate area to be ring-fenced in terms of policy creation and delivery but as part of the overall strategy for the enhancement of the wealth creation capacity of the economy into the future.

[41] Atkinson, R. (2002) *The 2002 State New Economy Index*

A set of indicators has been identified for Ireland, mainly based on work done in the US. The list is summarised in Table 3.2. Some of the indicators identified may be usefully compared with competitor economies – these are identified as comparison indicators in this table – while others would require time series analysis and are identified as trend indicators. They can be used as a guide to the role of policy and to where deficiencies may exist, and to the response of the economy following intervention.

Table 3-2 Indicators for Assessing Ireland's Progress of the New Economy

Description of Indicator	Comparison	Trend
Consumer Indicators		
Access to computer and to Internet (% of households)	✓	
Potential household broadband access (% of households)	✓	✓
Actual broadband uptake (number, % of households)	✓	✓
Access to broadband in Dublin and outside Dublin		✓
Adoption of new technologies	✓	
Online purchases by households (value)		✓
Use of online financial services e.g. banking online		✓
Flexible work patterns e.g. part-time or self-employment	✓	✓
Computer literacy (% of population with computer skills)	✓	✓
Education (schools with internet, pupils per computer)	✓	✓
Access/Use of e-Health services	✓	✓
Use of e-Government services	✓	✓
Business Indicators		
Corporate investment in R&D		✓
Business to business e-procurement (% of purchases)	✓	✓
Business to consumer transactions (value)		✓
Business to consumer transactions (% of total sales)	✓	
Businesses with an intranet (by size of business)	✓	✓
Trends in business inventories (as % of GDP)		✓
Number of registered trademarks		✓
Venture capital to high tech sector (value)		✓
Percentage of business with outsourcing relationships	✓	✓
Inward FDI in high tech sectors (value)		✓
Structural Indicators		
Investment in the ICT sector (% of total)	✓	✓
Internet hosts per 1,000 inhabitants	✓	
Share of output from high tech MNCs		✓
Share of output from SMEs in high tech sector		✓
Employment in high tech MNCs (number, %)		✓
Employment in SMEs in high tech sector (number, %)		✓
Value added by high tech sector as % of total		✓
Employment by enterprise size	✓	✓
Number of enterprises by size		✓
Number and proportion of Science and Technology graduates	✓	✓
Change in VAT registration per annum		✓
Employment by skill level	✓	✓
Relative Manual/non-Manual earnings	✓	✓
Government R&D expenditure	✓	✓
Online availability of government services	✓	

This list should be treated as preliminary and further research would be required to finalise the indicators in advance of evaluation. In addition, decisions would be required in respect of the relative importance of individual measures to assist appraisal.

As a preliminary measure, Table 3.3 provides values and commentary based on the work of the National Competitiveness Council[42]. The ranking provided refers to the value achieved by Ireland relative to other OECD economies for which a comparable measure was available.

Table 3-3 Ireland's New Economy Relative to Other OECD Countries

Indicator	Value	Rank
Number of PCs per 100 population	39.1	6th of 16
Number of internet users per 1,000 population	289.5.	12th of 16
Broadband penetration per 100 population	0.01	15th of 16
ISDN subscribers, % change 1998-99	196.6	1st of 8
Mobile telephones per 1,000 population	753.5	5th of 16
Compound annual growth of mobiles 1995-2001	61.5	6th of 16
Internet hosts per 10,000 population	33.7	9th of 16
Business to consumer transactions (US$ per 1,000 population)	20	3rd of 9
Business to business transactions (US$ per 1,000 population)	360	8th of 9
% of SMEs connected to internet	58	3rd of 10
DSL as proportion of total lines	0.06	10th of 10
ICT expenditure as % of GDP	5.7	11th of 16
ICT employment as % of total	4.6	6th of 14
Telecom investment 1995-1999	101.5	1st of 10
% of population aged 25-34 with 3rd level education	29	8th of 13
Science and Engineering as % of total degrees awarded	26.9	5th of 15
New science and technology PhDs per 1,000 population	0.61	6th of 12
FDI inflow (% of GDP in 2000)	21.7	1st of 16
Venture capital as % of GNP (1999)	1.5	4th of 10
Share of foreign affiliates in manufacturing R&D (1997)	58.5	11th of 12
High tech investment as % of total (2001)	81	1st of 7
Patent applications per million population	87.6	10th of 12
Expenditure on R&D as % of GDP (1997-2000)	1.39	11th of 16
Labour productivity (% change 1996-2001)	26.2	1st of 12
GDP per person employed in manufacturing 2001 (US$ 000s)	70.5	3rd of 16
GDP per person employed in services 2001 (US$ 000s)	55.7	5th of 16)
Total export growth 2001 (%)	12.1	5th of 16
Export services growth 2001 (%)	8.3	7th of 16

These indicators provide a mixed picture of Ireland's progress in the development of the information society relative to other countries. As has been widely discussed, performance in this period in respect of aggregate measures of output, investment and productivity was very good in Ireland. On core IT measures such as access to and use of technology it generally achieves a mid-table outcome indicating that there are deficiencies. The lowest positions are with respect to usage of broadband and high speed lines. Some supporting requirements such as education levels and R&D in technology also display weaknesses. Further analysis indicates that this research weakness is particularly noticeable in indigenous firms.

[42] The main source is National Competitiveness Council (2002) *Annual Competitiveness Report 2002*

These findings are supported by research and international comparisons carried out by IMD[43]. This research ranks Ireland as the 11th most competitive economy – among countries with populations below 20 million – down from 9th in 2002 and 5th in 2000. The greatest weaknesses are identified in the area of infrastructure where Ireland is ranked 18th of the 29 small countries. This weakness is seen across all areas of infrastructure apart from education with Ireland ranked 18th for technology infrastructure and 17th for scientific infrastructure. Most notably, Ireland was placed in last place, i.e. ranked 29th, for the availability, speed and cost of internet access.

The overall conclusion from this area of research is that although there have been improvements in Ireland's performance compared with some years ago, Ireland still lags developments in other OECD countries in the development of the information society. Provision of infrastructure is a major weakness but cost of access to technology and supporting areas such as R&D and scientific education are also inhibiting progress and competitiveness.

Conclusions

Despite flat-rate narrowband internet access services only becoming available in Ireland recently, of the order of 40% of Irish homes use the internet today. Given this and a number of other factors, SMEs and residential consumers are likely to be eager users of broadband in the right circumstances.

Ireland also compares well with other countries regarding availability and pricing of very high capacity international broadband services.

Similar to many other EU countries, Ireland currently has a variety of network platforms providing broadband services nationally. Of these, the fixed telephone network and cable TV networks provides by far the most likely platforms for significant supply of broadband. To date in Ireland, very little investment has taken place in cable TV networks. As a result the dynamic of network-based competition for broadband, which drives take-up in many EU States, is almost completely absent in Ireland. Thus, the imperative on the fixed incumbent to invest in broadband upgrades, and to drive consumers to take up DSL services, is significantly reduced.

Having presented the availability of services across various platforms, we make a number of observations about broadband availability and choice:

- service availability follows population density
- large parts of the country do not have access to any terrestrial broadband service
- choice of service provider is generally very limited

These observations lead on to a number of conclusions about the market for supply of broadband in Ireland.

[43] "World Competitiveness Yearbook 2003". IMD, 2003

When added to the analysis of potential future take-up of broadband (in Sections 4 and 5) and the analysis of the potential economic value of broadband (in Section 2), current levels of supply point to evidence of a market failure in broadband - where supply is failing to meet a latent demand.

The supply market, as evidenced by the step change seen in price levels and take-up elsewhere, is characterised by significant economies of scale to suppliers as usage increases. These would allow for significant price decreases, however, these decreases will only arise where demand grows by large amounts. The development of the Irish industry to date suggests that this may be an appropriate analysis since it explains why charges are high and take-up is low even in areas where the technology is available, but there has been little evidence of new market entrants emerging.

A second market failure arises due to social benefits that will arise but will not accrue to private developers since they cannot be charged for. Many of these social benefits can be described in terms of a more inclusive society that overcomes the current problems of social and regional imbalance. Overcoming the imbalance that has emerged has been given prominence in Irish economic policy in recent years in under the regional and social inclusion programmes contained in the *National Development Plan* and in the *National Spatial Strategy*.

We conclude that these market failures are very unlikely to be addressed by the industry in the short to medium term. Ultimately, it falls to Government to try and resolve the situation.

The Government's target for the sector is to see the widespread availability of affordable, always-on broadband within three years. Specifically, they wish to see Ireland within the top decile of OECD countries for broadband connectivity within three years. Based on an analysis of comparative data for a number of EU states, we draw the following conclusions:

- Ireland currently ranks second last in the EU for broadband penetration
- While we have enjoyed a large % growth rate over the last 12 months, this must be judged against the very low level from which we were at recently
- Our % growth rate in the last 6 months is above the EU average but will not lead to Ireland closing the gap on its EU counterparts in the short to medium term

To assess more accurately the task that Ireland faces in meeting the Government's target by March 2005, we have projected an EU best broadband penetration of 12% by 2005. To hit this target Ireland will need over 450,000 broadband users - an almost fifty-fold increase from current levels.

As set out above, the current circumstances in the broadband sector point strongly to a market failure in the supply of broadband. This holds out the prospect of a significant level of unsatisfied demand in the medium/long term. Unless this situation is addressed the Government's target for 2005 will not be achieved.

The research undertaken in preparing this report has uncovered a number of areas where data deficiencies may inhibit the measurement of the roll-out and economic impact of ICT and broadband in Ireland. As a result, it is important that the impact of this technology and, indeed, the development of the information economy in general is monitored.

A set of indicators has been identified for Ireland, mainly based on work done in the US. Some of the indicators identified may be usefully compared with competitor economies – these are identified as comparison indicators in this table – while others would require time series analysis and are identified as trend indicators. They can be used as a guide to the role of policy and to where deficiencies may exist, and to the response of the economy following intervention. The indicators should be treated as preliminary and further research would be required to finalise them in advance of evaluation.

The overall conclusion from this area of research is that although there have been improvements in Ireland's performance compared with some years ago, Ireland still lags developments in other OECD countries in the development of the information society.

4 How many Broadband users will there be?

The Irish Government has stated a target for the number of people using broadband (see previous Section). However, given that Internet use is at a relatively early stage of development in Ireland, the social and economic importance of Government ambitions for broadband is sometimes questioned. Broadband need is apparent in early-adopting, highly technology literate parts of Irish society. However, to date in the mainstream a need has not emerged. The question regarding whether this need will develop in the mainstream of Irish society is addressed – "How many broadband users will there be?".

This chapter will build evidence of underlying trends to generate a projection of the number of broadband users in Ireland over 20 years. It adopts the perspective of the consumer, and generates projections for the growth of demand should supply be unconstrained.

This projection can be adapted and used as an ongoing template for consensus between stakeholders (e.g. Government policymakers and private firms).

At the heart of the question as to how pervasive would broadband be in society, is the extent to which user behaviour changes as a result of adoption of technology. We profile the evolutionary process whereby consumers' behaviour changes with maturity of technology usage.

The methodology adopted consisted of the following steps:

1. Analysis of the factors underlying adoption
2. Research of adoption drivers
3. Comparison with international experience
4. Consultation with the industry

The consultation with industry included the following players:

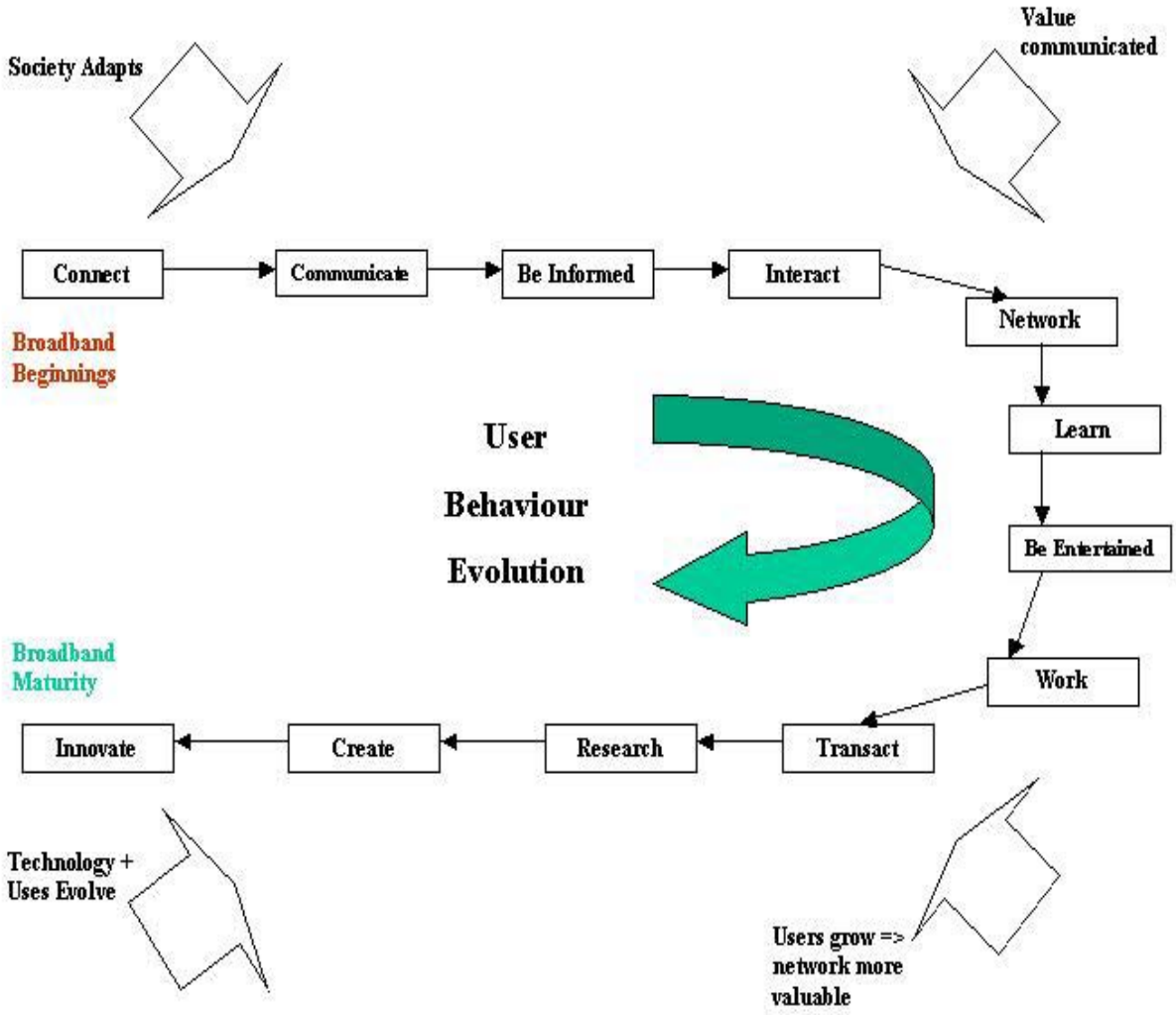
Telecom Operators	(e.g. EsatBT, Eircom)
Telecom Equipment Manufacturers	(e.g. ST Microelectronics, Aware)
User Device Manufacturers	(e.g. Intel, Cypress Technologies)
Application Developers	(e.g. Enteraktion, Microsoft)
Visionaries	(e.g. Vint Cerf, Reed Hundt, Alistair Glass)

Factors Driving ICT Adoption in Society

At the heart of the question as to how pervasive would broadband be in society, is the extent to which user behaviour changes as a result of adoption of technology. Users derive more value and need from ICT with maturity of usage. There are network effects driving the adoption of any technology in society.

The following figure illustrates the factors driving this change for consumers from broadband beginnings to maturity:

Figure 4-1 Consumer Behaviour Influenced by Technological and Society Change

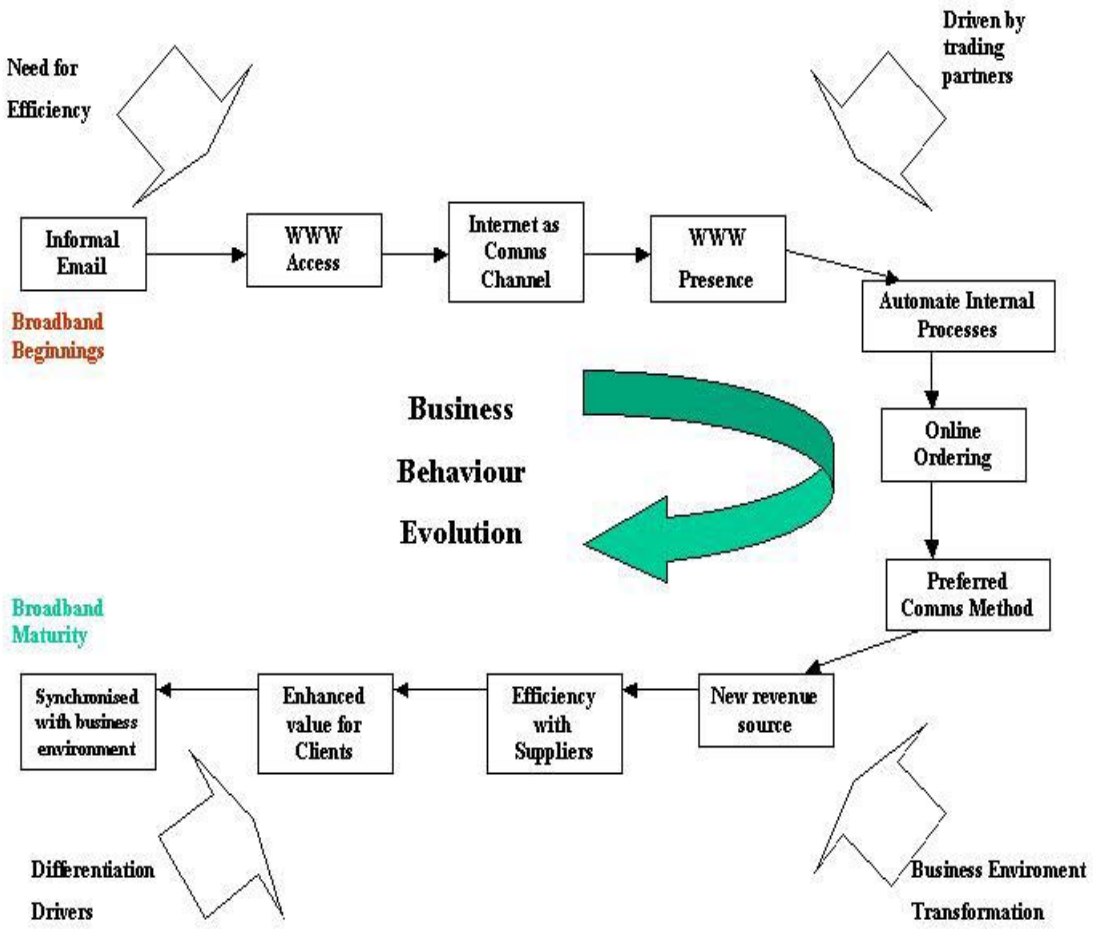


Source: Sonas Innovation

As can be seen from Figure 4.1, use of ICT in the home is an evolutionary process. Users become more accustomed to the technology and can put it to more effective uses with familiarity. An ICT and broadband user will have higher communications requirements over time, and will become more dependent on broadband. The value of each of these activities becomes higher as more people are connected to the network.

There are similar drivers for the business user as can be seen from the following figure:

Figure 4-2 Business Behaviour Influenced by Technological and Economy Change



Source: Sonas Innovation

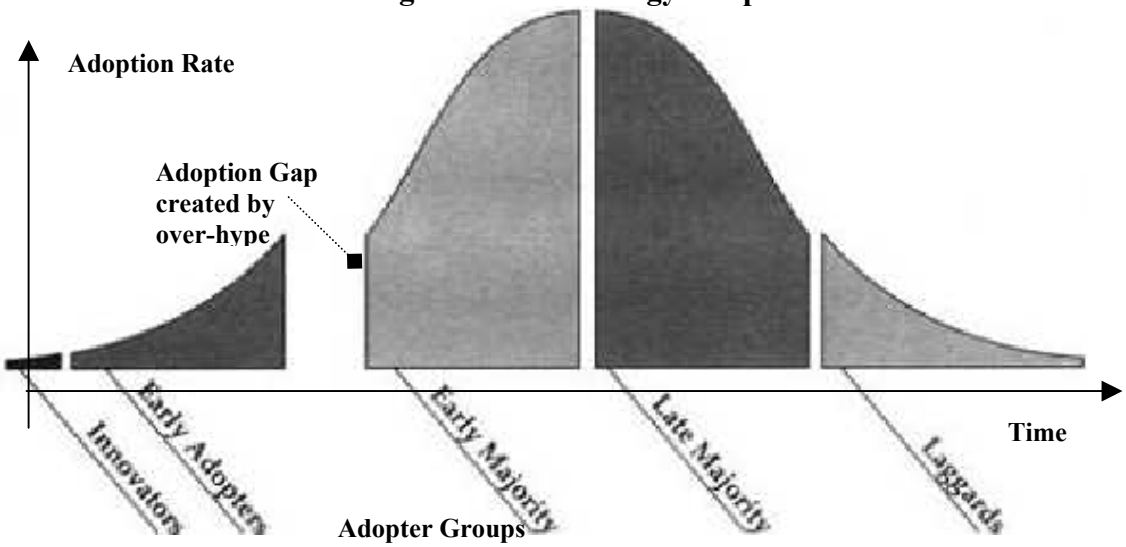
An evolutionary pattern for broadband adoption exists for the business user. Again, it is driven by the utility which can be gained from the system as the business's capabilities increase, and the environment itself becomes more pervasive to broadband.

This "network effect" is described by Metcalfe's Law, which describes how the value of the network is equivalent to the square of the number of people using the network. This effect drives accelerated uptake of ICTs in society as increasing numbers of people adopt.

Adoption Patterns

Any new technology introduced in a society will go through a process of adoption over time. Those segments, or groupings of people, more disposed to adopt and use the technology adopt earlier. These segments are sometimes referred to as 'Innovators', 'Early Adopters', 'Early majority', 'Late Majority' and 'Laggards'. The rate at which a technology is adopted is plotted over time in Figure 4-3 Technology Adoption Curve

Figure 4-3 Technology Adoption Curve



Source: Kotler et al

Similarly with characteristics of adoption of other technologies, consumers' perception of broadband as a technology of value will drive its adoption successively through the segments of the society who are most disposed to deriving these benefits. The fundamentals behind this approach will later be utilised to determine the total numbers of broadband users for Ireland.

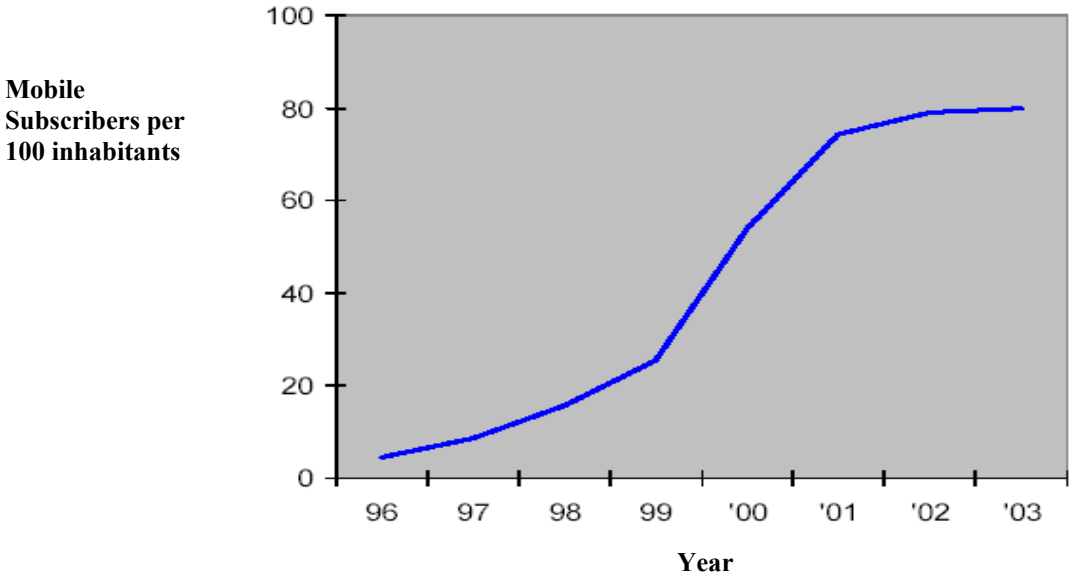
The adoption gap indicated in the figure (above) also highlights the phenomenon of over-hyping of technologies. During the adoption gap, the extent to which the technology will become fully adopted in society is questioned.

There are many other experiences of technology adoption which can inform likely adoption of broadband. Devices including the mobile phone, the video cassette recorder, the colour television, the compact disk player and the personal computer have all undergone a process of adoption over time. The pattern where technologies form an "S curve" in the early to middle stages of adoption, as benefits of a technology are dispersed throughout segments of a society, is well accepted by technology business and by academia.[44]

[44] Frank Bass – Diffusion Model

Broadband and mobile communications have some similar characteristics in terms of potential for "personal" experiences and communications utility. The adoption of mobile phones by users in Ireland, as seen in the next illustration was rapid.

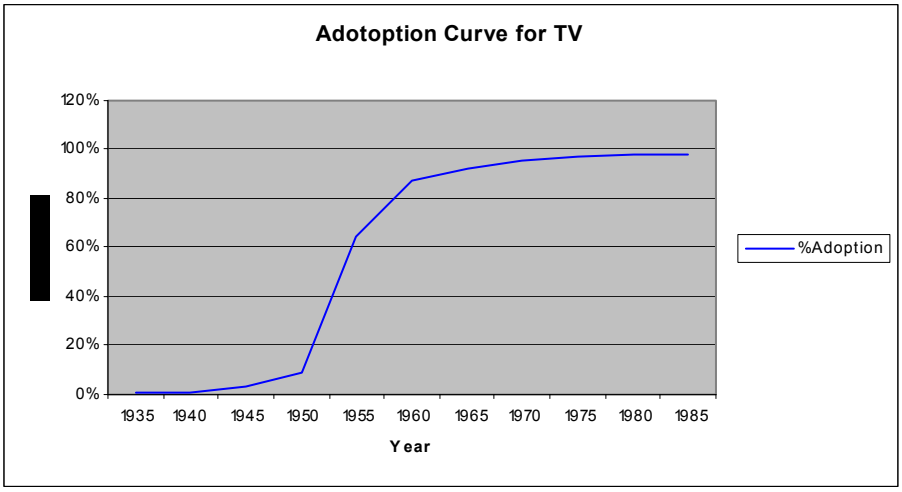
Figure 4-4 Number of Mobile Phone Subscribers



Source: Comreg Quarterly Data Reports

There is evidence to suggest that entertainment in the home will be transformed by broadband technologies in the next twenty years. According to Tom Walsh, CEO of Enteraktion (who produce interactive 3D video entertainment), "Kids will demand the same 3D immersive video entertainment experience on the TV that they have become accustomed to from computer gaming". He believes that the consumer of the future will demand an interactive entertainment experience. As such, adoption of colour TV may have similar characteristics to the adoption of broadband. The following illustrates the percentage adoption of colour TV in households in the US:

Figure 4-5 Adoption of Television by Users (in the US)



Source: Nielsen Media Research-NTI, Jan. each year

The characteristics of these technology adoptions (rate and extent of adoption) give a good indication of how broadband would become adopted.

Broadband has been available in other developed countries for some years before it was introduced in Ireland, so these adoption experiences will inform the view for adoption in Ireland. The US Federal Communications Commission states, in relation to broadband growth rates, "At this pace, consumers are adopting current broadband technologies at a faster pace than CD players, cell phones, colour TVs and VCRs."[45]

Research by McKinsey shows that "At the current pace of growth, broadband will achieve 25 percent penetration in the United States within 6 years of its commercial launch. PCs reached this level in 15 years, mobile telephones in 13, and the World Wide Web in 7."[46]

There are a number of other drivers which may impact on broadband provision and take up

- Plant Renewal - It is likely that the economics of plant renewal for communications operators will become a key driver in the promotion of broadband in the medium to long term. This was previously experienced at the time of the roll-out of digital exchanges in Ireland in the 1980s, when the previous generation of mechanical switches became expensive to operate and maintain. A consensus view is that all communications (including phone and cable TV) equipment being purchased in 5 years will be broadband ready. Older plant and equipment will become too expensive, and upgrades will happen to control costs.

- Generation X - Demographic factors may have the effect of driving broadband, given the widespread use of broadband-related technology by youth. Research in the US shows that ninety percent of children between the ages of five and seventeen now use computers proficiently.[47] These young users will mature and accelerate the acceptance and need for broadband in the mainstream. This effect will accelerate the arrival at a "Tipping point" (i.e. where there are sufficient broadband users to form a critical mass of users in a society – generally reckoned at 35%). The case study on the use of IT by schoolchildren in New Zealand (Section 5) illustrates the increased value accruing to use of ICT in the classroom once it is used by all students pervasively.

- New Broadband Technologies - While the current generation of Internet technologies are more closely aligned with the personal computer, the next generation, involving broadband communications links and an array of broadband enabled devices in the home, are generally expected to have different uses and benefits, and will follow a more accelerated adoption path. ST Microelectronics plan that there will be a number of devices in the home which will be networked together to a broadband pipe. Intel's product roadmap sees the low cost of broadband-enabling devices driving high speed connectivity capability to multiple digital devices in the home. Eircom see this as an

[45] UNDERSTANDING BROADBAND DEMAND - Review of Critical Issues" Office of Technology Policy U.S. Department of Commerce, September 2002

[46] "Making sense of Broadband", McKinsey Quarterly, June 2003

[47] "Understanding Broadband Demand: Broadband & Business Productivity", US Technology Administration, March 2002

area of opportunity such that devices will be able to rival the utility of mobile devices. Research of the underlying evolution of technologies underpinning broadband (e.g. usage of new devices, increased utility of the network as more applications become possible) is outlined in the next chapter, in the section titled "Evolution of Technology".

Projection for Broadband Adoption in Ireland

We conclude this section by drawing together the various strands presented in this Section and the Model for Estimating Consumer Surplus (see Section 2). Two scenarios of broadband take up are presented.

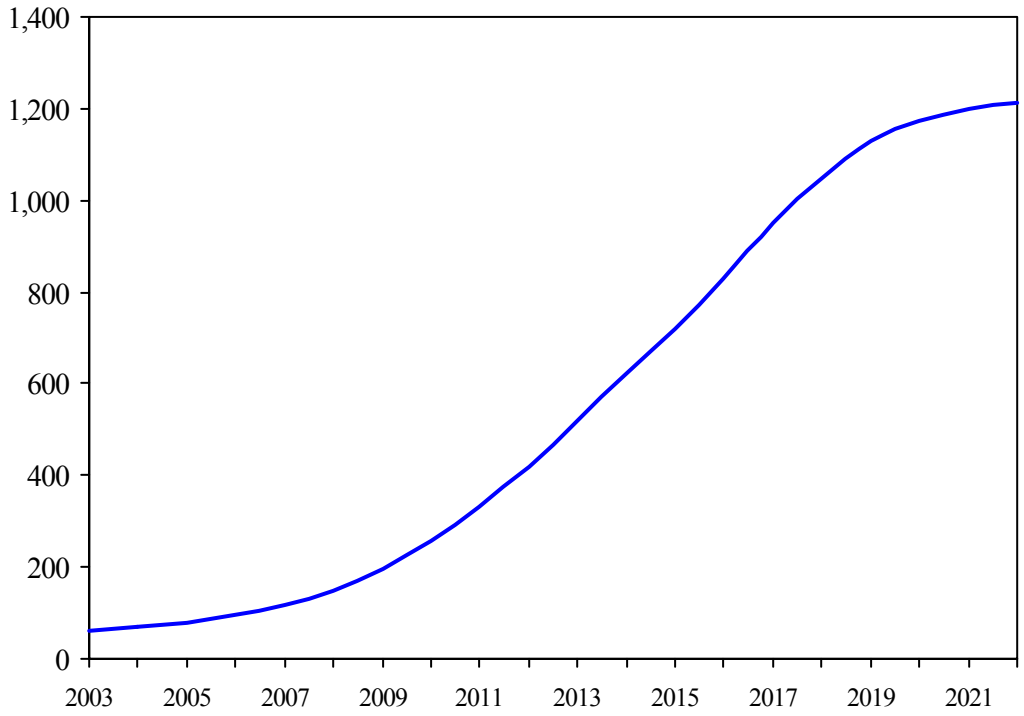
Our analysis is a demand-side analysis. It is based on the evolution of demand without reference to the actual or projected supply conditions in the market. While this is a projection for the future, the speed at which adoption will happen will obviously be significantly influenced by market conditions and Government policy. A key value which this adoption path may bring is a consensus view between all stakeholders on the timeframe over which we can accurately target progress towards broadband objectives.

The first projection assumes a penetration rate of 90% of households is achieved indicating 1.2 million active broadband household connections in 2024. It is also necessary to set out an appropriate profile of connections for the period. We assume a 5% connection rate in the first year of operation (2004), equivalent to just over 60,000 connections. To achieve 90% household penetration in 20 years would require constant annual growth of almost 17.1% per annum for the full period. However, this assumption of a constant rate of growth appears unlikely and it is more likely that after a slow start the rate of growth would accelerate before slowing as it approaches its steady level of penetration.

This approach is in keeping with the Kotler adoption curve referred to above and the example product life-cycles presented. Eventually, lower prices, due to economies of scale, and the availability of richer content attracts the mass market. Then as the technology matures and the market approaches saturation the annual rate of growth falls towards a steady state.

The number of connected households in each year under this approach is shown in Figure 4.6 on the next page. This approach is further described in Appendix 2 of this report.

Figure 4-6 Number of Broadband Connections (000s)



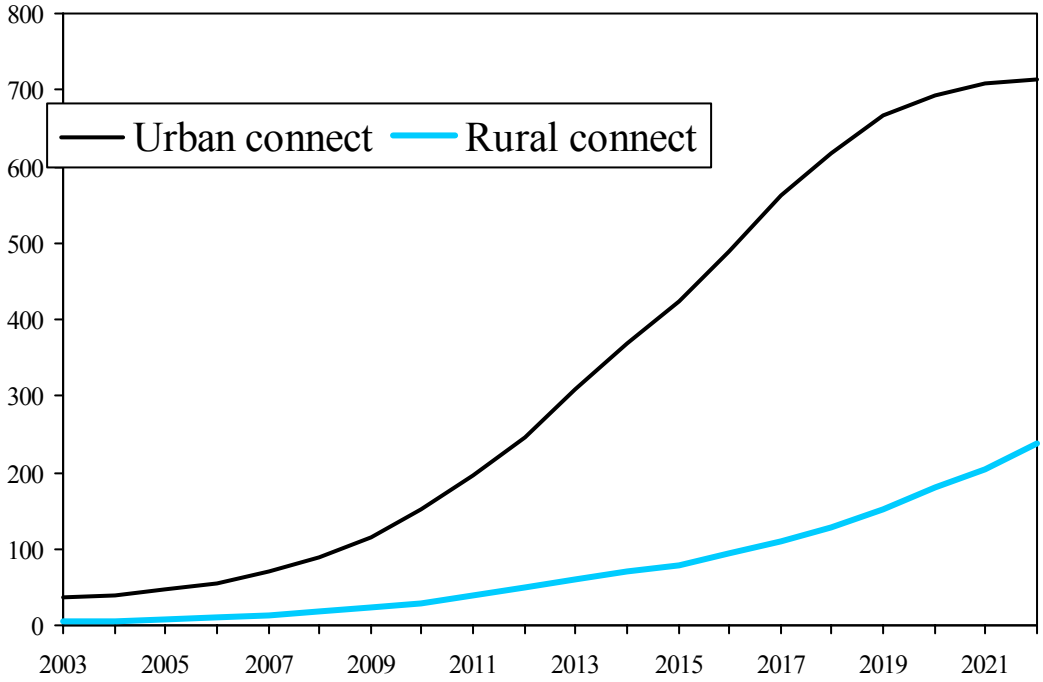
In summary, this graph projects the household take up and penetration levels set out in the table below:

Table 4-1 Summary of Adoption Projection

Year	Number of connections	Household Penetration (%)
2007	117,000	9%
2012	417,000	32%
2017	951,000	72%
2022	1,200,000	90%

The second projection of household uptake recognises that there are issues related to accessibility in areas of low population density. The assumptions here are that while penetration in towns rises to about 40% in the first 10 years and 90% in the following 10 from a base of 5% in the first year i.e. at the same rate as was assumed for all households in the first calculation, it reaches only 10% of rural households in the first 10 years and 50% after 20 years from a base of 1% in the first year. This gives the number of household connections as shown in Figure 4-7 Number of Broadband Connections (000s) – With rural population adjustment:

Figure 4-7 Number of Broadband Connections (000s) – With rural population adjustment



In summary, this graph projects the household take up and penetration levels set out in the table below:

Table 4-2 Summary of Adoption Projection with Rural Adjustment

Year	Number of urban households	Number of Rural Households	Overall Household Penetration (%)
2007	69,000	14,000	7%
2012	246,000	50,000	23%
2017	561,000	110,000	51%
2022	714,000	239,000	72%

Conclusions

At the heart of the question as to how pervasive would broadband be in society, is the extent to which user behaviour changes as a result of adoption of technology. Users derive more value from ICT with maturity of usage. We present two figures which illustrate the factors driving this change for consumers and businesses from broadband beginnings to maturity:

Any new technology introduced in a society will go through a process of adoption over time. There are many other experiences of technology adoption which can inform likely adoption of broadband. Devices including the mobile phone, the colour TV, and the PC have all undergone a process of adoption over time and we use a number of these to drawn parallels for broadband adoption. We also draw on experience to date with broadband adoption in other countries and profile a number of other likely drivers of broadband adoption.

We conclude this section by drawing together the various strands presented in this Section and the Model for Estimating Consumer Surplus and by setting out two scenarios of broadband take up.

The first projection assumes a uniform national take-up of broadband and projects a penetration rate of 90% of households is achieved in 2024. The interim steps towards this long-term projection are as follows

Year	Number of connections	Household Penetration (%)
2007	117,000	9%
2012	417,000	32%
2017	951,000	72%
2022	1,200,000	90%

The second projection of household uptake recognises that there are issues related to accessibility in areas of low population density. The assumptions here are that while penetration in towns rises to about 40% in the first 10 years and 90% in the following 10 from a base of 5% in the first year i.e. at the same rate as was assumed for all households in the first calculation, it reaches only 10% of rural households in the first 10 years and 50% after 20 years from a base of 1% in the first year. This gives the number of household connections as shown below.

Year	Number of urban households	Number of Rural Households	Overall Household Penetration (%)
2007	69,000	14,000	7%
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2017	561,000	110,000	51%
2022	714,000	239,000	72%

5 How Much Broadband is Needed?

The Irish Government has identified, in the "New Connections" document, an objective of 5 Mbps to the home in the 2012 – 2017 timeframe. Players with different interests have questioned whether such a need exists or will develop in the future.

This section addresses one of the key requirements of the Terms of Reference - to identify the short and medium term broadband capacity requirements for residential/SME users. We approach the question from the perspective of how demand could evolve should broadband be freely available at an economic price.

Our aim is to develop a projection that can be adapted and used as an ongoing template for consensus between stakeholders (e.g. Government policymakers and private firms providing services).

The methodology adopted consisted of the following steps:

1. Analysis of Broadband application trends in key sectors (e.g. education and health)
2. Assessment of broadband usage trends
3. Consideration of the evolution of technology

Key Application Areas

In the previous Section, the evolution of user needs was examined. This describes how it takes time to initiate use of a technology, experiment with it, adapt its capabilities to benefit specific uses, discover new ways to do current tasks, and employ the technology to enable completely new uses (sometimes referred to as "applications").

Analysis of some key application areas will further illustrate this. Chosen areas are:

1. Education
2. Health
3. Communications
4. Teleworking
5. Entertainment

Education

Increasingly the educational system will involve technology in its core activities. As learning is an information-based activity, the effective harnessing of ICT can deliver much improved pedagogical results. In business today, any competitive information-based company will be a very high user of ICT and broadband to deliver higher quality services.

The case study on students in a school in Tallaght (see next page) shows the way use of broadband and IT has had a significant impact on the approach to education in one school in Ireland. As evidenced in the case study of students in New Zealand, student laptops and an

ICT enabled curriculum allow for digitally literate students to become better prepared for a technology-based workplace.

The potential is that a knowledge network could be established, supporting the work of teachers and improving accessibility and quality for students. Teachers could contribute diversely to pedagogical materials, students could teach each other, and technology could become a learning enabler in the classroom. Students could choose to be taught by teachers outside their school, technology could allow for tangible benefits including access to a wealth of pedagogical resources which would be otherwise unavailable. Broadband usage could mean a higher quality educational system for Ireland. An interest in science, and innovation in all fields would result.

Case Study – Broadband changes internet use in Tallaght school

Saint Mark's Senior National school is based in Tallaght in West Dublin. It was founded in 1973 and today has 420 pupils, ranging in age from 9 -12 years of age. It has twenty one teachers.

The school's ICT development started in 1997 with the purchase of 5 computers. Today the school has a broadband service based on a cable modem (512K) from NTL. The school building is fully networked and every classroom has 2 computers and access to broadband internet.

The change to broadband has had a huge impact. According to the Principal, Richie Walsh, "Before we got high speed access we never bothered to use the internet. You could spend ten minutes downloading a web page. A teacher can't wait that long in a classroom situation. It would completely lose the children's attention".

The school makes heavy use of IT and communications technologies as an aid to education. The school's website (www.saintmarks.ie) includes a School News section which allows students, teachers, and parents to keep up to date with what is happening in the school. The news is produced weekly by different classes and is uploaded onto the website.

Weekly school assemblies make heavy use of technology with video clips and slide shows a central part of the proceedings. This approach provides a much more attractive and interesting presentation of material for children. Vast resources are available at the teacher, and students' fingertips in the classroom.

Case Study – NZ school sees digital literacy as an essential life skill

St Cuthberts Junior school is an independent girls school in Auckland, New Zealand. The school has 600 students aged from 5 to 12 years.

Consideration of how new technologies could be used as part of the education process, led, in 2000, to the school beginning a trial using laptops. The trial followed a lot of analysis of the principles underlying the use of IT in education and a detailed consideration of the learning environment. Today all students in the junior school have an Apple iBook laptop computer.

The extent to which ICT has now become important to the learning process in the school is highlighted by the high usage of the laptops. The laptop is used for about 70% of class time.

The school has established its own high speed wireless network which allows students to log on and use their laptops at any point in the school campus. This supports the concept of "anywhere anytime learning". The School's aims in this regard are to develop (i) Genuine integration of ICT into the curriculum, (ii) Digitally literate students, and (iii)

Liz Battersby, Head of the Junior School is convinced of the importance of ICT in education, "We believe that digital literacy is an essential life skill. Traditionally girls were not moving into jobs in the technology sector. We want students to be well prepared for careers in these sectors".	No wait time for access to ICT resources Each class has their own section on the school's website (www.stcuthberts.school.nz)

Health

The distributed nature of the health service is such that there are multiple service locations and organisations, all of which rely on data regarding the patient for treatment. Creating a unified view of the patient, which would be accessible where appropriate from any health organisation could allow for a higher quality, more efficient service. In business today, any competitive company with such a distributed structure will be a high user of ICT and broadband to allow for coherence and synchronisation of activities.

Access to broadband technologies could empower Irish health practitioners with relevant and timely information in whichever organisation they work. In Section 2 (Why Does Broadband Matter?) we provide estimates for the savings which could result from investment in ICT in this sector. Our case study on the Southern Health Board (Section 2) illustrates the value of broadband to a multi-faceted healthcare authority. Centralised medical records, collaboration between medical teams, ongoing professional updates and learning, remote access to medical results and records, and a consistent view of the patient whatever part of the system he or she engages with are all possible. Broadband could mean easier and more efficient access to a higher quality health service.

Communications

Communications effectiveness is increased significantly by adoption of technology. Usage of mobile technology in Ireland has reached very high levels of usage (80% of population adopting within 6 years). It is likely that the popularity of using ICT to aid communications will reach a wider audience once broadband is accessible in the home.

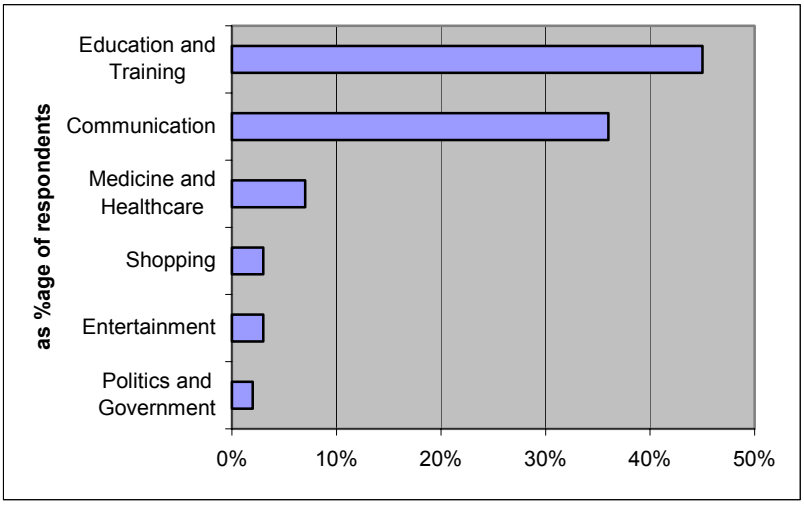
Communications is widely regarded to be one of the applications that will gain mainstream adoption once there is a sufficient number of users in society online with broadband. Dr. Bill Mularie, CEO Telework Consortium in the US believes: "… I think the killer application is …. human-to-human communications."[48]

People today are avid users of technology to aid communications. Society now expects instant, and quality communications. Broadband will allow for a myriad of new uses. Sharing home videos with friends and family via broadband could be one such example. Consumer uses will be unpredictable in the same way as text messaging gained in popularity.

[48] "UNDERSTANDING BROADBAND DEMAND: Broadband and Business Productivity" Office of Technology Policy U.S. Department of Commerce, March 2002

The potential for the Internet as a communications medium is commonly recognised as seen from the following study of users projections of how the Internet will be used in the future:

Figure 5-1 Forecast of Internet Purpose in 2011



Source: SBC Communications, 2001

In the Celtic Manuscripts case study (Section 1), a business located in a remote part of Ireland is heavily reliant on ICT to ensure that they are competitive. The lack of affordable broadband, and the communications enabled by it, is threatening their growth and survival.

In the case study below, broadband has proven to allow for continued communication between children in hospital and their school environment.

Case Study – Broadband helping sick children keep up with school

The Centre for Health Informatics at Trinity College Dublin (TCD) and a number of hospitals, including Temple Street Children's Hospital, have partnered in a project using ICT to allow children in hospital to maintain contact with their friends and family. The project is known as Áit Eile and began in September 2000.

The project involves using communications links to allow children to access the internet through a secure portal. The children can use the facility to send emails, access games and educational material (including creative writing and arts and crafts applications), and in some cases have video phone calls with children in other hospitals and friends. A bulletin board feature allows access to news and information on health matters. The children can use the portal to share experiences about their stay in

As a result video calls to friends are available to children at Temple Street.

Broadband's capabilities to increase levels of communications are described by Paula Hicks Project Manager, TCD, "Video conferencing technology has been available for years. Broadband has now made it more accessible to people. Áit Eile allows kids and teachers, who don't have a lot of IT skills, to set up a video link with the click of a button".

Following a child's encounter with the Áit Eile experience, the partners hope to have achieved at least one of the following objectives (i) Improved Communication, (ii) Socialization with Peers, Family and Healthcare Professionals, and (iii) Improved Self-Esteem

hospital with other children. To facilitate a fuller participation in the project, Temple Street Hospital has installed a broadband connection.	The partners are also looking at extending this project, using wireless technology, to allow children in isolation wards gain access to the portal. Further links to homes and schools are planned for the future

Teleworking

Broadband technology can allow for much greater flexibility and productivity. Research from the US shows that the most significant driver for consumer broadband adoption has been teleworking.[49] Research in Europe projects that the number of teleworkers will rise from 4.5 million in 2000 to 17.5 million in 2010. [50]

With the current pattern of urbanisation in Ireland, transport infrastructure will come under increased strain. There is increasing pressure on professionals to locate in an urban environment. However, lifestyles are changing to give rise to a higher attractiveness to working from a rural area. The positive impacts of broadband-enabled teleworking would include:

- Protect the environment – reduce traffic / congestion
- Improve work-life balance – allowing for family-friendly working arrangements
- Build on the country's reputation as a digital island
- Encourage rural sustainability and enabling rural development

In the Mission Critical case study (Section 3), a Dublin-based company could not make full use of its office in Meath due to lack of cost-effective broadband infrastructure. As a result, two employees from Meath have to commute to HQ in Dublin each day.

In the Bealtaine case study (Section 3), there is a clear competitiveness problem when compared with the range and quality of services on offer to international competitors, as illustrated in the case study on the Swedish home worker (see Section 5).

Entertainment

Entertainment uses are often the first to exploit new technology. Gaming has reached a high level of popularity in Ireland, with statistics showing that the country is second only to Japan in the penetration of Playstation devices. Gaming has heightened expectations of our youth, who now see the 2-D TV entertainment as increasingly boring. Even with DSL-speed broadband, enlarging video images to the full size of the computer monitor (between 13 and 21 inches on the diagonal) will vastly degrade the video quality. Quality expectations on a consumer entertainment device is impossible to meet.[51] The creation of an interactive 3-D video experience for the consumer is underway and will drive the need for broadband in the home.

[49] In- Stat/MDR, June 2002
[50] EU Emergence Project, May 2000
[51] From consultations with entertainment company

Standards have been established for transmission of video signals (MP4), require a 6 Mbps stream to accommodate one High Definition Television (HDTV) channel. It is generally accepted in the industry that for any entertainment use, that 4 such channels in operation at any time would allow for the need for a 24 Mbps pipe into the home. [52]

File-swapping is an application increasing exponentially in usage as illustrated in Figure 5-4 Application driven network growth. The increase in devices projected in Evolution of Technology indicates that devices requiring file-sharing will be gaining increasing adoption in the home, increasing the need for bandwidth.

Entertainment has already proven to be one of the first application areas to drive broadband take-up. In South Korea, a study by Netvalue in May 2001, the usage of high bandwidth entertainment applications is very significantly higher in South Korea, where broadband usage is significantly higher than in the US or the UK.

Table 5-1 Internet Usage as % of Internet Users

Application	South Korea	US	UK
Audio-video	73.9%	23.8%	29.5%
Games	54.1%	5.8%	4.1%
File transfers	39.2%	22.8%	21.4%

Research by In-Stat MDR concludes: "The forecasts of devices and revenues for home networking products only begin to capture the value impact that moving from standalone devices to networked appliances will have. The overall impact is well beyond the number of adapter cards or wireless LAN connections in TVs and stereos, as the move will help reshape the market for digital entertainment in the next decade…"[53]

Broadband Usage Trends

There are a number of broadband trends which will inform the analysis of how much broadband users will need in Ireland. The core trends relied upon are described here.

Once it is made accessible and usage begins, the amount of broadband consumed grows at significant rates. Research into the levels of broadband usage in other countries where broadband has been available for some years (e.g. Korean or Japan) shows that the amount of broadband in use is markedly larger than those in less mature markets (e.g. Italy).

The following table depicts the typical amount of broadband an advanced user subscribes to in other countries:

[52] From consultation with consumer technology company
[53] In-Stat MDR "The Top Ten Drivers of the Converged Home Network", April 2003

Table 5-2 Broadband use in more mature markets

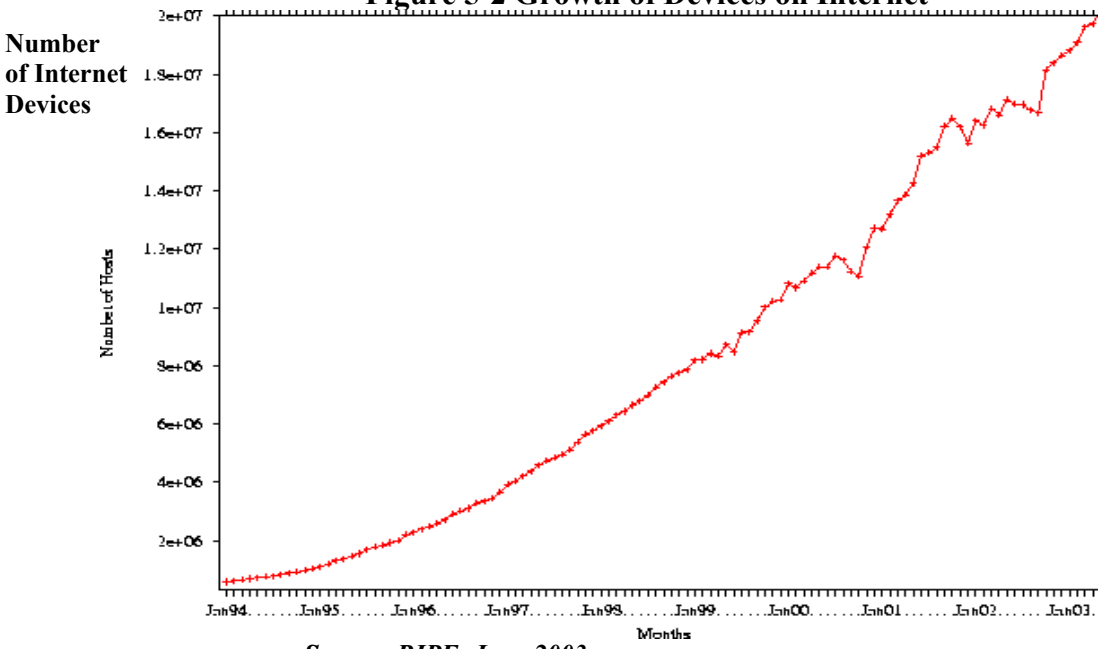
Country	Downstream Kbps	Upstream Kbps
Korea	1544-1800	640
Japan	1500	512
Canada	960	120
Germany	768	128
US	768	128
UK	500	250
France	500	128
Italy	256	128

Increased Broadband Users Drive More Broadband Use - A significant driver behind the amount of broadband consumed is the number of users on the broadband network. As there are more users, there is more utility in interaction between each other. The utility of the network grows exponentially with the number of users (known as Metcalfe's Law). A historical analogy is the increased value of fax machines as there were more users to send faxes to.

Research shows that broadband users are increasing rapidly. In a report published by Nielsen//Netratings in May 2003, it was reported that over one quarter of Europe's online population is now using Broadband. Furthermore, it was noted that in the 13 months from April 2002 to April 2003, the number of European surfers using high-speed grew by 136%. In some countries the growth rate was higher, with the UK experiencing the largest increase at 235% during this period. 28% of European Internet users are now connected at high speed, a growth of 14% from April last year. In the US 35% of the population surf the web using a broadband connection, but this figure is dwarfed by some of the Asia Pacific markets, with 82% of Hong Kong's Internet population connected via broadband.

Increase in Devices on the Internet - The number of devices on the Internet not only reflects the number of users, but also the number of destinations to go to online, and associated services to consumer. Statistics from RIPE, the European organisation responsible for managing "addressing" in the Internet, has plotted the following growth in devices using the Internet:

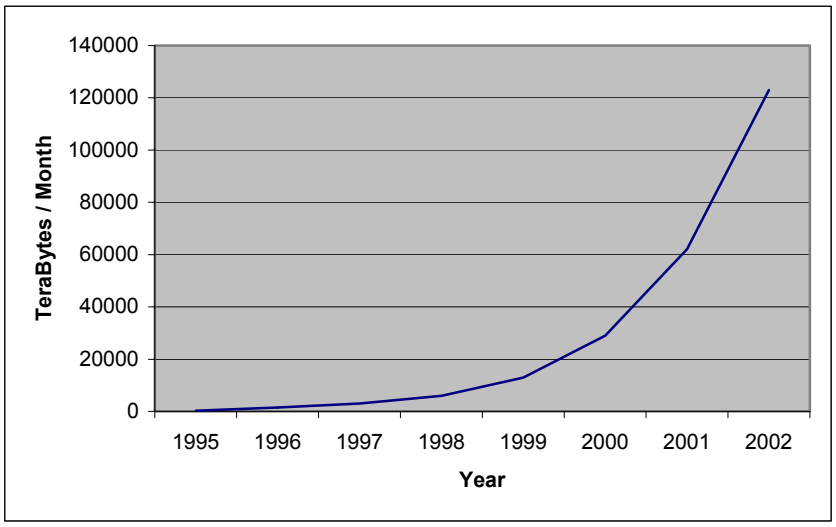
Figure 5-2 Growth of Devices on Internet



Source: RIPE, June 2003

Overall Traffic Trends - Traffic on core Internet backbones has continued to grow over recent years. This traffic is directly related to the amount of broadband each user on the Internet now needs and will require in the future. Research referred to indicates that Internet traffic is likely to double every year. The following illustrates its growth:

Figure 5-3 Traffic on Internet Backbones in the US

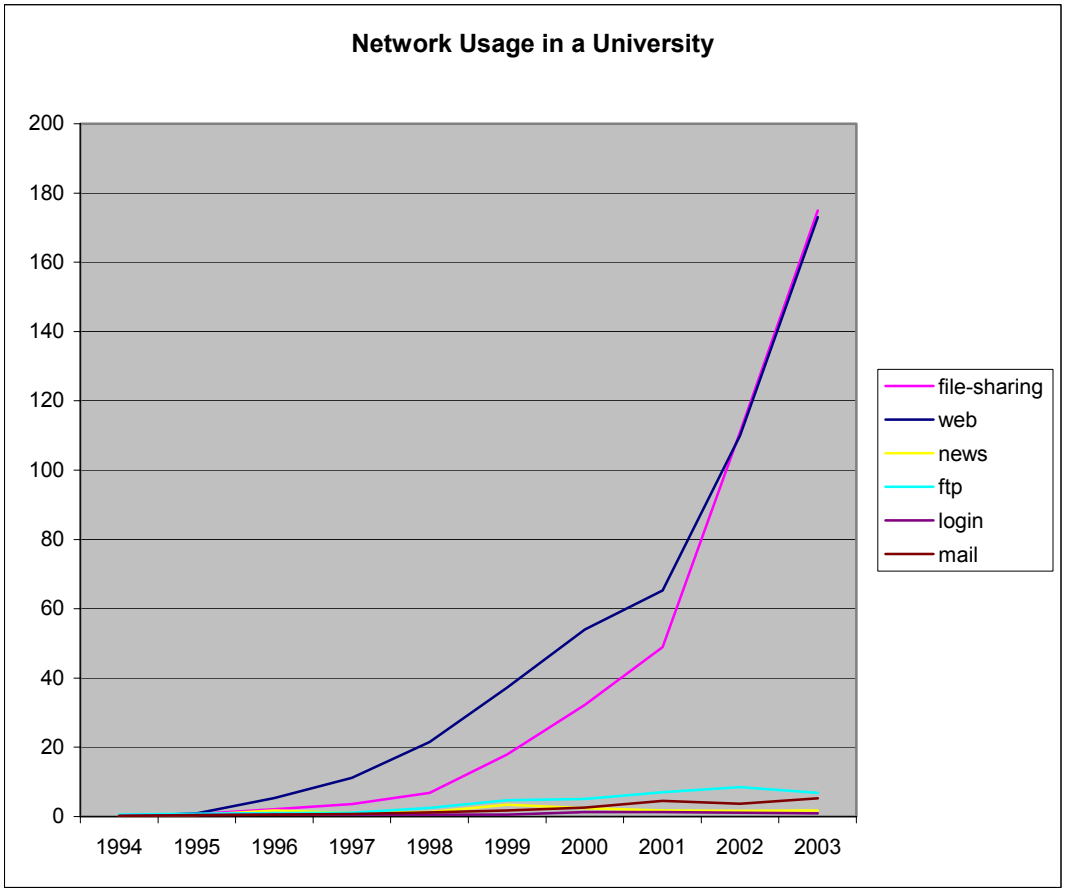


Legend: Traffic in 2002 is 123,000 TeraBytes. This approximates network transfer of contents of 250 Million CDs.

Source: "Internet traffic growth: Sources and implications", Andrew M. Odlyzko, University of Minnesota, Minneapolis – Draft

Applications Getting 'Fat' - In recent years, the proliferation of multimedia content on the web, along with the file-sharing phenomenon, has driven growth in traffic needs to new levels. There is little data available on usage of applications generally on the Internet. However, a representative sample has been selected. Statistics were available for traffic in use by a university in the US. Users in a university will generally have relatively good access to broadband facilities. (Students' age profile will allow for a useful perspective on 'mainstream' applications of the future) As such, this environment will reflect usage in other such unconstrained environments (e.g. broadband at home). These statistics show that there have been huge increases in the amount of data intensive web and file-sharing activity. The following graph plots the growth in traffic due to these emerging applications:

Figure 5-4 Application driven network growth



Source: University of Warerloo Statistics, March 2003

Evolution of Technology

Technology develops at a remarkably constant speed. The evolution of computing (based on silicon technology) has increased according to Moore's Law – the doubling of ICT capability every two years. The utility and adoption of this technology happens in waves, as functionality increases and costs reach affordable levels such that a critical mass is reached.

Today there is evidence of emerging needs for networked devices arising from the dramatic changes in the consumer electronics industry. There is blurring at the functionality boundaries between consumer devices, which will all require networking for interoperability. Mobile communications devices have digital cameras included. Gaming consoles have video play and record capability. Video cameras connect to the HiFi and TV devices. Personal computer capability is becoming included in communications hubs for the home as a central resource for all digital devices. As this level of networking increases, the demand for broadband will grow.

Our technical analysis of Internet / broadband technologies shows that there will be a "third wave" of applications brought about by broadband. Current communications by computers / other devices have been restrained by the lack of bandwidth / broadband for network intensive applications.

First wave (1985 – 1995) - Email
Internet connected stand alone applications on specific computers.
The organization is real and local.
The network is subservient to the computer

Second wave (1995 – 2005) - Web
Applications and services are accessible by anyone using web *(e.g. WWW)*
Organization, data and application are location specific
Computers become dependent on networks
First wave of web services and concept of virtual organization as an overlay to multiple physical locations

Third wave (2005 – 2015) - Networked Applications
Data and application uncoupled from specific locations or machines *(can be accessed and directed from many locations)*
The computer is subservient to the network
Data and application exist in "cyberspace" *(i.e. completely in the network and are not bound to any specific machine or location)*
Virtual organization using virtual data and virtual applications[54]

This primarily follows from research which has been conducted by CANARIE, a Canadian research organisation.

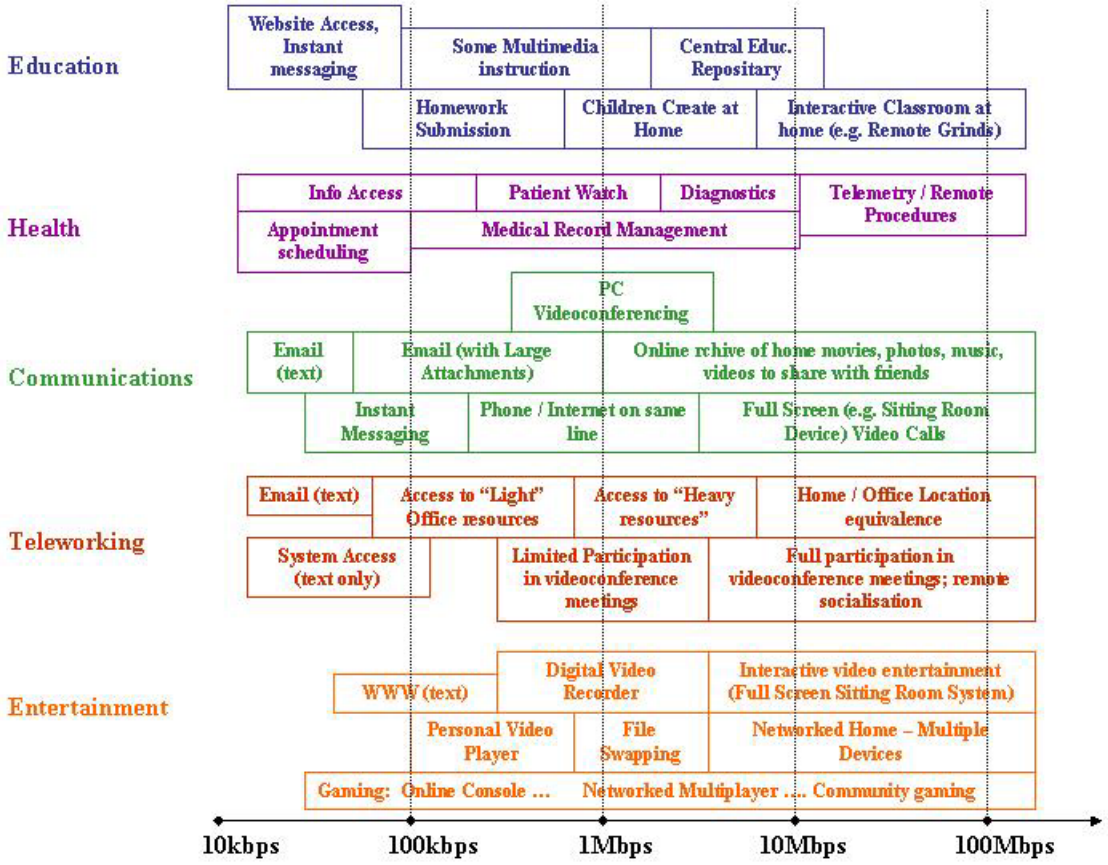
[54] Adapted from CANARIE "The Third Wave". http://www.canarie.ca

The emergence of this third wave is also borne out by discussions with the technology companies who are investing today for tomorrow's market. Industry players developing applications and ICT devices are currently designing and building for 1Gbps connectivity capability to the end user. The incremental cost of hardware with very high speed broadband capability is small, so devices are now having this technology included. Intel has become a significant promoter of broadband and is investing in wireless as an alternative medium for broadband provision. Technology providers to the communications operators are planning for the interactive digital home and SME customer base.

In our view, the evolution of technology leads to a requirement for more and more broadband. In each of the application areas identified above (e.g. health or education), the more users become familiar with, and gain utility from, broadband, the more information is required to serve that need. Similarly, the more the users are capable of utilising ICT and broadband, the more feasible it is to provide services over broadband. The network effects of more users accelerate adoption once a critical mass is attained.

Example applications and their corresponding broadband need (within each of these domains) is illustrated in Figure 5.4. Each of the above example uses or applications has an increased need for broadband (from left to right).

Figure 5-5 Broadband uses evolution



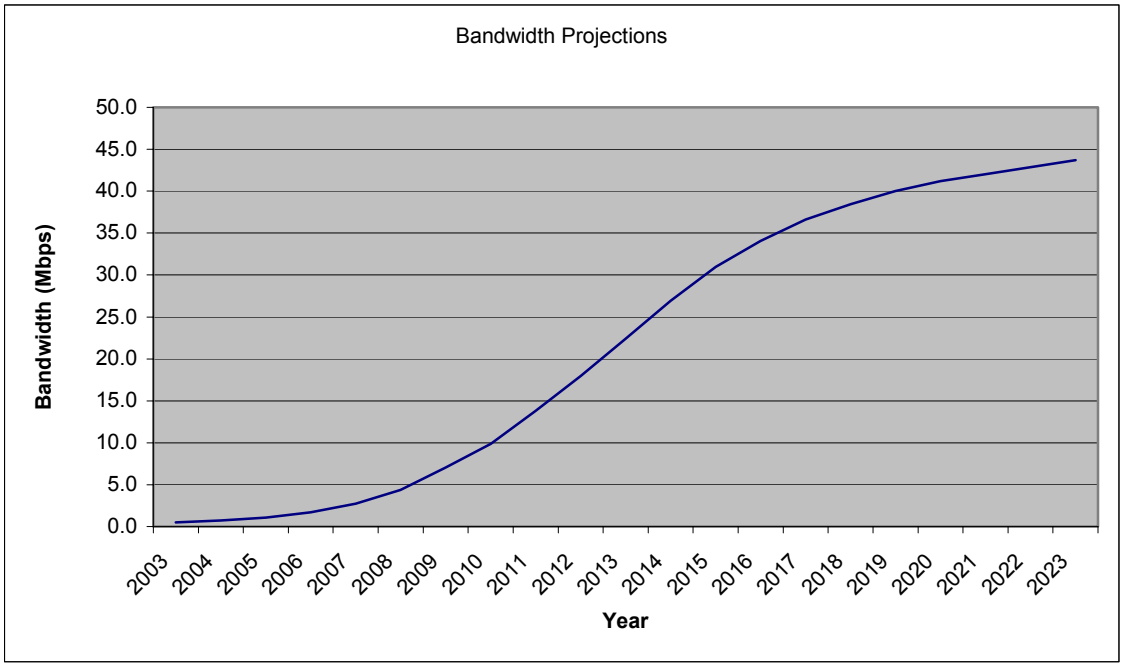
Source: Sonas Innovation

Broadband Usage Projection

We conclude this section by drawing together the various strands presented in this Section and in other parts of the report. A projection of the amount of broadband that will be used may be made based on the technology adoption methodology used in Section 4. Using this methodology, the demand of a consumer who uses a standard broadband offering today can be estimated for the future. As emphasised throughout this Section, the user will adopt applications over time which will require more broadband. The standard DSL / Cable Modem service today at 512kbps is taken as the starting point. Trends already experienced in other markets and with other technology adoptions underpin this projection.

The following graph illustrates the projection:

Figure 5-6 Projection of bandwidth used by an Irish consumer



In summary, this graph projects the broadband usage levels set out in the table below

Year	Bandwidth Usage
2005	1Mbps
2010	7 Mbps
2015	28 Mbps
2020	40 Mbps

The rationale behind this approach must acknowledge:

- Growth rates are below 60% - less than the 100% CAGR proven intrinsic to internet backbone traffic since 1995 (see Figure 5-3 Traffic on Internet Backbones in the US)
- Growth of broadband usage is conservative relative to higher growth evidenced in usage of a broadband local link in a relatively unconstrained environment– (see Figure 5-4 Application driven network growth)
- Growth of devices on the internet is higher than rates adopted here – (see Figure 5-2 Growth of Devices on Internet)

This trend also fits with interviews of network technology companies and application developers who see 50 Mbps to the home / SME as the direction the market has adopted. The case study below from Sweden, shows that other more advanced markets are already providing 10 Mbps broadband.

The following case study is an example of how in other countries, 'fat' broadband is becoming a common offering at an affordable price. Asia is leading the way with 10 Mbps available for €20 a month in Japan. Even closer to home in Sweden, users are needing more advanced broadband than is available in Ireland:

Case Study – Broadband Availability for Teleworker in Sweden

Ragnar Lone works as a computer games developer in Stockholm. His Company (Gatorhole) employs 6 people and also provides IT networking consultancy services. Ragnar works from home for around 2 hours each day, where he has a 2.5Mbps ADSL connection.

For work purposes he uses email and logs into clients' mainframe computers to carry out network checks. He can also use his DSL connection to test network-based games. For leisure time he likes to watch movies on-line. The DSL connection supports all this activity.

For his home service he pays approx €25 per month. Currently, he has a choice of 5 different providers.

He also has the option of a higher capacity service (8Mbps) for approx €43 per month.

A company called Bredbandsbolaget (www.bredband.com) is pioneering very high capacity services in some urban parts of Sweden. They provide a 10Mbps connection to homes via a fibre connection (which can be scaled up to 100Mbps). This supports a video on demand service so people can watch a whole range of movies through their computer. The company offers a choice of 1000 movies and had over 80,000 customers at the end of 2002.

The simple message emerging from this research is that when broadband is made available to users, they have an intrinsic capability to utilise it and require more.

One of our key aims in this report is to focus debate and policy actions on the needs of end users. We believe that adopting the projection methodology used in this Section may provide a concrete way to measure Ireland's progress against other countries and, in particular, against the Government's targets for the sector. We return to this point in the following Section (Recommendations).

Conclusions

The core subject matter of this Section is forward looking and there are compelling trends which point to an increase in the amount (or quality) of broadband that users will need. We draw on:

- Development of use in specific application areas
- Quantifiable broadband trends
- Technology evolution
- Industry views

A key conclusion is that utility derived from broadband occurs more significantly at higher speeds, and where the user has a high level of familiarity with it. The fact that utility in the earlier days is lower creates the "Broadband Gap" referred to in Section 3 (Where are we now?)

Finally, a projection is made for the way demand for broadband could develop for an average user.

Year	Bandwidth Usage
2005	1Mbps
2010	7 Mbps
2015	28 Mbps
2020	40 Mbps

This analysis shows that the Government's 5 Mbps target by 2012 is realistic, if not conservative. These levels of availability are currently being met in other EU countries - see Swedish case study. As such, the target is conservative and efforts to track progress to reach the target should be sustained. The target is a key one, as we saw that increasing orders of utility are available when sufficient bandwidth is available.

6 Recommendations

The following recommendations stem from the research conducted for the compilation of this Report. This research served to inform and support the following recommendations to Government by the Information Society Commission:

Recommendation 1 - Increase Government Role in Broadband Market

The analysis outlined in this report shows that conditions for market failure exist. However, there are clear economic benefits to stimulation of a thriving market. Potential demand is high for the take-up of broadband services. Research indicates that a Government role is justified and essential where climate for private investment is furthered.

A: Set ongoing broadband targets
Targets have been set for the medium term, and these need to be brought down to short-term goals. This will set meaningful, challenging yet achievable targets for the communications industry and Government to ensure our relative standing matches policy ambitions.

B: Focus the market on end users
An output of the research is that there is an opportunity to employ a user-focussed approach to the broadband market. This increases meaningfulness of objectives, and likely success of policies. This will ensure that there is a common focus between Government and the communications industry. Develop a broadband user website, with potential to register an interest in broadband

- Adopt a framework for evaluation of the functioning of the supply market[55]
- Investigate the application of such a framework to ensure any Government investment in the sector is protected by a risk-reward trade-off

C: Structure the market for competition
Research has shown that there is a lack of competition in the provision of broadband services. There is not a clear position on whether government would like to promote competition between companies who own infrastructure or those who provide services. This mixed signal may have negatively impacted on investment levels. A market structure set by consistent, clear and long-term policy will ensure a predictable climate for investment.

- Adopt a position regarding whether competition is required in infrastructure or services or both
- Utilise instruments in place to promote such competition, e.g. regualtion

[55] For Example, Broadband Stakeholders Group, Second Annual Report and Strategic Recommendations, November 2002. Simple, quantifiable and realistic measures are adopted in a dashboard of indicators. Significant broadband growth has been experienced following adoption.

Recommendation 2 - Government should lead by example

The Irish Government should set itself a target of reaching the top decile of the OECD in effective use of ICT. This will span activities from procurement to automation of internal processes.

A: Position ICT as key enabler for each public service

The report has found that there is a clear path of adoption of ICT in society. Ireland's progress along this path should be accelerated through the directed application of the Government role both as customer and creating the environment for consumption. While the communications operators will need to become more sophisticated in the creation of real consumer propositions in marketing broadband, so too should Government package ICT usage and broadband alongside other key needs being met by public services. Government should support the adoption of broadband / ICT in Irish society with a range activities including:

- Procure ICT services in a way which actively promotes competition in the communications market
- Utilise ICT within the Health service as an enabler of efficiency and effectiveness
- Create educational package for students / parents to use ICT in support of schoolwork
- Support Teleworking as a policy goal through meaningful measures (with incentives set against the cost of incremental usage of transport infrastructure at peak loading)
- Reform internal Government processes to form a customer centric organisation, with ICT as an enabler
- Utilise available community centres and voluntary resources to allow for open access broadband centres for all

B: Accelerate rate of transformation of Government business

Research in this report has shown that there is significant potential for savings in public sector current expenditure. An examination of the Health sector showed potential for €150m of savings annually. This examination should be more thoroughly conducted for each are internally within government, and ICT strategies adopted. This will drive savings and increase effectiveness. This will also market potential of ICT to business, increasing the rate of transformation to a globally competitive knowledge economy.

- Perform a comprehensive business case for ICT internally on each sector of Government activity
- Prioritise activity with highest likelihood of impact
- Implement with specific performance goals

C: Mainstream broadband as a utility infrastructure

Broadband is an essential infrastructure for economic competitiveness. Broadband should be seen as a utility infrastructure in common with others (e.g. Road, rail, electricity, etc.). Albeit that the market is now privatised, the State still has a role to

ensure the infrastructure is at globally leading levels. Considerations regarding building broadband as part of any infrastructure programme would generate significant savings over the long term.

- Include a broadband remit for the National Infrastructure Body
- Ensure planning authorities include provision for broadband within all activities and provide a supportive framework for commercial broadband investment

D: Adopt a strategy for disadvantaged areas

The report has shown that there are dangers of an information society for a few in Ireland. Economic and social benefits would unfairly accrue accordingly. A policy should be adopted where the State encourages investment where private investment alone is not possible.

- Determine whether broadband should be considered as part of the universal service for communications
- Develop a framework to ensure that rural areas and social groupings are not excluded from the information society

Recommendation 3 - Measure the effects of ICT in Irish society

ICT has been shown to have significant impact on the competitiveness of the economy. We found that our standing relative to other countries will lead to disproportionate gains or losses. An approach outlined in the report, section titled "Monitoring the Information Society" should be adopted. This will allow for clear appraisal of the success or otherwise of initiatives to improve Ireland's standing:

- Measure the adoption of ICT in society with the range of indicators proposed.
- Provide segmentation by region and demography
- Measure, with ongoing relevant comparative targets, the usage of broadband in Ireland on a quarterly basis – both numbers online and quality of broadband
- Benchmark to ensure improvement relative to other countries is closely monitored
- Ensure all targets are aligned to ensure the overall objective of top decile in the OECD by the target timeframe is met

Appendices

Appendix 1 – Productivity Analysis

These data are shown in Table A1 and have been interpreted by many as one of the main reasons for the growth of the economy in this period

Table A1 Change in Productivity (% per annum)

	1995	1996	1997	1998	1999	2000
Traditional	6.3	2.1	3.5	3.3	3.0	6.7
Food Processing	6.3	-1.1	0.9	7.0	2.7	4.0
High technology	11.6	6.9	11.0	19.2	11.8	8.4

Slevin (2002) analyses the important role of productivity growth in determining the performance of the economy in various periods. She shows that total hours worked in high-tech sectors in Ireland in the period 1997-2001 grew by 6.2% per annum while average annual output growth was 17.6%. This means that average labour productivity (ALP) growth was 11.4% per annum in this sector. However, the picture is very different in the traditional manufacturing sector. Here, average hours worked did not grow while output grew by 1.6% per annum indicating ALP growth of only 1.6% per annum. A similar picture emerges when data on total productivity growth (TLP) are examined. Table 2 shows TLP figures for the same years and sectors as in Table A2. They show the key role played by productivity growth in the performance of the Irish economy.

Table A2 Annual TLP Growth by Sector (%)

	1971-1999	1985-1990	1990-1995	1995-1999
Agriculture	0.7	0.4	0.4	0.3
Building and Construction	3.6	4.5	3.0	6.3
High-tech Manufacturing	2.5	3.5	2.1	5.7
Traditional Manufacturing	0.8	0.5	0.7	0.6
Market Services	0.7	1.1	0.5	0.3
Total Economy	4.9	6.0	3.8	7.0

Source: Based on Slevin (2002) Appendix 4, Table 5

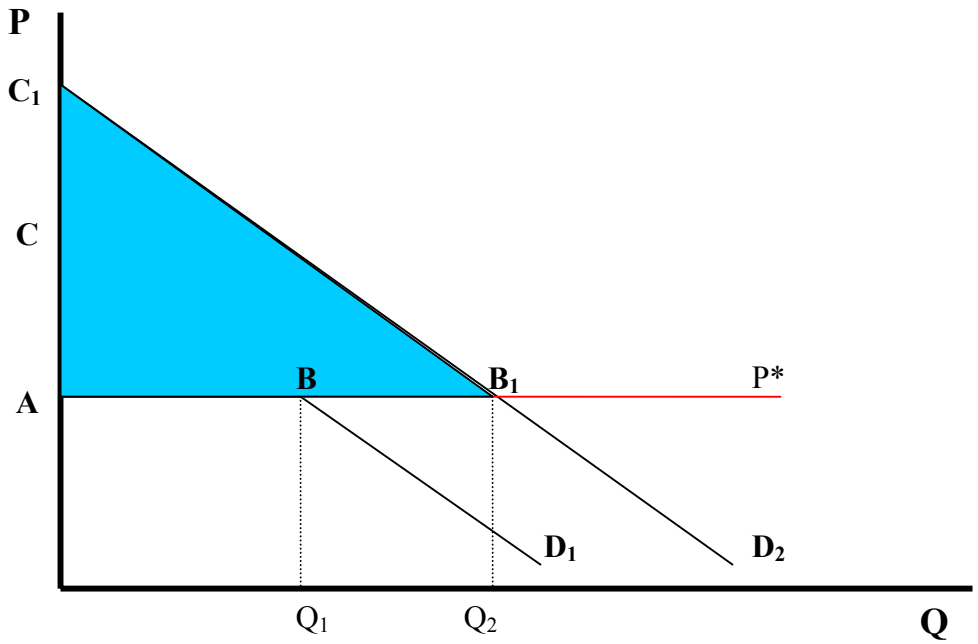
While many of the general trends already observed can still be seen in this table there are some important differences. The out performance of the high tech sector is not as noticeable, although the relatively poorer performance of the traditional sector remains. The explanation for this is the very large expansion that has occurred in capital intensity in the high tech sector. A similar feature is also present in the services sector where TLP is not as high as might be expected given the rapid growth of recent years. In this case, the productivity figures are not so useful over longer periods since the activities that comprise the service sectors have changed considerably. As a result, there has been rapid growth in new sectors many of which are capital intensive while other sectors such as personal services have grown, but find it difficult to achieve labour productivity gains.

Appendix 2 – Model for Estimating Consumer Surplus

Identifying Consumer Surplus

Any new marketed product or product improvement has the potential to create benefits for consumers as well as producers. Consumers may gain because they are able to purchase a new or improved product that was previously unavailable. They consume it up to the point at which the marginal value of the product to them is equal to its price. However, the price at which the good is available is the marginal valuation of the marginal consumer, in other words, the lowest valuation placed on the good by any consumer that is equal to or above the minimum price that producers are willing to accept. This, assuming a downward sloping demand curve, is less than all previous consumers. Thus, consumers receive welfare from consumption in excess of their evaluation of the welfare of holding on to their money. While this analysis has been criticised on many occasions, it does comply with the observed result that economic well-being rises as economic activity increases. The benefit of growth in demand and consumption is then approximated by the change in the consumer surplus. The argument is illustrated in Figure A1.

Figure A1 Consumer Surplus



With demand curve D_1, the quantity consumed is Q_1, price is P* and consumer surplus is the shaded triangle ABC. When consumption rises as a result of the availability of supply to Q_2, indicated by the shift of the demand curve to D_2, then the area of the triangle increases to AB_1C_1[56]. The difference between the before and after measurements

[56] For simplicity of exposition, it is assumed in this analysis that economies of scale mean that the new technology can be provided at the same price as the old technology. In fact, this assumption need not be used in the appraisal of broadband benefits since almost all demand will be additional.

of consumer surplus – the area BB_1C_1C – measures the net benefits to consumers of the new technology. A similar type of analysis could be undertaken in relation to the benefits to producers.

Data Requirements and Assumptions

Providing a valuation of the addition to consumers' welfare arising from the availability of broadband requires a number of pieces of information:

1. The nature of the demand curve and its elasticity
2. The period over which the evaluation takes place
3. Projections of the population
4. The rate of growth of penetration of the new technologies in this period
5. An estimate of the price of access

We also give full consideration to the factors identified in Section 4 (How Many Broadband Users Will There Be?).

It is common in appraisal to assume that the demand curve for a product is linear. Data from a survey of consumer demand for broadband may be used to construct a demand curve for access and suggests that this assumption is reasonable in the case of broadband[57]. It is worth noting that this may provide demand estimates that are somewhat on the low side since, as has been argued above, growth is likely to be supply driven with demand evolving as consumers realise the potential benefits and uses of access. The survey results are shown in Table 3. From these data it is also possible to project total revenue.

Table A3 Household Demand for Broadband (% of respondents)

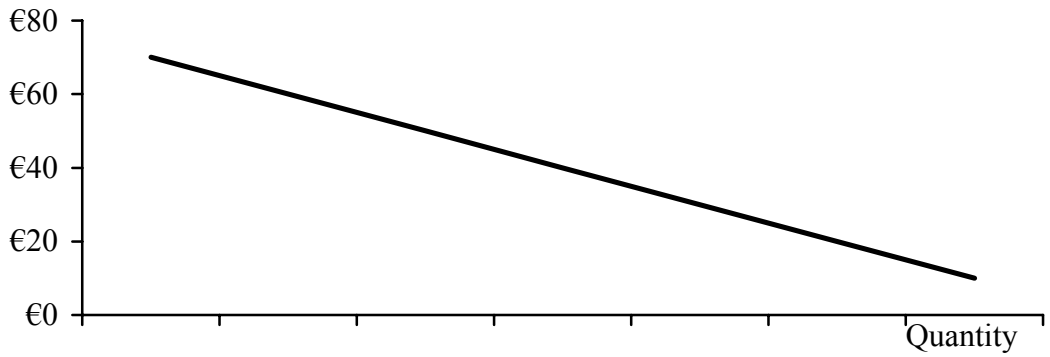
Monthly Fee	€70	€60	€50	€40	€30	€20	€10
Extremely likely	2	3	8	15	26	38	55
Very likely	3	6	8	11	11	13	7
Fairly likely	14	12	14	13	15	10	6
Fairly unlikely	12	13	11	9	5	3	2
Not very likely	16	17	14	11	7	4	3
Not at all likely	45	40	34	30	25	21	17
Don't know	8	10	10	12	11	10	11

Source: MRBI and ODTR (2002)

If it is assumed that the first three answers at each price level indicate demand while the bottom three indicate that there will not be demand, and that the 'Don't Knows' are even distributed, then these data provide the simple demand curve shown in Figure A2.

[57] *Consumer Demand for Broadband: Survey Findings*. MRBI and ODTR, September 2002

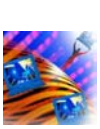
Figure A2 Household Demand Curve for Broadband Access



Regarding elasticity, Crandall and Jackson assumed elasticity of demand equal to -1 in the US. While this assumption at first appears arbitrary, it may not actually be a bad assumption to start with since, in an oligopolistic market, this represents demand where the supplier is experiencing marginal revenue equal to zero. This industry is subject to very large economies of scale such that the marginal cost facing suppliers at large volumes will approach zero. This is another way of saying that the main costs are in the capital and fixed costs and that, once connected, an additional user does not place great costs on the producer. In this situation, the profit maximising condition requires that the price will fall until demand rises to a level where marginal revenue approaches zero also[58]. This is the argument that costs for consumers will be lower when volume is high (but volume will not rise until prices fall). In summary, the assumption of elasticity equal to -1 appears valid.

The period for the evaluation should be a sufficient period for the technology to reach an equilibrium level of penetration. The development of broadband requires high up-front investment in infrastructure with fairly low subsequent running costs. However, unlike in the case of a road, the life of the infrastructure is limited due to the pace of technological development in this area. Adopting a timeframe of 20 years appears appropriate since the timeframe must be a balance between a sufficiently long enough period for broadband to achieve penetration rates comparable with existing communications technologies, such as telephones or television, but sufficiently concise to recognise adequately that the speed of the technology cycle has increased and there is the possibility that broadband could be superseded if a longer timeframe was adopted. It is also in keeping with the recommendations of the Department of Finance regarding investment in infrastructure projects[59]. However, although the infrastructure may still be used beyond this date, a final residual value should not be added in. Technological improvements mean that it is likely to be obsolete from the point of view of adding to the competitiveness or welfare of society.

[58] This does not mean that price approaches zero at this equilibrium.
[59] CSF Evaluation Unit (1999) *Proposed Working Rules for Cost Benefit Analysis*

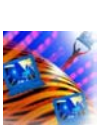


The fact that benefits will arise over a period while costs are mostly up-front means that the flow of returns must be discounted. Furthermore, it is essential that all opportunities costs are incorporated. In practice, this is very difficult but the problem is lessened if there is a general alternative use for funds that can be assumed in all CBAs and if a margin of error is built into the results. In Ireland, it has become commonplace to adopt repayment of the national debt as the alternative use of funds. Thus, the opportunity cost of the funds is the interest that could be saved on the national debt. This is usually taken to be 5% per annum of the funds involved. This value is then used as an appropriate discount rate to use – although it is debateable whether this is as appropriate going forward as it was in the past – and is in keeping with Government recommendations[60].

Some assumption regarding the likely uptake of broadband usage – the degree of penetration – is also required. Currently, there are in the region of 1.1 million colour television licences in Ireland. On the basis of the available data this would suggest a household penetration rate of about 90% over 20 years for a mature technology and this is used in deriving the first estimate below of potential net benefits to consumers. However, there are difficulties with trying to identify potential penetration rates for broadband by extrapolating from existing technologies. For example, it is currently estimated that adult internet usage is 40% with only 26% using the medium at home. However, growth rates have slowed. The problem with using a metric such as this as a basis for predicting broadband penetration over 20 years is that the existing internet has proven to be an inadequate medium – the fate of the stock market dotcoms illustrate this disappointment – and customers have not embraced it as a result. The potential is that broadband will overcome this deficiency. A good example of this is provided by the life cycle of mobile phones. When introduced using the original analogue technology with bulky handsets penetration was low. However, the introduction of digital technology facilitated new features such as text messages, pictures, greater security and reliability and network competition to control prices. This was allied with neater handsets and penetration and usage grew to levels that could not have been extrapolated from the analogue experience. In addition, the network effects discussed below mean that there is potential for further unpredictable development.

It can be argued that both mobile phones and broadcast television are unsuitable comparators since the development of broadband will be primarily based on cabling. However, as emphasised in Section 4, this argument fails to distinguish adequately between the technology employed in the medium and the utility of the medium. Penetration is based on utility: customers are unconcerned to a large extent as to the technology involved. The only issue then is with regard to the relative costs involved in the different technologies. The growth in the popularity of cable television services in recent years when mature broadcast technologies are available suggests that this is not a simple relationship and that businesses have been very innovative in developing ways to recover sunk costs. However, there is an issue here in relation to the relative penetration of broadband in urban and rural areas to the extent that beyond a certain level the

[60] Department of Finance (1994) *Guidelines for the Appraisal and Management of Capital Expenditure Proposals in the Public Sector*



potential growth of the medium could be restricted due to the need to access areas of low population density.

The estimates produced by Crandall and Jackson of the potential economic benefit of widespread diffusion of broadband internet in the US were based on broadband becoming as widely used in 20 years time as the telephone service is now. However, if broadband is only adopted by 50% of households, they estimate the potential consumer benefit to be closer to $100 billion. This means that the level of benefits is very sensitive to the level of adoption with a non-linear relationship. To reflect this, a second calculation is undertaken based on dividing the market between urban and rural households and assuming that penetration in rural areas will be both lower and slower than in towns[61]. The results of Census 2002 indicate that 59.6% of the population lived in towns in 2002 compared to 58.1% at the last census in 1996. The results of the Census in relation to households are not yet available but, in the absence of data, it is assumed that household size is the same in rural and urban areas. This means that the number of urban households is estimated at 717,570 with 486,400 rural households. Furthermore, it is likely that the urbanisation that has been ongoing will continue partly as a result of the factors that have been driving the process to date and due to the impact of the National Spatial Strategy with its emphasis on identifying leading development centres to promote regional growth. Combining the projected rate of population growth and a continuation of urbanisation trends means that the number of urban households will have risen to 854,160 in 20 years time while the number of rural households will have fallen slightly to 478,400. This forms the basis of the second estimate below of potential net benefits to consumers.

Population change is likely over this period implying growth in the potential market. A range of projections are contained in the CSO's *Population and Labour Force Projection 2001-2031* on the basis of alternative assumptions regarding migration and fertility rates utilising data from the 1996 Census. The available results of the 2002 Census suggest that the high assumptions are more appropriate given recent trends, but the projection of these over the full 20 year period could be problematic. This means that a projection based on moderate fertility and high immigration would appear to be most appropriate[62]. Alternative assumptions would clearly affect the future population and demand for broadband. If it is further assumed that household formation and household size remains constant at 3.25 over the period, then population and household growth will be as given in Table 4.

Table A4: Projections of Population and Households in Ireland 2002-21

	Population	Households	Annual % change in preceding period
2002	3,917,203	1,203,976	1.10
2006	4,068,329	1,250,383	0.95
2011	4,178,461	1,284,232	0.67

[61] Urban areas are identified as 'Towns' as defined in CSO (2003) *Census 2002 Volume 1 – Population Classified by Area*

[62] The moderate CSO projection under the M1F3 assumptions forecasts a population growth rate of 1.12% per annum in the period 1996-01. The actual rate in the period 1996-02 was just below this at 1.10% per annum.

2016	4,269,074	1,312,081	0.43
2021	4,335,656	1,332,545	0.31

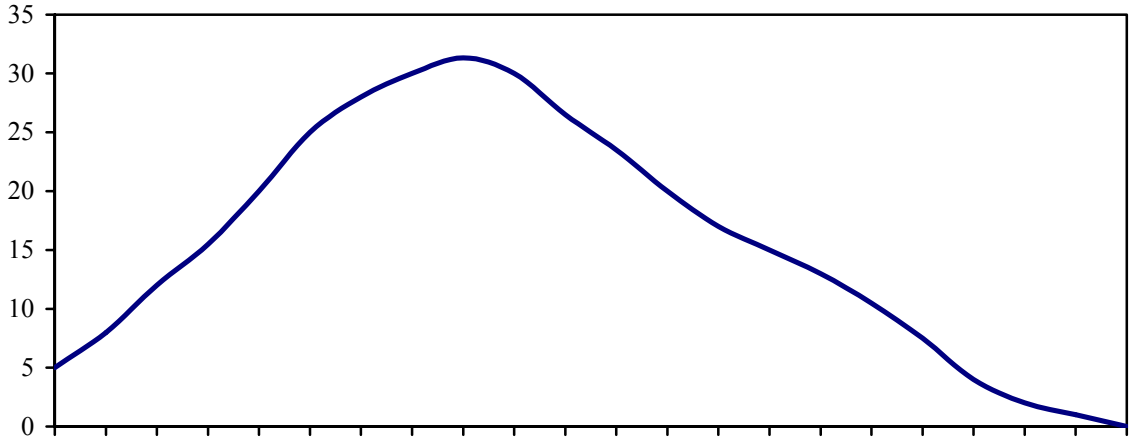
Source: Derived from CSO *Census 2002: Principal Demographic Results* and CSO *Population and Labour Force Projections 2001-2031*. The assumptions used here are equivalent to the CSO's M1F3 projection.

These projections indicate that the number of households in Ireland will increase by 128,569 in the period 2002-2021. This is equal to 10.7% growth over the 2002 figure. This is clearly a much slower rate of increase than has been the case for the past few years.

Estimates of Consumer Surplus

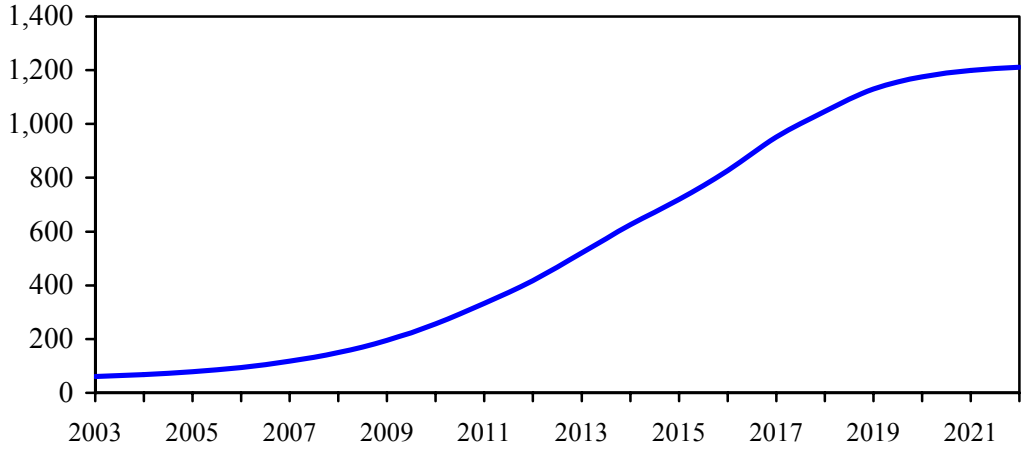
The first estimate of consumer surplus assumes that a penetration rate of 90% of households is achieved indicating 1.2 million active broadband household connections in 2024. It is also necessary to set out an appropriate profile of connections for the period. Assume a 5% connection rate in the first year of operation (2004), equivalent to just over 60,000 connections. To achieve 90% household penetration in 20 years would require constant annual growth of almost 17.1% per annum for the full period. However, this assumption of a constant rate of growth appears unlikely and it is more likely that after a slow start the rate of growth would accelerate before slowing as it approaches its steady level of penetration. Annual growth under this scenario is shown in Figure A3.

Figure A3: Assumed Broadband Annual Growth Life-Cycle (%)



This approach is in keeping with a typical product life-cycle where early adopters are attracted to the new technology but the numbers are limited. Eventually, lower prices, due to economies of scale, and the availability of richer content attracts the mass market. Then as the technology matures and the market approaches saturation the annual rate of growth falls towards a steady state. The number of connected households in each year under this approach is shown in Figure A4.

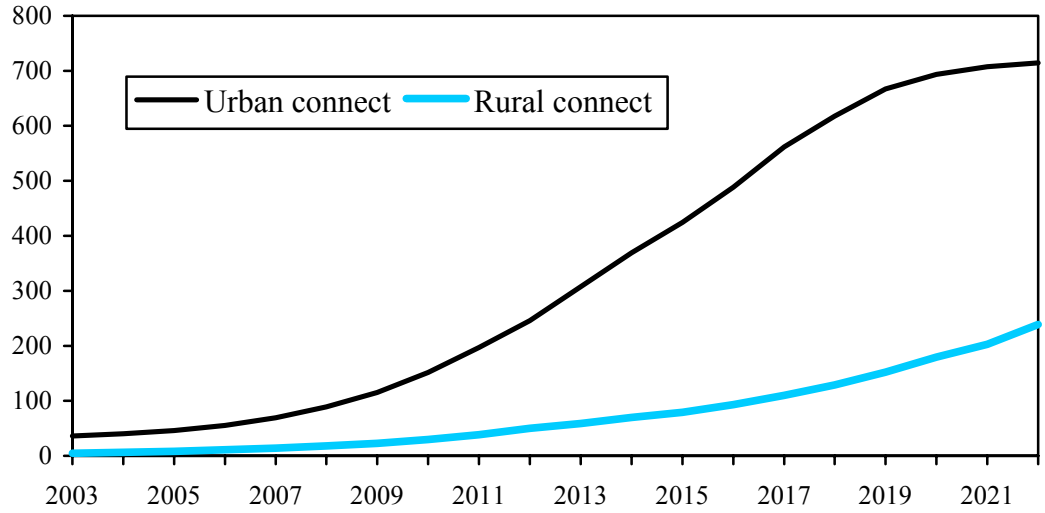
Figure A4: Number of Broadband Connections (000s)



Applying these market growth projections based on the population projections, and assuming access cost of €40 per month as discussed above, this indicates an industry with the potential to generate revenues of about €30 million in the first year rising to over €100 million by 2010. As discussed, consumer surplus at 50% of revenues would appear to be a realistic assumption. This means that, applying a real social discount factor of 5% per annum to the stream of returns indicates aggregate consumer surplus over the period up to 2024 with a present value of $1.3 billion. This is approximately equal to about 1.2% of GNP at present. In other words, the development of broadband along these lines increases economic welfare by approximately 1.2% of GNP as a result of increased consumer surplus.

The second projection of household uptake recognises that there are issue related to accessibility in areas of low population density. The assumptions here are that while penetration in towns rises to about 40% in the first 10 years and 90% in the following 10 from a base of 5% in the first year i.e. at the same rate as was assumed for all households in the first calculation, it reaches only 10% of rural households in the first 10 years and 50% after 20 years from a base of 1% in the first year. This gives the number of household connections as shown in Figure A5.

Figure A5: Number of Broadband Connections (000s)



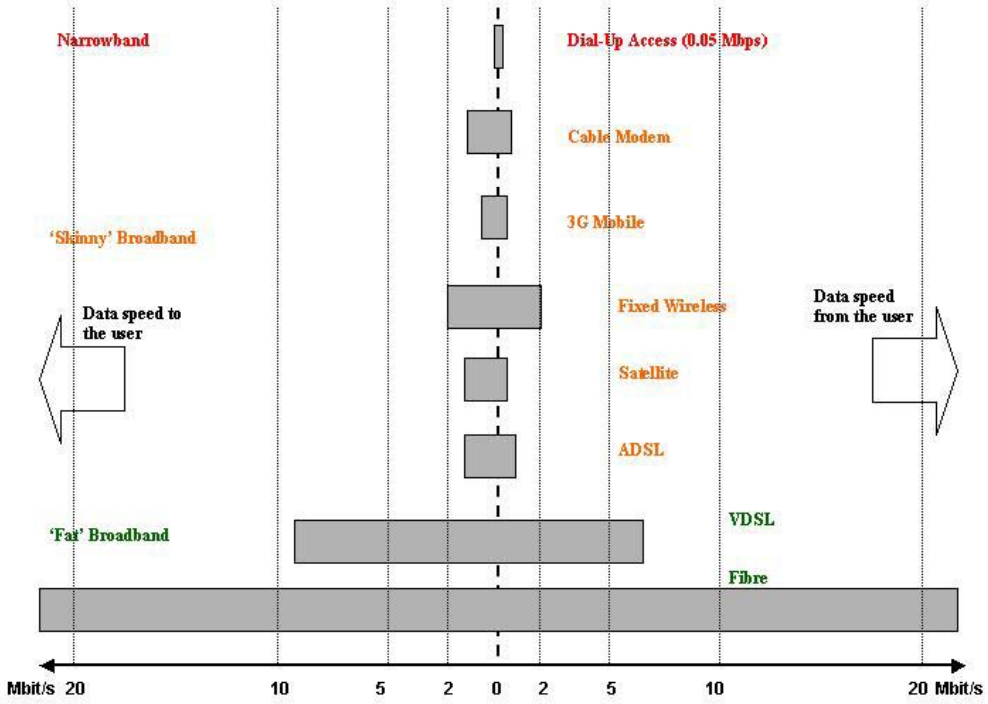
This lower penetration of rural households has an effect on the projected present value of the consumer surplus that arises. The calculation shows a present value of €0.96 billion or 0.9% of current GNP. This estimate is about 26% below the previous estimate based on a total take-up is 90% of all households and arises as a result of the additional costs to be addressed in providing broadband in areas of low population density.

Appendix 3 - Speed of Broadband Media and Services

Most 'skinny' broadband services do not allow for the same speed of information transfer both to and from the user. The following chart further represents communications services':

- Range of speeds
- Two-way communications abilities

Figure A6: Broadband Media & Speeds to End User



Source: Sonas Innovation

Legend

- Narrowband
- 'Skinny' Broadband
- 'Fat' Broadband

The two-way flow of information (both to and from the user) is more fully enabled with 'fat' broadband. This becomes important when the user and his/her digital environment becomes a more significant contributor to the communications flow as opposed to being more in 'receive mode only'.