Innovation and the development of a digital economy: assessing the socio-economic effects of broadband

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Table of contents:
Introduction ..................................................................................................................................... 3
Digital economy .............................................................................................................................. 3
The benefits of broadband............................................................................................................... 7
Broadband creates opportunities .................................................................................................. 14
Broadband availability through mandated access ........................................................................ 16
The dynamic relationship between networks, users and services .............................................. 18
Infrastructure, skills and use together drive the digital economy ............................................... 19
Summary ....................................................................................................................................... 24
Appendix 1: Biography of Professor Jason Whalley ................................................................. 25
Appendix 2: Biography of Dr Bert Sadowski ............................................................................. 28
Introduction

The digital economy that is emerging is complex and dynamic. It is underpinned by the need to ensure that everyone has access to broadband and that individuals and companies alike possess the necessary skills for them to participate in the digital economy, through using the existing services that are available as well as creating new ones. A decision of the Canadian radio-television and Telecommunications Commission (CRTC), which was announced in July 2015, focused attention on infrastructure. While widespread availability of broadband is a necessary condition for the emergence of a vibrant and innovative digital economy, it is not sufficient: individuals and companies also need to use Internet-based services as well, and this means that they need to possess relevant skills. Mandated broadband access will worsen the current situation. Due to mandated access companies will have fewer incentives to invest in new infrastructure, and as investment is a continual process that provides better quality the renewal of the broadband infrastructure is at stake if the mandated access decision is implemented. Broadband providers will shy away from investing in new infrastructure and the development of new and innovative services that address the needs of society, leading to a situation where no one is willing to invest in broadband infrastructure.¹

The government has an important role to play in overcoming this situation and providing incentives for private companies to continuously invest in broadband infrastructure and the development of new services that address societal needs such as an aging population or environmental change. To address these wide-ranging societal needs, the government can aggregate demand, offer training as well as build public-private coalitions that combine, for example, telecommunication companies with Internet service providers and health care organisations. In order to fully realise the potential of broadband in the digital economy, government involvement will be crucial to address deficiencies in information and communication technology (ICT) skills and the difficulties experienced by residential consumers and small and medium sized enterprises (SMEs).

In this report we focus on this wider context. We illustrate the complex and dynamic relationships between infrastructure, use and skills that together shape the digital economy. Through doing this we argue that while infrastructure provides the connectivity that underpins the digital economy and thus plays a key role, an equally important role is played by use and skills. If the benefits of widespread broadband availability are to be realised, then individuals and companies need to possess the relevant skills that enable them to use the services that are available, and as they use the services their skills will improve and thus encourage the further use of Internet-based services by individuals and companies.

Digital economy

A new, digital based economy is emerging. This new economy is epitomised by a series of high profile companies – we search for content via Google, buy books online at Amazon, use Facebook to keep in contact with our friends and family, share files through Dropbox and create and consume content electronically. And an app economy has emerged around smartphones, which not only enable users to ring one another but also engage in mobile banking, play games etc.

These companies have, of course, already made a significant contribution to today’s digital economy. The iPhone and its associated app store have not only created value for Apple, but also for the many companies, and sometimes the individuals, who develop apps. The revenues associated with the iOS app store are now very significant, with it not only being larger than Hollywood in the United States but also creating more than 600,000 jobs as well. And globally the size of the app economy, which includes both Apple and Android, has been estimated to be more than $140 billion by 2016.

Smartphones are multi-function devices where voice telephony is not a key feature to many users; they have changed how we take pictures, and how we pay for goods and services. As iPhone users increasingly adopt Apple Pay, the retailing and financial services sectors are affected. Quite simply, smartphones are disruptive devices, creating new markets while simultaneously affecting existing ones.

The digital economy is more, however, than just mobile phones. Amazon has revolutionised the retailing of books, transforming the physical retailing of books as well as popularising e-books through its Kindle reader. More broadly, Amazon has also demonstrated how it is possible to extend online retailing from markets like books and music into areas that were thought difficult to move online. As Amazon has developed its online retailing platform, it gained sufficient technical expertise to enable it to develop a new web services business. While companies like Amazon grab the headlines, it is worth remembering that many companies buy and sell with one another through the Internet. In 2013 the size of the manufacturing related business-to-business

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2 One way to shed light on the value that is being created is to look at the value placed on leading digital economy companies. In the most recent Financial Times 500 list of the world’s largest companies by market capitalisation, Apple is ranked first with a value of $724.7 billion (Dullforce, A., 2015, FT 500 2015, 19 June, available at www.ft.com). In the same list, Google is fourth with a market capitalisation of $342.5 billion, Facebook 29th ($183.9 billion) and Amazon 33rd ($172.8 billion).

3 Prominent examples of companies that have emerged out of the app economy include Rovio (the developer of Angry Birds) and King (Candy Crush).

4 It is estimated that the iOS app store has created 627,000 jobs while the number associated with Hollywood is a lot less at 374,000 (Meyer, R., 2015, The app economy is now ‘bigger than Hollywood’, The Atlantic, 27 January, available at www.theatlantic.com). Having said this, it is worth noting that Hollywood has had a lot longer period to create its jobs than the iOS app store has.


6 It has been suggested that the IT systems of banks does not favourably compare with Apple (Dunkley, E., 2015, Banks’ technology failing the ‘Apple experience’ text, Financial Times, 27 November, available at: www.ft.com). This partly reflects the central role played by legacy systems within the IT infrastructure of many banks, as well as the intuitive nature of today’s software.

7 While Amazon today operates a series of departments such as ‘clothes, shoes and jewellery’ and ‘car and motorbikes’. In the initial stages of the Internet it was suggested that goods that require to be tried, that is, experienced, to determine if they are suitable could not be sold online.

8 Amazon Web Services provides, in essence, the online infrastructure for companies located in other sectors and while it is arguably not as well known as its rivals, it is a large and profitable business. In the 6 months to 30 June 2015, Amazon Web Services generated revenues of more than $3 billion and an operating profit of $700 million (The Economist, 2015, Partly cloudy, 17 October, available at: www.economist.com).
(B2B) market was $1.75 trillion, while globally the B2B market is estimated to reach $6.7 trillion by 2020, or twice the size of the business-to-consumer market.

At the heart of the digital economy are a series of complex and dynamic relationships. These relationships cut across the whole economy, linking, for example, network operators with retailers, search engines, credit card providers, logistic companies and customers. The networks are the ‘pipes’ that enable consumers to connect to the services, whatever they may be, that they wise to use. One way that is often used to describe these complex and dynamic relationships is through the use of the ‘ecosystem’ metaphor. Through this metaphor commentators have identified different types of actors within the digital economy, as well as how they combine together to deliver the services and products that consumers want. Martin Fransman, for example, has identified four layers of actors within the digital ecosystem: the providers of network elements; network operators; content and application providers; and, consumers. Actors within these four layers are linked together through a series of relationships. The ecosystem that he proposes is shown below in Exhibit 1.

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12 These are referred to as ‘symbiotic’ relationships and link together the four layers in six different ways (Fransman, M., 2010, The New ICT ecosystem: Implications for Policy and Regulation, Cambridge University Press, Cambridge, UK). These symbiotic relationships mean that actors in the two layers that are linked together are, in some shape or form, dependent on one another. For example, the providers of network elements sell their equipment to network operators, who, in turn, are linked with content and application providers on the one hand and their consumers on the other.
Exhibit 1: A simplified model of the new ICT ecosystem


The actors located within each of these four layers, as well as the nature of the relationships that bind them together, changes over time, reflecting their success or failure in the marketplace. The difficulties that manufacturing companies such as Nokia and Research in Motion have experienced in recent years as they have struggled to adjust to the smartphone era are well documented, as are the constantly changing strategies of Yahoo. Similarly, the rapid growth of app developers like Zynga and King has attracted considerable attention, not least because of the

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difficulties that they have faced when trying to sustain their rapid growth in a highly competitive and fickle market.\textsuperscript{16}

Through the ecosystem metaphor the inter-dependencies that exist within the digital economy are highlighted. While there is a tendency to focus on content or application developers on the one hand or equipment manufacturers on the other, a key but often overlooked component of the digital economy ecosystem are the network operators. Through operating wireline and wireless infrastructures, network operators provide the conduits – pipes – that link individuals, companies and governments together. In other words, network operators provide the connectivity that underpins the digital economy. Without such connectivity, individuals would not be able to use Google Maps when they are lost, companies would not be able to buy and sell online and governments would not be able to communicate with their citizens. There is, quite simply, no digital economy without connectivity.

Thus, the emergence of a digital economy within a country requires several conditions to be satisfied. Firstly, consumers, regardless of whether they are businesses or individuals, need to be able to access the Internet through a network. Secondly, consumers need to actually use the Internet. Not only must there be a trigger event that encourages a business or individual to start using the Internet in the first place, but subsequent use is then dependent on their ability to access and use services that they find valuable. In other words, the emergence of a digital economy is dependent on both the availability of access infrastructure and on the subsequent use of Internet based services.

The benefits of broadband

Politicians around the world have argued that broadband is crucial to their country’s (economic) future, with some countries investing considerable amounts to achieve their broadband ambitions.\textsuperscript{17} For example, as early as 2009 South Korea announced a 1.3 trillion won / US$25 billion investment programme to deliver fast broadband by 2012\textsuperscript{18} while more recently Australia has invested close to A$30 billion to help fund a national broadband network.\textsuperscript{19} But what are the benefits of broadband?


\textsuperscript{17} For an overview of the broadband investments being undertaken around the globe, see, for example, Economist Intelligence Unit (2012) \textit{Full speed ahead: the government report Q1 2012}, March, Economist Intelligence Unit: London, UK.

\textsuperscript{18} Korean Communications Commission (2009) \textit{Korea Internet speeds to be ten times faster by 2012}, 28 March, available at: eng.kcc.go.kr

\textsuperscript{19} The Australian government’s investment is capped at A$29.5 billion. This equity investment, however, has been provided in stages: A$5.2 billion over the period 2008/2009 to 2012/2013, A$3.4 billion in 2013/2014 and A$20.9 billion between 2014/2015 to 2017/2018 (Turnbull, M., 2014, \textit{Joint release with The Hon. Paul Fletcher MP: Investing in Australia’s communications infrastructure}, Minister for Communications, 13 May, available at: www.minister.communications.gov.au). The 2015 Australian budget amended this staged allocated, albeit slightly, bringing forward contributions of A$2.5 billion from
Firstly, broadband creates economic benefits at both the local and national levels. Research has found that the economic effects of broadband are both ‘real and measurable’. When focusing on the effects of broadband on the local economy, the research concluded that communities with broadband experience more rapid growth in terms of employment, the overall numbers of businesses and the number of businesses operating in information technology (IT) intensive sectors. A study for the International Telecommunications Union, the UN body with responsibility for ICT including broadband, summarised the literature in 2012 and found that broadband positively contributes to economic growth. Many estimates of this positive contribution can be found, with some examples including:

- Using data from 120 countries, it was found that for every 10% increase in broadband penetration resulted in additional per capita GDP growth of 1.21% in developed and 1.38% in developing countries.
- A study of 22 OECD member states between 2002 and 2007 that found an increase of 1% in broadband penetration increased economic growth by, on average, 0.025%.
- The economic value to a household of increasing broadband speeds by 4 Mbps in OECD countries has been estimated to be $2,100.
- The use of broadband in EU member states between 2005 and 2011 contributed 1.36% annually to GDP.
- The McKinsey Global Institute found that the Internet contributed one-third of the economic growth in Sweden between 2004 and 2009, and a fifth of the UK’s over the same period. The corresponding figure for Canada was a tenth.

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27 No single explanation for the relatively poor performance of Canada is provided in the report. The report does, however, draw attention to factors that undoubtedly pay a role, namely, the collapse of Nortel on the one hand and the under developed nature of the Internet supply chain within Canada (du Rausas, M.P., Manyika, J., Hazan, E., Bughin, J., Chui, M. and R. Said, 2011, *Internet matters: The net’s sweeping impact on growth, jobs, and prosperity*, May, McKinsey Global Institute, available at: www.mckinsey.com).
It has been estimated that raising the level of mobile broadband penetration in emerging markets so that it matches western Europe would add between $300 and $420 billion to their economies and generate an additional 10 to 14 million jobs.28

The availability of broadband adds between 0.3% to 0.6% to the share of businesses in IT-intensive sectors.29

For every one-percentage increase in broadband penetration in a state within the United States, it has been suggested that employment would increase by between 0.2% to 0.3% per year.30

In areas with broadband, there will be a 2% lower rate of unemployment compared to other urban areas.31

These economic benefits are generated in a variety of ways. Broadband creates jobs directly through the building and subsequent operation of the network.32 The impact of broadband though is wider than this – jobs are created as existing companies build their online presence or develop new innovative services and products.33 A series of studies in recent years from the United States have found a positive relationship between the availability of broadband and employment.34 Quite simply, those US counties with better broadband availability had lower unemployment rates in 2012. Moreover, a 2013 review of the literature exploring the relationship between ICT and productivity observed evidence of how ICT facilitated innovative activity in other sectors of the economy.35 In other words, the benefits of ICT can be felt across the economy wherever they are adopted.


32 For example, it is estimated that the recent £3 billion network expansion announced by Virgin Media in the UK will create 6,000 new jobs, including 1,000 new apprenticeships (Jackson, M. 2015, Virgin Media UK cable broadband network - 17 million premises by 2020, ISP Review, 13 February, available at: www.ispreview.co.uk) while Bell Canada’s fibre investment in Toronto has been estimated to generate between C$900 million and C$1.5 billion of economic output in the next two years through a combination of employment and uses of the network (Singer, H., 2014, Economic impact of FTTH deployment in Toronto, Economists Incorporated, Washington DC, USA).

33 Katz, R. (2012) Impact of broadband on the economy, April, Telecommunications Development Sector, ITU: Geneva Switzerland. An initial appraisal of the ‘Superfast Cornwall’ project in the UK initially after it was completed found that a majority of users stated that it had enabled their business to grow and work in different ways (Superfast Cornwall, 2013, Superfast Cornwall research into the impacts of superfast broadband, November, available at: www.superfastcornwall.org)


An Australian study has tried to quantify the financial benefits from using broadband. Six possible areas where broadband could generate a benefit are identified in the report, with households gaining A$3,800 annually by 2020. As all households are not the same, the report also explores the benefits with respect to different types of ‘typical’ households, finding that all benefited from access to broadband but to different degrees and in different ways. The ‘older age’ household benefits from reduced health care costs while the ‘young professional’ gained in the longer term from the education that they had received. The range of benefits, both financially and hours saved per year, are shown below in Exhibit 2.

### Exhibit 2: The benefits in 2020 (A$)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Financial savings A$</th>
<th>Other impacts A$</th>
<th>Time saved (hours/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single person over 75</td>
<td>7,402</td>
<td>14,586</td>
<td>58</td>
</tr>
<tr>
<td>Student under 25</td>
<td>5,074</td>
<td>651</td>
<td>268</td>
</tr>
<tr>
<td>Single professional over 25</td>
<td>-599</td>
<td>13,113</td>
<td>-377</td>
</tr>
<tr>
<td>Double income, no kids</td>
<td>9,673</td>
<td>n/a</td>
<td>146</td>
</tr>
<tr>
<td>One income, two kids</td>
<td>7,458</td>
<td>3,367</td>
<td>204</td>
</tr>
<tr>
<td>Unemployed under 21</td>
<td>13,074</td>
<td>-370</td>
<td>6</td>
</tr>
<tr>
<td>Empty nesters over 65</td>
<td>2,237</td>
<td>n/a</td>
<td>-33</td>
</tr>
<tr>
<td>Carer / disability household</td>
<td>23,154</td>
<td>6,392</td>
<td>275</td>
</tr>
<tr>
<td>Single mother</td>
<td>484</td>
<td>6,532</td>
<td>14</td>
</tr>
<tr>
<td>Single person household</td>
<td>-1,844</td>
<td>5,367</td>
<td>35</td>
</tr>
</tbody>
</table>


Interestingly the report also looked at the benefits accruing in different parts of the country. Almost all of the ten typical households identified in the report enjoy travel time savings, with the exceptions being the ‘empty nesters’ and ‘single parent’ living in outer regional and remote areas.

Another study, conducted in New Zealand, looked at the impact of broadband on four different sectors: healthcare, education, business services and dairy farming. This study found that the impact of broadband is significant, with the healthcare sector, for example, benefiting to the tune of NZ$5.9 billion. This saving arises from a variety of factors, such as reduced costs and

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37 In all, ten different ‘typical’ households are identified: older age, young student, single professional, couple with two incomes and no children, couple with one income and one child, unemployed, empty nesters, household of two, single parent, single person (Deloitte Access Economics, 2013, *Benefits of high-speed broadband for Australian households*, report commissioned for the Department of Broadband, Communications and the Digital Economy, Canberra, Australia).


40 The corresponding benefits over a 20 year period for education, business services and diary farming were respectively NZ$3.6 billion, NZ$14.2 billion and NZ$9.1 billion (Alcatel-Lucent, 2012, *Building the*
improved access to medical resources. One study in the United States sought to estimate the economic impact of telemedicine in 24 hospitals located in four Mid-western states. The study found that the economic benefit across these hospitals varied from between $20,000 to $1.3 million per year, with the average financial gain being over $500,000 a year.

Furthermore, broadband can help with the tailoring of healthcare solutions to the needs of patients, and with the remote monitoring of patients that reduces, and perhaps even removes, the need to admit them to hospital. Prolonging the ability of older people to, for instance, stay in their own home rather than look after them in a hospital or nursing home not only enhances their quality of life, but it is also cheaper as well. The use of IT in healthcare also offers the possibility of collecting and sharing data, so that new drugs and medical techniques can be developed and the patient provided with better, personalised care.

In July 2015 the Department of Health in the United Kingdom launched an investigation into how the National Health Service could better use IT, in terms of becoming more efficient as an organisation but also with regards to improving the care provided to patients. A range of initial suggestions have emerged, with perhaps the most headline grabbing one being that doctor’s surgeries should aim to have 10% of their patients online by 2017. In addition, it has been suggested that:

- Every National Health Service building should provide free WiFi. This would enable patients to be remotely monitored using apps, or for patients to maintain contact with friends and family through social networking websites.
- Technology can be used to improve the efficiency of the National Health Service through reducing the amount of time that staff spend on bureaucratic matters. Not only would this free up time for other uses, but it would also reduce the number of errors being made as well.

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*benefits of broadband. How New Zealand can increase the social and economic impacts of high-speed broadband, Alcatel-Lucent: Wellington, New Zealand).*


• Awareness of the online services currently available to patients needs to be improved. At the moment, while 98.6% of doctor’s surgeries offer the possibility of booking appointments with a doctor online, this occurs in just 12% of cases. Similarly, while 97.4% of surgeries could issue repeat prescriptions online, this occurred in only 4% of cases.  

However, if the benefits of using IT across the National Health Service are maximised, then those who use the National Health Service with the greatest health and social care needs are also need to be online. And, those who provide health care services also need to have the necessary skills and confidence to make the most of the opportunities that IT use creates. That the UK government has sought to bring together a broad array of interested parties – health and care bodies, doctors, not for profit and civil society – together to explore how IT can be utilised by the National Health Service illustrates the scope of the challenge on the one hand and the need to adopt a multi-dimensional approach to implementation on the other.

Secondly, individuals benefit through being online. Through accessing the Internet consumers are better informed; they can read their favourite newspaper, watch TV or search for information to help them make a purchase or better understand world events. Individuals can also stay in touch with friends and family through social networking websites such as Facebook, or even find romance online through dating websites like match.com.

Individuals also benefit financially. In 2014 the UK government estimated that the annual savings to individuals from being online at £560. While this report did not break down this figure into its constituent parts, others have tried to identify specific areas where individuals benefit. Individuals benefit from the reduced price of goods and services online, and from using price comparison websites to switch between, for example, electricity providers or banks.

There are also time related savings as well for individuals. Not only can they buy their groceries online, but they can also arrange to have them delivered at a time they find convenient. Similarly, they can engage with the government electronically, accessing government services, contacting their elected representatives or even paying their taxes when it is convenient for them – for example, in the United Kingdom 23,000 individuals submitted their tax return on Christmas Day 2013.

In a study on the benefits of teleworking based on broadband in the Netherlands and Belgium, the researchers found that these benefits are related to the use of new Internet based services in

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companies (e-business) and in local government (e-government). The savings in these two areas are expected to be realised in terms of the reduced re-location time of administrative personnel, savings in travel time, decreases in CO₂ emission and reduced usage of letters and paper in the office. The total value of these savings over the period 2010 to 2030 was significant, with the estimate from traditional broadband technologies being €930 million and €1.14 billion using fibre technologies for a medium-sized located city in Europe.  

There are, thirdly, environmental benefits from broadband. A 2007 report from the United States suggested that the widespread adoption of broadband could save as much as 1 billion tons of greenhouse gas emissions over the course of a decade. These savings would arise from a combination of widespread e-commerce adoption, the take-up of telecommuting and teleconferencing and the use of electronic rather than physical products. Furthermore, the provision of medical information online reduces the need to visit a doctor’s surgery. This, of course, has obvious environmental benefits. Another study by the same authors focused on the indirect environmental effects of broadband, linking them to the effects for residents and employers. They found that tele-commuting could reduce greenhouse gas emissions over a 10-year period to the tune of almost 600 million tons from less driving, reduced office construction and the use of less energy by businesses.

More recently, it has been suggested that the use of cloud computing services is another source of environmental benefits, as documents can be shared electronically and not physically. There are also environmental benefits from sharing films online, with research from Sweden suggesting that faster connections increase the environmental benefits achieved. While many examples of the environmental benefits of broadband focus on developed countries, it is worth remembering that they also have a role to play in developing countries. In China, for example, recent research has found that ICT adoption and use does reduce CO₂ emissions, though the impact differs across the country.

In summary: the benefits of broadband are significant and wide-ranging. Broadband contributes to economic growth, and provides users with financial benefits that can be quite substantial. In

58 For example, a subscriber to a newspaper could opt for an electronic rather than physical copy, thereby reducing the need for post on the one hand and the printing and publishing process on the other.
59 Adroit Economics (2011) Economic and social impact of broadband in Berkshire, Prepared by Adroit Economics for and on behalf of Thames Valley Berkshire Local Economic Partnership, Altrincham, Cheshire. This report estimated that within Berkshire, which is a relatively small English county, that the online provision of medical information would result in 120,000 fewer visits to doctors per year.
addition, there are many benefits associated with the use of broadband networks to deliver services. Not only can access to services be improved, but these services can also be tailored to the specific circumstances and needs of users. Finally, there are environmental benefits associated with the use of broadband, through the reduced need to commute or travel on the one hand and the use of electronic rather than physical resources on the other.

Broadband creates opportunities

While the availability of broadband offers the possibility of benefits for residential users, it does not automatically mean that they will utilise the different Internet based services that are available. Research has shown that with an increase in broadband speed residential users will adopt more and a greater variety of Internet based services.\(^6^4\) However, while research has mostly focused on the adoption of conventional Internet based packages (which includes TV, Internet and telephony), adoption decisions of new Internet based services in areas such as health or governmental services have been different.\(^6^5\) With respect to conventional Internet based services, residential users have opted for different packages mainly based on price and speed variations, with new Internet based services user experiences and learning have become predominant.

As broadband availability provides opportunities for residential users, the adoption of Internet based services and the usage of these services differ.\(^6^6\) As has been shown residential users might opt for particular Internet based services, such as Internet provision, but their individual valuation of opportunity costs of leisure time might affect their preference for the usage of entertainment services instead of opting for Internet based services providing educational services. Therefore, broadband availability provides residential users with an option to utilize particular Internet based services, which they then might or might not utilize.

And as the speed of broadband connections improve, more demanding applications can be used online as well as multiple devices used simultaneously. The Information Technology & Innovation Foundation has explored what is possible with existing and next generation Internet access.\(^6^7\) The range of possibilities, using existing and next generation Internet access, is illustrated in Exhibit 3 (below). The existing Internet allows, for instance, music to be downloaded and thus shared, but with next generation access it is possible for musicians to collaborate remotely when composing and recording music. Faster connections also allow for more devices to be connected simultaneously to the Internet. As households increasingly have


multiple devices, they demand better connections so that they can access online services like video streaming and gaming.

Exhibit 3: The differences between today’s and the next-generation Internet

<table>
<thead>
<tr>
<th>Today’s Internet</th>
<th>Next-generation Internet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent: downloading music from all over the world</td>
<td>Collaborative: creating music with other musicians all over the world</td>
</tr>
<tr>
<td>Reactive: websites</td>
<td>Interactive: virtual worlds</td>
</tr>
<tr>
<td>Private resources: online backups</td>
<td>Shared resources: online file servers and remote devices</td>
</tr>
<tr>
<td>Centralised computing: local data sets and computing</td>
<td>Cloud computing: distributed data sets and computing</td>
</tr>
<tr>
<td>One-to-one or one-to-many communication: webcam chats</td>
<td>Many-to-many communications: virtual conferences</td>
</tr>
<tr>
<td>Lower quality: lower quality audio and video</td>
<td>High quality: high-definition audio and video</td>
</tr>
</tbody>
</table>


The development of digital skills has been a key mechanism through which residential users increase their use of Internet based services. These skills are highly dependent on the way users deal with new Internet technologies such as social media, websites, web forums and discussion groups. These skills are developing as users experiment and learn how to use these new Internet technologies. Therefore, the way these digital skills are developing is through ‘learning-by-doing’ and is dependent on the purpose Internet technologies are used for on the one hand and the resources a residential user want to access with these technologies on the other.

With greater availability of broadband, new strategic options are emerging for small and medium-sized enterprises as well. While large (multinational) enterprises can easily provide sufficient broadband infrastructure and Internet based services for themselves, small- and medium-sized enterprises (SMEs) are mostly unable to do so. They are later adopters and users of Internet based services such as digital supply chain management or customer relationship management systems. SMEs can develop new business models to exploit these new strategic options through,

68 A recent report focusing on selected Asian markets highlighted the widespread trend of multiple device ownership (Appier Research Report, 2015, *Cross-screen user behavior insights Asia 1H*, available at: www.appier.com). In those countries included in the analysis, a majority of multiple device owners in every case owned two devices. Interestingly in Japan a third of multiple device owners had four or more devices, with the corresponding figure in Australia and Taiwan being a fifth.


for example, entering into partnerships with other companies or by discovering new markets. While the availability of broadband creates new strategic options for companies that can translate via the use of Internet based services into more employment and increased productivity, this is particularly true for SMEs.⁷⁴ The support for this is widespread:

- Germany: broadband-based Internet access resulted in more innovative activity.⁷⁵
- Ireland: broadband adoption positively impacts on firm productivity and productivity growth in manufacturing firms.⁷⁶
- Italy: small and medium enterprises benefited more when they adopted advanced rather than basic broadband services.⁷⁷
- New Zealand: the adoption of broadband positively impacted on firm productivity.⁷⁸
- USA: The availability of broadband increases the development of new business models such as the exploitation and marketing of farm campsites or the creation of web-shops selling agricultural products.⁷⁹

It is clear, therefore, that broadband creates opportunities. These opportunities emanate not only from broadband providing access to a range of services but from individuals and companies using these services in a creative and innovative fashion. This will result in productivity gains for companies as well as enable new ways of working, changes in consumption patterns and how we engage in leisure activities.

Broadband availability through mandated access

In July 2015, the CRTC extended wholesale mandated access requirements to fibre-to-the-premises (FTTP).⁸⁰ This expansion took the form of mandated access, which is when one company uses the network of another to provide services to its own customers. In the decision taken by CRTC, the mandated access decision required cable and telephone access networks using DOCSIS 3 and FTTP to be made available to competitors at regulated rates.

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Today Canada is arguably already well served by infrastructure providers. In 2014, two wireline broadband technologies – DSL and cable modem – were available to 82% of households across Canada, with a slightly lower proportion of connections in each case delivering speeds of more than 5 Mbps. However, these DSL and cable modem based networks are not suitable for everyone in tomorrow’s digital economy due to the use by many of data demanding innovative services provided through dynamic coalitions of companies. In contrast, FTTP based infrastructure will be able to support such services and is future proof as well. Hence, not only will mandated access ensure that existing networks are not expanded geographically into those areas not already served but it will also remove the incentive for companies to invest in FTTP. In other words, mandated access will result in the infrastructure needed tomorrow not emerging.

It was hoped that those companies who entered the broadband market through using the network of another company would, over time, build their own infrastructure. How this hope would occur in practice is often explained with reference to the ‘ladder of investment’, a metaphor that equates sequential infrastructure investment to the rungs of a ladder. While the ‘ladder of investment’ metaphor has influenced regulatory bodies, especially but not exclusively within Europe, there is a growing body of research that suggests that infrastructure investment has not developed as expected. One extensive review of the academic literature highlighted the range of opinions regarding the relationship between access regulation and investment, while noting that a majority of the research examining local loop unbundling found that it discouraged infrastructure investment by both the incumbent and new entrants alike. Other research has found that within the European Union access regulation has a negative impact on the willingness of companies to

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83 79% of households had access to a connection of more than 5 Mbps through DSL and 81% via cable modem (Canadian Radio-television and Telecommunications Commission, 2015, Communications Monitoring Report, October, available at: www.crtc.gc.ca).


The dynamic relationship between networks, users and services

Mandated broadband access does not provide infrastructure investment incentives. Despite these rather disappointing results, mandated broadband access has been used by policy makers. Empirical evidence has, however, shown that mandated access has had a negative effect on new infrastructure investment and put new entrants at a disadvantage as well. To address the societal challenges of a digital economy, a key task for policy makers is to remove the disincentives and barriers to continuous investment in broadband infrastructure and to develop new services in areas like healthcare, education, energy and security.

With the emergence of new Internet-based services in the area of health, education, smart grids or security, residential users will be able to appropriate the real, external effects of broadband. However, as these new Internet-based services are developed in other (non-broadband) sectors, their emergence is not only dependent on the dynamics in the (other) sector but also access to the broadband network is required to facilitate their growth. In this respect, broadband can develop its full potential as a general purpose technology, enabling growth elsewhere in the economy.

There is a need for companies to develop a critical mass of users of new services in areas such as healthcare and security. For residential users, the provision of Internet-based health care services such as video contact with home care workers or tele-monitoring of patients with chronic diseases requires health care companies to become involved in the provision of new services. In cases order to obtain access to the broadband network, health care providers have to work together with Internet service providers and service operators to develop a critical mass of residential users for


their new services. In addition, telecommunication companies have to cooperate with health care providers when discussing the technical requirements at the passive layer, for example, the availability of virtual private networks connections or greater standardization with respect to the underlying broadband technology. For health service providers, privacy considerations have triggered (or impeded) investment in health monitoring services. Similarly, those SMEs interested in installing real-time TV surveillance at an industrial park require security service providers to cooperate with broadband service providers to provide e-security services. For these service providers, a minimum critical level of small- and medium sized firms is required to guarantee the provision of security services (using real-time TV surveillance) for companies at a particular location or even at different industrial parks.

In general, users affect not only the innovation processes of retail providers by opting for particular service packages, but users change their behaviour as a result of the availability of broadband and Internet-based services. In this respect, users are ‘co-evolving innovators’, that is, they not only influence the output of the whole ICT ecosystem but they also decide how the system works. For residential users, for example, the availability of new services in the area of health is dependent on local demand and on the interaction with health service providers providing these services targeted to the needs of the local community. For small and medium sized enterprises at industrial parks, the availability of broadband does not guarantee that companies will use any Internet-based services requiring high capacity. But SMEs will adopt surveillance services using real-time TV cameras if insurance companies provide discounts to those companies subscribing to the service. In these cases, co-adoption between end users and providers from other industries – for example, health insurance or security providers – are important for adoption.

Infrastructure, skills and use together drive the digital economy

Many governments around the world have drafted national broadband plans. While these plans reflect the specific circumstances facing a particular country, a survey of the plans by the OECD reveals that common themes can be identified. Governments have, for example, set targets, either in terms of the percentage of the population where broadband will be available or the specific speeds to be delivered. Recognising the role that the Internet can play educationally, some governments have sought to ensure that broadband is available to schools, colleges and universities, while others have sought to overcome the lack of digital skills that prevent many from going online.

What the survey highlights is how national broadband plans are as much about skills and use as they are about infrastructure. The dynamic interplay between these three areas is clear in a report


from the International Telecommunications Union that proposes an ‘ICT Development Index’.\textsuperscript{101} The position of a country on the index is determined by three sub-indices covering the areas of use, access and skills.\textsuperscript{102} In 2015, a majority of the countries in the top ten positions of the overall index are from Europe, though the number one spot goes to Korea. Interestingly, most of these European countries have relatively small populations: for example, Denmark is ranked second on the list (5.7 million people), while Luxembourg is sixth (562,000).\textsuperscript{103} The two exceptions are the United Kingdom, which is ranked fourth, and the Netherlands, which occupies the eight spot, whose populations are 64 million and 16 million respectively.

Exhibit 4 ranks the G7 group of countries by their position in the 2015 overall index. The list is headed by the United Kingdom, with Canada coming sixth. There are two lessons to be drawn from this table. Firstly, Canada’s position between 2010 and 2015 has slightly declined, as has that of Japan. In contrast, the United Kingdom has been able to substantially improve its position between 2010 and 2015, rising from tenth to fourth. The United Kingdom’s position highlights the second lesson, namely, that how the performance of a country can vary across the three sub-indices. As can be seen from Exhibit 4, the UK does very well on the access and use sub-indices, but not on the skills sub-indices. This suggests that if the UK is to improve its position next year, it will need to improve quite substantially its position on the skills sub-indices while maintaining its relative position on the other two sub-indices.

Exhibit 4: Internet development index, 2015

<table>
<thead>
<tr>
<th>Country</th>
<th>Overall rank 2015</th>
<th>Overall rank 2010</th>
<th>Access sub-index ranking (out of 167)</th>
<th>Use sub-index ranking (out of 167)</th>
<th>Skills sub-index ranking (out of 167)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>4</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>44</td>
</tr>
<tr>
<td>Japan</td>
<td>11</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>35</td>
</tr>
<tr>
<td>Germany</td>
<td>14</td>
<td>17</td>
<td>5</td>
<td>23</td>
<td>33</td>
</tr>
<tr>
<td>USA</td>
<td>15</td>
<td>16</td>
<td>31</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>France</td>
<td>17</td>
<td>18</td>
<td>12</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>Canada</td>
<td>23</td>
<td>21</td>
<td>22</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>Italy</td>
<td>38</td>
<td>31</td>
<td>36</td>
<td>40</td>
<td>32</td>
</tr>
</tbody>
</table>


Canada was sixth among the G7 countries in both 2010 and 2015. If it is to improve its position among this group of countries, the sub-indices suggest that an across the board response is required. As the mandated access decision of CRTC removes the incentives of companies to invest in infrastructure, the position of Canada on the access sub-index will not improve. Indeed, quite the opposite will occur: as other countries invest in their own infrastructures the position of Canada on the ranking will fall. The position of Canada on the use sub-index has fallen between 2010 and 2015, from 18\textsuperscript{th} to 26\textsuperscript{th} position respectively, highlighting the need for policy initiatives


\textsuperscript{102} The ICT Development Index is a weighted index of three sub-indices: access (40%), use (40%) and skills (20%). In turn, each sub-index is further divided to five parts for access, three for use and three for skills (International Telecommunications Union, 2015, Measuring the Information Society Report 2015, ITU, Geneva, Switzerland).

\textsuperscript{103} In rank order the top ten countries are as follows: Korea, Denmark, Iceland, United Kingdom, Sweden, Luxembourg, Switzerland, Netherlands, Hong Kong and Norway (International Telecommunications Union, 2015, Measuring the Information Society Report 2015, ITU, Geneva, Switzerland).
in this area. Focusing solely on access as the CRTC decision does will not help address the need to ensure that Canadians use their broadband connections, while improving skills is of little value if they do not actually use the Internet.

Exhibit 5 brings together broadband connectivity, Internet use and its external effect on the economy. The relationship between these three factors is not linear. While broadband connectivity is surely a key indicator of the development of the digital economy within a country, it is not necessarily the most important one.
Exhibit 5: Stages model of broadband adoption and its impact on the digital economy

Exhibit 6 shows, for a number of European countries with advanced broadband infrastructure, how broadband connectivity is linked to Internet use. The table shows that for residential users in most countries high household access to broadband (column 2) is related to high Internet use as shown by the frequency of Internet access (column 3). Therefore, a well-developed broadband infrastructure is a pre-requisite for widespread and greater intensity of Internet use by consumers. Slovenia and Poland represent an exception as Internet use of residential users is lower compared to countries with a similar broadband infrastructure like Slovakia and Latvia. This suggests that there are other factors involved in facilitating greater Internet use by final consumers such as the development of ICT skills.

For business users, broadband connectivity is measured as a percentage of companies with a wireline broadband connection (column 4), while Internet use is measured by the percentage of companies selling through the Internet (column 5). For most countries, broadband connectivity is a precondition for selling through the Internet but, once more, it is not the only factor determining whether companies use the Internet. For example, countries with a similar level of business use of the Internet like Belgium and Germany can display very different patterns with regards to broadband access: 25% of companies sell via the Internet in these two countries, yet access to broadband varies between them, being 95% in Belgium and 86% in Germany. Greater broadband availability presents companies with more options to use the Internet for different business activities, but the ICT skills of the personnel within companies is an important determinant when explaining their ICT usage patterns.
Exhibit 6: Broadband connectivity and Internet use, selected European countries 2015

<table>
<thead>
<tr>
<th>Countries</th>
<th>Households with broadband access</th>
<th>Frequency of Internet access (once a week)</th>
<th>Percentage of enterprises with wireline broadband connection</th>
<th>Percentage of enterprises selling via the Internet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slovenia</td>
<td>75</td>
<td>68</td>
<td>96</td>
<td>16</td>
</tr>
<tr>
<td>Poland</td>
<td>71</td>
<td>63</td>
<td>77</td>
<td>10</td>
</tr>
<tr>
<td>Slovakia</td>
<td>76</td>
<td>76</td>
<td>87</td>
<td>13</td>
</tr>
<tr>
<td>Latvia</td>
<td>73</td>
<td>72</td>
<td>91</td>
<td>9</td>
</tr>
<tr>
<td>Hungary</td>
<td>74</td>
<td>75</td>
<td>85</td>
<td>11</td>
</tr>
<tr>
<td>Estonia</td>
<td>81</td>
<td>82</td>
<td>94</td>
<td>13</td>
</tr>
<tr>
<td>Sweden</td>
<td>87</td>
<td>91</td>
<td>94</td>
<td>26</td>
</tr>
<tr>
<td>Germany</td>
<td>87</td>
<td>82</td>
<td>86</td>
<td>25</td>
</tr>
<tr>
<td>Belgium</td>
<td>81</td>
<td>83</td>
<td>95</td>
<td>25</td>
</tr>
<tr>
<td>Iceland</td>
<td>93</td>
<td>97</td>
<td>98</td>
<td>23</td>
</tr>
<tr>
<td>UK</td>
<td>88</td>
<td>89</td>
<td>95</td>
<td>20</td>
</tr>
<tr>
<td>Norway</td>
<td>88</td>
<td>95</td>
<td>89</td>
<td>26</td>
</tr>
<tr>
<td>France</td>
<td>77</td>
<td>80</td>
<td>98</td>
<td>16</td>
</tr>
<tr>
<td>Netherlands</td>
<td>95</td>
<td>91</td>
<td>96</td>
<td>17</td>
</tr>
<tr>
<td>Denmark</td>
<td>85</td>
<td>92</td>
<td>90</td>
<td>26</td>
</tr>
</tbody>
</table>


In other words, a key mediating factor in explaining the link between broadband connectivity and Internet use are the development of ICT skills. The development of these skills is, to a certain degree, dependent on educational levels, but, to a larger degree, it is also shaped by the ‘learning-by-using’ processes that characterise the Internet. Moreover, and perhaps as equally important, is the evolution of new Internet-based services in other sectors such as health, education and surveillance as these encourage Internet users by individual and business consumers. The potential of broadband adoption will only be realised if these other sectors are affected.\(^{104}\)

However, as these external effects will not come about by themselves there is a role for governmental institutions at different levels to act as ‘bridging institutions’ between the broadband and non-broadband sectors. Learning of examples of ‘best practices’ in the use of new Internet-based services in areas like e-health and e-education will play a pivotal role in facilitating the evolution of the digital economy that is taking shape. In addressing the societal challenges of today’s digital economy, governmental initiatives should target areas that are considered as vital for the development of society as a whole. In the areas of health and environmental benefits, broadband and the use of Internet-based services can provide innovative solutions by contributing to the self-reliance of the elderly and by reducing emissions due to teleworking. Training and education will play a vital role in developing the Internet-related skills of individuals and businesses, especially in small- and medium-sized enterprises.

The improved and more extensive ICT skills of residential users will influence the way in which people are able to participate in the digital economy, start new web-based companies and generate new sources of income from ICT related activities. Moreover, within SMEs there will be a greater need for employees with ICT skills who can then capture the opportunities arising from

new Internet-based services in areas such as e-procurement, customer relationship management or supply change management. The development of these skills needs to be priority as SMEs are currently unable to satisfy their needs in new emerging ICT areas like big data and cloud computing.\(^{105}\)

In order to generate the indirect effects of broadband in emerging areas like e-health and e-education new coalitions, alliances, of broadband operators, service providers and, in the case of e-health, health insurance companies are needed. These coalitions are broadly based and essential if the potential of broadband is to be unleashed. Here the government is needed to address the challenges of the digital economy, to build private-public coalitions targeting these challenges and to develop innovative policy instruments that facilitate the development and growth of these new coalitions.

Summary

A significant and far-reaching digital economy is emerging. This digital economy is broader than those activities like buying books or groceries online that many of us now take for granted, encompassing the use of Internet-based technologies by companies as well as governments. It promises to create new jobs and fuel economic growth as broadband networks are built and new innovative Internet-based services emerge. Aside from these economic benefits, the widespread use of broadband and Internet-based services will have an environmental impact and help deliver improve the delivery of key social Internet-based services such as healthcare.

However, if these benefits are to be achieved then something more than ensuring the availability of broadband infrastructure needs to happen. The mandated access decision taken by CRTC will not expand the coverage of broadband infrastructure within Canada and removes the incentives for companies to invest in the future in the networks required to support the digital economy that is emerging. As such, it harms the development of a vibrant digital economy within Canada. Furthermore, by focusing on the mandated sharing of infrastructure the decision ignores the need to ensure that individuals and companies within Canada use the Internet-based services that are available or that they possess the ICT skills necessary to exploit the opportunities that abound in the digital economy. Infrastructure, ICT use and ICT skills together shape the digital economy, in terms of how existing opportunities are exploited and new ones arise. Infrastructure provides broadband connectivity, but individuals and companies will not be able to exploit this if they lack the relevant ICT skills required to use the Internet-based services that are available. Quite simply, the focus needs to shift away from broadband infrastructure to include the development of ICT use and ICT skills as all three elements interact in shaping the digital economy. It is only through adopting a wide-ranging approach will Canada realise the undoubted benefits that the digital economy offers.

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Appendix 1: Biography of Professor Jason Whalley

Current position: 2013 onwards, Professor of Digital Economy, Newcastle Business School, Northumbria University, Newcastle, UK

Previous position: 2000-2013, Lecturer then Senior Lecturer and Reader, Department of Management Science, University of Strathclyde, Glasgow, UK

Education: PhD Management Science, Department of Management Science, University of Strathclyde, Glasgow, UK

MA International Relations, University of Leeds, Leeds, UK

MA Geography, University of Cambridge, Cambridge, UK

Books


Articles


Appendix 2: Biography of Dr Bert Sadowski

Current position: 2002 onwards, Associate Professor in Economics of Innovation and Technological Change, University of Technology, Eindhoven, The Netherlands

2014-2017, Distinguished Expert in Intellectual Property Rights, Wuhan University of Technology, China

2015 onwards, Visiting Professor, Newcastle Business School, Northumbria University, Newcastle, UK

Previous positions: 2000-2002, Associate Professor and Chair International Management, Nijmegen School of Management, Nijmegen, The Netherlands

1998-2002, Senior Researchers and Assistant Professor, Technical University, Delft, The Netherlands

1995-1998, Researcher and Assistant Professor, MERIT and Universiteit Maastricht, The Netherlands

Education: PhD Technology Strategy, Science Policy Research Unit, University of Sussex, Brighton, UK

MSc Technology & Innovation Management, Science Policy Research Unit, University of Sussex, Brighton, UK

Books


Articles


Research reports


**Research projects 2002 onwards**

The importance of open access for publicly financed broadband networks for Province of Noord Brabant (June – September 2015)

Evaluating the Social Benefits of Broadband Networks for Province of Noord Brabant (November 2013- February 2014, €20,000)

Next Generation Infrastructures Project - “What are the public benefits of open access? Evaluating the social cost and benefits of municipal broadband networks” 2012-2014, with University Ghent. Project nr. 02.30 TUE (€180,000)

Next Generation Infrastructures Project - Co-Producing Service Innovations: Fiber Infrastructure and Strategic Use of ICT applications by SMEs, Project nr. 04.14.TUE, (starting 2010-2014, €508,000)


NWO (Dutch National Science Foundation) project - A case of Services of General Economic Interest? A Real Options Analysis of Municipal Broadband Networks in the Netherlands, NVN 458-06-006 (starting 2007 – 2010, €250,000)

Project - I-Vision Broadband, Municipality Eindhoven with Department Electrotechnology, TUE (2007, €70,000)

Project - Evaluation of the Austrian Center for Innovation and Technology (ZIT), together with Regional Consulting and Convelop for Austrian Chamber of Commerce, Vienna (2007)

Member of DIME (Dynamics of Institutions and Markets in Europe) project, Network of excellence, coordinated by the University of Eindhoven involving cooperation with 25 European universities and research institutes including Cambridge University, Max Planck (Jena) and Fraunhofer Institute (2006 - 2009).

EU Project - The Structure of Innovation and Economic Performance Indicators (SIEPI) The variety of innovation efforts and the effects on growth, employment and international production in the sectors of the European economy (Contract n. HPV2-CT-2002-00017) (2003 – 2005)
