CHAPTER 1.5

Fiber Broadband: A Foundation for Social and Economic Growth

SEAN WILLIAMS
BT

Sustainable, long-term growth in the European Union (EU) is vital to the overall health of the world economy. For a developed region such as the European Union, a significant proportion of growth is likely to come from knowledge-based industries, underpinned by information and communication technologies (ICTs). Indeed, the European Commission's Europe 2020 vision describes such a future for the region in the Digital Agenda.[1]

The foundation for digital prosperity is fiber broadband Internet access, often referred to as *superfast broadband.* In describing the economic benefits of Internet adoption, a report for the McKinsey Global Institute says: "[broadband] infrastructure, the backbone of the entire Internet ecosystem, is an irreplaceable prerequisite. It creates the platforms upon which users, and organizations experience the Internet, and upon which entrepreneurs and businesses innovate."[2]

Indeed, superfast broadband access has the potential to transform local economies, businesses, households, and public services. It will help improve the performance of existing firms, enable new businesses to emerge, and encourage flexible working patterns. Superfast broadband is key to opening global markets to regions previously denied access, providing new job opportunities, and boosting productivity.

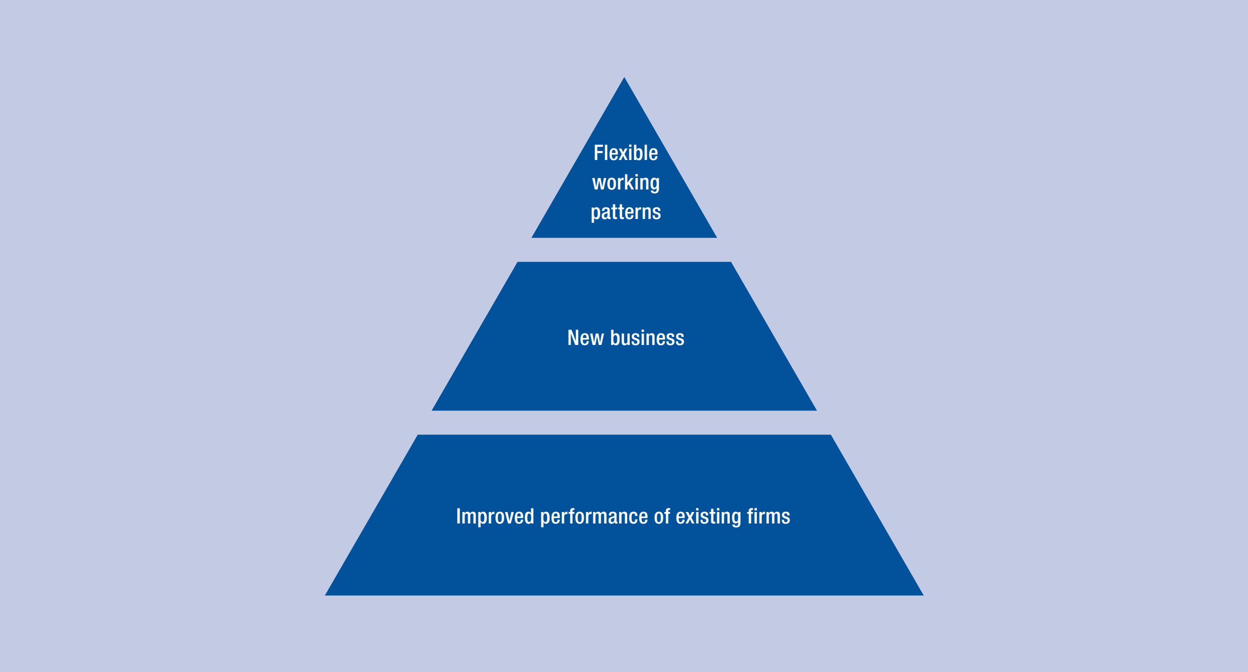
Statistical evidence of the positive economic impact of broadband infrastructure has existed for some years. According to the Broadband Commission, a joint body of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Telecommunication Union (ITU), every 10 percent increase in broadband penetration results in additional growth of 1.3 percent in national gross domestic product (GDP).[3] Similarly, in a 2011 study across 33 countries in the Organisation for Economic Co-operation and Development (OECD) by Chalmers University of Technology, consultancy Arthur D. Little and ICT vendor Ericsson found that doubling the broadband speed for an economy increases GDP by 0.3 percent.[4]

New research now available from Regeneris Consulting provides even greater detail about the potential economic impact of superfast broadband in urban and—crucially—less-developed rural areas, as demonstrated later in this chapter.[5]

Investment in fiber broadband also has the potential to deliver social goods, for example by improving public service levels in areas such as health, education, e-government, and democratic participation at lower cost than would be available offline. Evidence for social goods is anecdotal rather than statistical.

The idea that broadband infrastructure can drive economic development has been championed for some time. Indeed, broadband infrastructure, coupled with a functioning and fair market for access and services, is central to Europe 2020 and the Digital Agenda for Europe;[6] it underlies similar strategies adopted by

Figure 1: Economic impacts of superfast broadband



Source: Regeneris Consulting, 2012.

OECD governments, including the UK government;[7] and is espoused on a global scale by the Broadband Commission.[8]

However, much of the thinking behind these strategies predates the euro crisis. We need to recognize that the effects of the global financial crisis that began in 2007 are still being felt more than five years later—and even now, there is no immediate end in sight.

We no longer operate in a world where "build it and they will come" is a viable strategy for developing national-scale infrastructure. Nor are communication markets currently in a healthy state. Revenues are shrinking for telecommunication providers at the same time that operating costs are increasing because of the rising demand for data on networks.

How can the global, international, and national visions for universal broadband Internet access be fulfilled? Should these visions be put on hold until more favorable economic conditions emerge, or should they even be abandoned?

No, the big vision still holds promise. However, new means of execution—in terms of both technology and market dynamics—are required for an era where the public purse is tightly constrained and the ability of private firms to raise capital is diminished.

This chapter advances the debate first by reviewing recent independent research from the economic consultancy Regeneris Consulting, detailing the economic impact of high-speed broadband infrastructure on environments as diverse as capital cities and economically deprived rural regions. Second, it aims to articulate technical and market solutions that can meet the challenge of the current economic climate.

ECONOMIC IMPACT

BT recently commissioned Regeneris Consulting to assess the potential economic benefits of BT's £2.5 billion investment in fiber broadband in the UK market,[9] focusing on four areas:

- Norfolk and Suffolk, a rural area;
- Caerphilly, a town in Wales;
- Sunderland, a city in the northeast of England; and
- London, the United Kingdom's capital city.

As businesses increasingly move into the digital realm, fast Internet access is arguably more important than conventional physical infrastructures in supporting vital flexibility. Where fiber broadband is prevalent, businesses can be encouraged to remain in or relocate to regions previously excluded from traditional regeneration, creating jobs and bringing economic growth to those areas.

Supplying commercial premises with fiber broadband will help businesses grow and benefit the local economy by facilitating flexible working patterns, enabling new startup businesses, and helping to improve the performance of existing businesses (see Figure 1).

Improved performance of existing firms

Fiber broadband will allow businesses to operate more efficiently and to develop new products and services:

- Small and medium-sized firms will be able to take advantage of the latest generation of online collaboration tools—such as file and document sharing, shared workspaces, and high-definition video conferencing—that, before the advent of fiber broadband, only large enterprises could afford to exploit.

- Real-time online collaboration among colleagues and business partners can accelerate decision making and time to market, and reduce delays and the need for business travel. By reducing or even eliminating the requirement to travel, it can reduce a firm's carbon footprint and improve employees' work-life balance.

- Several people can share the same connection and not notice any degradation in performance, even if they are using bandwidth-hungry applications such as video conferencing or uploading large files.

- In all types of business, interaction with customers and suppliers can also be enhanced—for example, by enabling slicker, more interactive e-commerce sites, and by reducing the time needed to upload product demonstrations and how-to videos to both the business's own site and social media sites such as YouTube.

Regeneris expects knowledge-based industries, and the places where they are most concentrated, to exploit faster broadband most effectively and generate the greatest impacts. For example, the time required for transferring large files such as videos, graphic designs, or software applications can be cut from hours to minutes.

New businesses

Fiber broadband is expected to help greater numbers of new businesses emerge by reducing barriers to entry in certain sectors. Although there are many ways in which this can occur, cloud computing is perhaps the most significant because it dramatically reduces the required upfront capital and ongoing support costs of setting up in business and allows steady, flexible growth.

Superfast connectivity will also help firms of all sizes exploit cloud computing so they can scale their information technology (IT) systems dynamically to fit their business needs, obviating the requirement for firms to invest in server hardware and software licenses. This can further help relieve the IT burden by making remote data storage and backup easy to operate in the background. The burden of security and upgrade falls to the service provider and not to the business.

The carrot of abundant fiber broadband can also encourage firms with purely digital business models to relocate to previously underdeveloped areas.

Flexible working patterns

Widespread availability of fiber broadband will allow more flexible working patterns, opening up new employment opportunities and enhancing the productivity of existing staff. With fiber broadband, employees will be able to access data and applications from home, on the move, or at the premises of customers or suppliers with the same alacrity as they can in the office.

Regeneris estimated the cumulative impact on jobs and gross value-added (GVA) among new and existing firms exploiting faster, next-generation broadband services over 15 years. In conducting the analysis, it was assumed that the uptake and exploitation of faster services will, in time, approach those currently found for ADSL services. Regeneris drew on research from across Europe to inform these assumptions.

Findings in detail

For any one location—whether a rural area, a town, or a city—Regeneris found that fiber broadband could create between £143 million and £19.8 billion in additional GVA. This equates to an annual increase in GVA of between 0.3 percent and 0.5 percent.

For the rural area of Norfolk and Suffolk, for example, Regeneris found that fiber broadband could lead to:

- an annual increase in GVA of 0.3 percent per annum over 15 years: every £1 a business invests in fiber broadband in this rural area will create nearly £15 in additional GVA for the UK economy;

- roughly 1,470 business startups and support for 7,780 home workers as a result of cloud computing; and

- around 1,810 jobs created through business startups and increased levels of trading at existing businesses.

For the UK town of Caerphilly, Regeneris found that fiber broadband could lead to:

- an annual increase in GVA of 0.5 percent per annum over 15 years: every £1 a business invests in fiber broadband in this town will create nearly £16 in additional GVA for the UK economy;

- roughly 140 business startups and support for 1,030 home workers as a result of cloud computing; and

- around 225 jobs created through business startups and increased levels of trading at existing businesses.

For the UK city of Sunderland, Regeneris found that fiber broadband could lead to:

- an annual increase in GVA of 0.4 percent per annum over 15 years: every £1 a business invests in fiber broadband in this city will create nearly £14 in additional GVA for the UK economy;
- roughly 320 business startups and support for 1,580 home workers as a result of cloud computing; and
- around 436 jobs created through business startups and increased levels of trading at existing businesses.

For London, the United Kingdom's capital city, Regeneris found that fiber broadband could lead to:

- an annual increase in GVA of 0.5 percent per annum over 15 years: every £1 a business invests in fiber broadband will create nearly £10 in additional GVA for the UK economy;
- roughly 6,600 business startups and support for 73,000 home workers as a result of cloud computing; and
- around 26,200 jobs created through business startups and increased levels of trading at existing businesses.

In some economically deprived areas of the United Kingdom, these dynamics are already at work. For example, a business in Northern Ireland called Print It For Me saves two hours a day that was previously spent waiting for files to download.[10] It also saves £7,500 a year by using cloud-based backup for its IT systems, replacing onsite equipment. The business concept is relatively simple, but it would not be possible without the ability to handle large files quickly over fiber broadband.

These types of businesses attract creative, tech-savvy people who, in turn, bring prosperity to the region. With this in mind, Cornwall and the Isles of Scilly in the far west of England aim to become one of the best-connected rural areas in Europe.[11]

In September 2010, BT announced an investment of £78.5 million, backed up by a further £53.5 million from the European Regional Development Convergence funds and investment from the local authority of Cornwall and the Isles of Scilly. The intention was, and remains, to boost the local economy by attracting and retaining high-tech, high-growth, creative, and low-carbon businesses that make use of high bandwidth.

According to local authority leaders, the rollout will create an estimated 4,000 new jobs and protect a further 2,000 jobs that are currently under threat from the recession.

SOCIAL IMPACT

What applies to businesses in terms of increased efficiency and effectiveness can also apply to public services. Online delivery of services can unlock significant cost savings and serve to increase levels of satisfaction among citizens.

Nevertheless, the social impact of superfast broadband is more difficult to quantify than its impact on jobs and economic performance. Real benefits around improved access to lifelong learning, social inclusion, more flexible working possibilities, and enhanced social capital may be realized through superfast broadband.[12] Also evident is the blurred area where the wider economic impacts of superfast broadband take-up translate into social goods such as retained and created jobs, reduced transport congestion that in turn reduces costs, enabled virtual agglomeration, and improved economic adaptability and resilience.[13]

Enough anecdotal evidence has accumulated over the years to present a body of potential best practice, even though it is not easy to measure social impacts objectively. Some of this evidence is presented below.

Citizen services

In 2010, the Guldborgsund Municipality in Denmark opened what is arguably the first video-linked citizen services center in Europe.[14] The center enables citizens in the remote region to receive one-on-one advice from government officials at a much lower cost than a staffed center could provide. Without this cost savings, the center would have had to close, depriving the citizen of this service. Other Danish municipalities are looking to adopt the concept.

On a more humble scale, the cost to the United Kingdom's Driver Vehicle Licensing Agency of issuing vehicle excise licenses has been cut by 45 percent since the process was transferred online, saving around £8 million a year. The new system was used by 18 million people in 2008.[15]

Fiber broadband makes such systems intuitive and fluid to use.

Healthcare

These dynamics can also be applied to health services. For example, the US Veterans Health Administration (VHA), which provides healthcare for approximately 6 million military veterans, makes extensive use of e-health technologies.[16] Telemedicine is used in radiology, mental health, cardiology, pathology, dermatology, and in-home care tele-consultations for patients with spinal cord injuries and those with other chronic conditions.

The current and previous US administrations have cited the VHA as a model for the rest of the US healthcare industry for providing efficient and effective medical care. Other health authorities are looking to learn from the VHA's techniques.[17]

Of course, hospitals cannot be replaced by broadband connections, but many health services lend themselves to online delivery. Among these telemedicine services are booking appointments; consulting with experts; and providing information about healthy diet, exercise, treatment, and recovery after illness or treatment.

Education

With fiber broadband, similar models can also be applied to education. Academic establishments can offer remote access to live lectures and self-paced tuition as part of lifelong learning, bringing access to education to those who—because of a disability or for economic or social reasons—are unable to regularly attend an academic institution.

Numerous examples of this are already in use across academia, which has benefitted from the high-bandwidth Joint Academic Network (JANET) for many years. One such instance is the Blackboard virtual learning environment running at Bradford University in the north of England, which enables students and academic staff to collaborate remotely on learning materials.[18]

Local schools can also use remote-access, shared-learning facilities to enable parents to participate more in their children's education and build a sense of community around the school. One example of this is Radio Sandaig, run by Sandaig primary school in Scotland.[19]

Furthermore, fast broadband access enables existing health and education establishments to amplify the services they can offer in the region by tapping into the expertise available in national and even international centers of excellence.

AFFORDABLE FIBER

How will the vision for a sustainable, growing economy and improved society built on fiber broadband be achieved when the public coffers are all but empty and private capital expenditure is laboring under severe constraint?

The answer to this lies in two places: the technology used for fiber broadband, and the dynamics of a competitive market for access and value-added services. Deployment needs to be as efficient as possible, making the best use of the resources available and minimizing disruption associated with the transition.[20]

Why not mobile?

With the arrival of 4G wireless infrastructure in various parts of Europe, the mobile phone network now offers connection speeds that potentially match those of fixed broadband. Tests show that early 4G networks are typically capable of delivering 36 Mb/s download and 16 Mb/s upload speeds.[21] Economically loaded commercial networks in the field are, realistically, likely to be considerably below these speeds. So could mobile, rather than fixed wire, provide a viable economic infrastructure for superfast broadband?

The problem here is one of cost of deployment in a capital-constrained environment: mobile requires expensive new infrastructure and wireless spectrum is rationed, whereas fixed wire can leverage the telephone infrastructure already in place.

Furthermore, wireless uses a shared resource for connection to the customer. Thus, the more bandwidth customers consume, the more spectrum and/or base stations are required, so costs increase rapidly with uptake. Eventually this becomes uneconomic. Fixed-wire broadband has a far more graceful capacity-uplift roadmap, even when hybrid fiber/copper solutions, such as fiber-to-the-cabinet (FTTC), are deployed.

Arguably, a pure fiber infrastructure—where a fiber connection is provided to every subscribing premise (FTTP, also known as FTT*x* or FTT-home/-premise/-subscriber)[22]—is unlikely ever to be capacity-constrained because operators can simply add wavelengths to increase capacity if needed. However, the economic costs of universal FTTP delivery are prohibitive.

That said, high-speed mobile data does have a role to play in a superfast infrastructure, as an in-fill technology to reach remote communities where fixed line is uneconomic (see the section "Reaching the rest," below).

Why FTTC?

Where insufficient funding for the universal deployment of FTTP but an established copper telephone infrastructure exists, then FTTC makes economic sense because it leverages assets already in place, minimizes local disruption during rollout, and avoids the most expensive and complex replacement of individual connections to individual premises while still delivering very high broadband speeds.

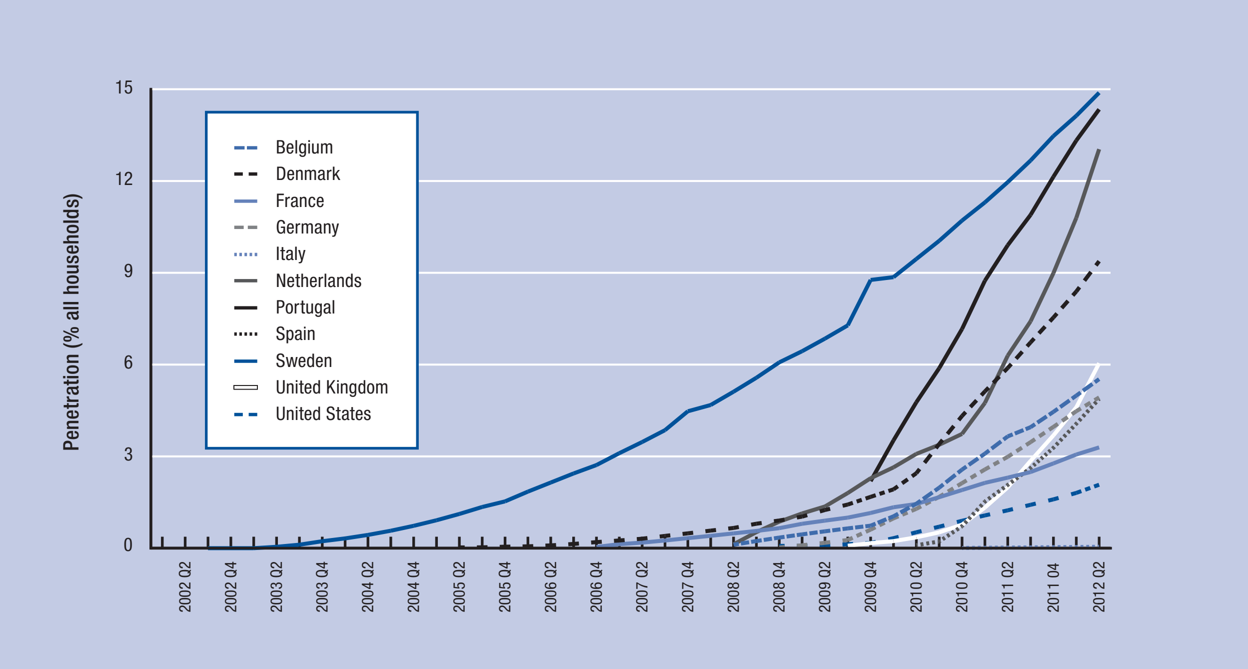
Dogmatic attachment to FTTP as the only technology solution appropriate for fiber networks is actually a barrier to investing in fiber broadband because it massively increases the cost and disruption, undermines the business case, and thus delays deployment.[23]

The criticism leveled at FTTC is that it is not future-proofed. Further expenditure will be incurred in the future to upgrade the network to FTTP as demand for bandwidth increases. However, experience has shown that there is plenty of headroom in FTTC technology for bandwidth increases.

BT's FTTC network in the United Kingdom is currently able to deliver up to 80 Mb/s downstream and up to 20Mb/s upstream speeds (depending on line lengths).[24] This is double the speed obtainable from the technology available only 18 months ago, and is comfortably in excess of the Digital Agenda's aim of a minimum coverage of 30 Mb/s.[25]

Technology providers are developing solutions that could deliver over 200 Mb/s on FTTC. Future

Figure 2: Growth of superfast broadband household penetration, European Union



Source: BSG, 2012.

technologies, such as G.fast, could see speeds measured in gigabits over the final copper connection.[26]

That said, local factors such as housing density and copper line length also have a significant impact on the economics of technology choice.

Competitive market

The other foundation for achieving an affordable and sustainable rollout of fiber broadband is a market for access and value-added services that serves to keep down consumer prices while ensuring high service levels and continued investment in the network. An environment that supports a large number of wholesale telecommunication providers and retail Internet service providers (ISPs) can enable this; it is also in the interests of consumers and the major network operators.

The UK example shows that a healthy number of wholesale telecommunication providers and retail ISPs is an important driver for achieving and maintaining a high number of end-subscribers, which underpins the business case for network investment.[27]

Competition drives down prices. If a retail ISP increases its price, there are dozens of others to which customers can turn. Competition also ensures that service standards are kept high. If a service provider lets standards slip, there are dozens of others waiting to snap up their customers. If any service provider withdraws from the market, customers have a choice of dozens of others to take their place.

BT is making the biggest purely commercial investment in fiber access without state aid in Europe, and is rolling out this fiber more quickly than any other provider. Already about 60 ISPs are testing BT's fiber product.[28] Its fiber broadband package has the same headline price as copper-based broadband to encourage rapid customer uptake.

Early indications show that this strategy is working. Plotted against similar fiber rollouts in Europe and Japan, BT appears to be ahead of the curve in terms of penetration and subscriber uptake (see Figures 2, 3, and 4). The UK government has committed to a target of having the best superfast broadband in Europe by 2015.

REACHING THE REST

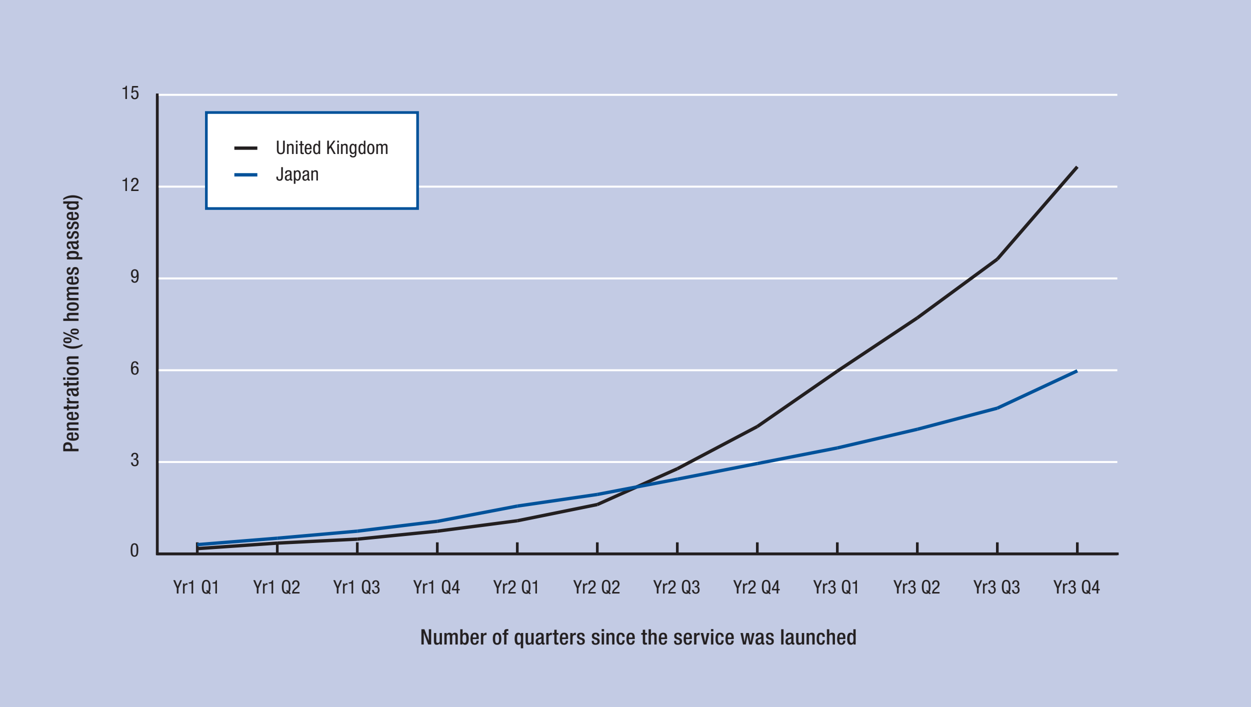
If superfast broadband is to fulfill its promise of contributing to social and economic growth in the most impoverished areas of the globe, it needs to connect *all* citizens, even those who are in the most remote regions.

The commercial business case for fiber investment will always fall short of full national coverage. That is just a fact of life for communication networks: as customers become more dispersed and more remote, the costs of reaching them become uneconomic.

Nevertheless, the Digital Agenda calls for 100 percent coverage of the population with a minimum of 30 Mb/s broadband by 2020. Public funding should be focused on reaching those outside the range of economically viable private investment.

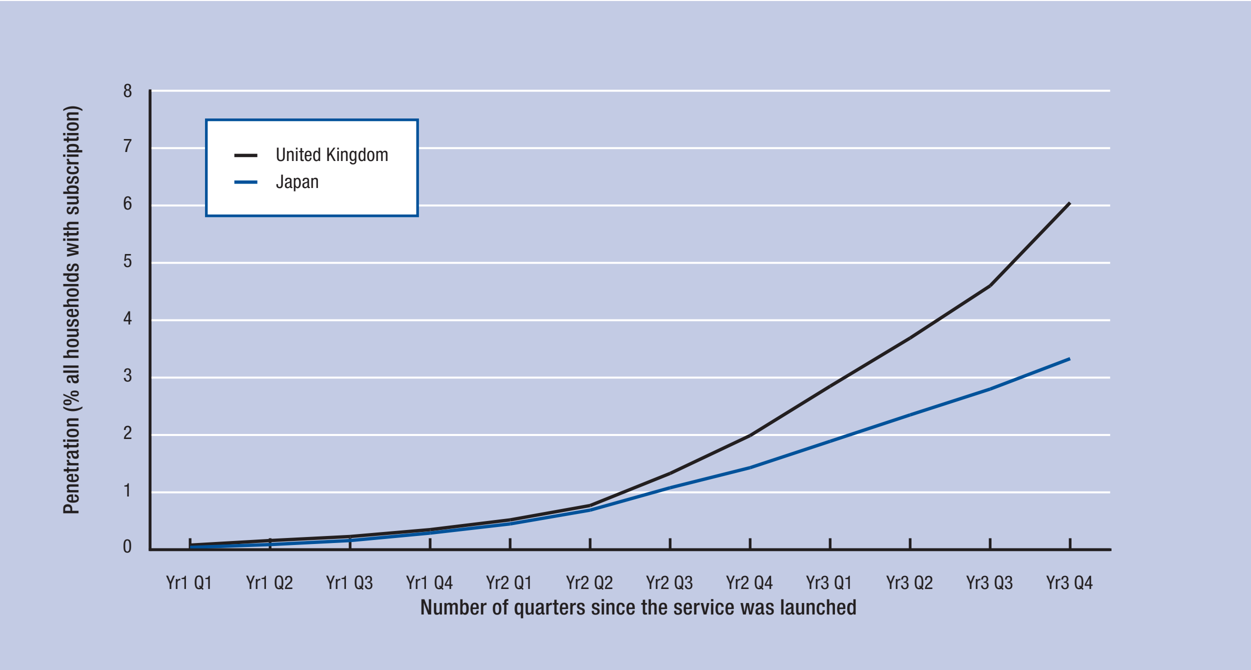
In the United Kingdom, the government has pledged to provide £530 million to reach customers in the “final

Figure 3: Penetration of superfast broadband homes passed, United Kingdom and Japan



Source: BSG, 2012.

Figure 4: Superfast broadband subscriber growth, United Kingdom and Japan



Source: BSG, 2012.

third,"[29] who fall outside the viable business case for private network development. BT believes that public funding and additional private investment could bring fiber broadband delivering up to 80 Mb/s to 90 percent of the United Kingdom by the end of 2017, as well as ensuring that perhaps 99 percent of premises are able to access broadband of more than 2 Mb/s.

Achieving 99 percent coverage would still leave some 280,000 premises unconnected, but technologies that are able to fill this gap—such as fixed copper and fiber networks or satellite and terrestrial wireless solutions—could be deployed to reach these premises. For example, in the remotest parts of the west of England, trials to use the 4G mobile network,[30] along with wireless broadband in interleaved television spectrum for delivering broadband to the very last premises, are under way.

CONCLUSION

The vision of social and economic growth through fiber broadband infrastructure that underpins a growth in knowledge- and ICT-based jobs still holds promise. The Regeneris research adds detail to a growing body of evidence.

Specifically, Regeneris found that, from rural areas, such as Norfolk and Suffolk, through towns and cities to the capital, fiber broadband could lead to a significant annual increase in GVA and the creation of jobs through business startups and improved business performance. Telecommunication providers such as BT can point to economically deprived areas, such as Cornwall and Northern Ireland, where these findings are apparent.

As Europe and the wider developed world attempts to emerge from the recent financial crisis and downturn, such growth will be vital.

The potential for social growth is strongly linked to economic growth: an increase in jobs and prosperity, along with a shift from waning high-carbon industries to low-carbon, knowledge-based businesses and reductions in travel and emissions all provide a social benefit as well as an economic one. Evidence of social growth is more anecdotal than evidence of economic growth that is more easily measured—how does one measure social growth?—but there are enough anecdotal examples to build a sound case.

The issue, then, is not *whether or not* fiber broadband can help drive social and economic growth, but instead *how to achieve* coverage as close as possible to 100 percent with minimum public expenditure. This chapter argues for market-based strategic solutions that governments and regional authorities are strongly urged to adopt.

First, technical neutrality is fundamental. Governments do not have a good track record of picking technology winners and should let the market choose solutions likely to attract the highest degree of private investment. These solutions are likely to be those that leverage existing telecommunication assets.

This may mean surrendering a dogmatic attachment to deploying a pure fiber network. However, experience has shown that hybrid fiber/copper technologies, such as FTTC, can provide superfast broadband speeds and are continuously increasing their potential speeds, and at considerably lower costs and with less disruption than deploying pure fiber to every end point. Surely it is better to be able to afford superfast broadband for as close as possible to 100 percent of the population than to adhere to a technical specification that inhibits investment and leaves more of the population unconnected.

Second, both the infrastructure and the market for services must be designed to encourage competition. It is more efficient to build a common superfast broadband infrastructure shared by many equally competing service providers than to build multiple competing infrastructures. However, the common infrastructure provider must be regulated to prevent it from exploiting a monopolistic position, and the infrastructure must remain open to service-level competition. As shown in this chapter, multiple competing service providers can drive down prices and maintain high service levels for consumers.

Whether infrastructure providers are one or many, standardization at the system level is vital. Retail margins are wafer thin, so retail ISP systems for order handling, billing, repair, and so on need to be highly automated and integrated with wholesale telecommunication provider systems.

With the large majority of population coverage achieved through private investment, limited public funds can be focused on the most remote areas that are beyond the reach of the private business case.

NOTES

1 See European Commission 2010a for details about the Europe 2020 vision; see European Commission 2010b for the Digital Agenda for Europe.

2 du Rausas et al. 2011.

3 Broadband Commission 2010.

4 Ericsson 2011.

5 Regeneris Consulting 2012.

6 European Commission 2010a; 2010b.

7 BIS 2009.

8 Broadband Commission 2011.

9 Regeneris Consulting 2012.

10 See http://www.btplc.com/ngb/Casestudies/Business/Printitforme.pdf.

11 Charlesworth 2010.

12 BSG 2008.

13 BSG 2008.

14 Cisco 2011.

15 BIS 2009.

16 Empirica, Work Research Centre, and the Institute of Integrated Study 2009.

17 Cruickshank 2012.

18 See http://www.bradford.ac.uk/management/about-the-school/student-resources/blackboard/ .

19 See http://www.sandaigprimary.co.uk/radio_sandaig/index.php.

20 See BSG 2008.

21 BBC News 2012.

22 See Wikipedia, "Fiber to the *x*" entry. Available at http://en.wikipedia.org/wiki/Fiber_to_the_x.

23 The Broadband Stakeholders Group released a report that estimated that FTTP to the entire United Kingdom would cost £28.8 billion. The report also looks at "whether an initial deployment of FTTC would inhibit a subsequent upgrade to FTTH. From a pure cost perspective it is not clear that this would be a problem. About 50% of the initial FTTC investment could be re-used in an FTTH upgrade." Analysys Mason for the BSG 2008, p. 4.

24 Jackson 2012; see also BT 2010, p. 17; and the BT Openreach Fact Sheet, available at http://www.openreach.co.uk/orpg/home/products/super-fastfibreaccess/fibretothecabinet/fttc/downloads/GEA_FTTC_3.pdf.

25 See European Commission 2010b.

26 Maes 2012.

27 Ofcom 2010.

28 BT 2012, p. 45.

29 GOV.UK DCMS 2013.

30 BT 2011a, 2011b.

REFERENCES

Analysys Mason for BSG. 2008. *The Costs of Deploying Fibre-Based Next-Generation Broadband Infrastructure: Final Report.* Report commissioned by the Broadband Stakeholder Group. Cambridge, UK: Analysys Mason Ltd. Available at http://www.dc10plus.net/resources/documents/http___www.broadbanduk.pdf.

BBC News. 2012. "4G Speed Put to the Test." BBC News Technology, October 2. Available at http://www.bbc.co.uk/news/technology-19805535

BIS (Department for Business, Innovation & Skills). 2009. *Digital Britain: Final Report.* London: Department for Culture, Media & Sport and Department for Business, Innovation & Skills. Available at http://webarchive.nationalarchives.gov.uk/+/http://www.culture.gov.uk/images/publications/digitalbritain-finalreport-jun09.pdf.

Broadband Commission. 2010. *A 2010 Leadership Imperative: The Future Built on Broadband.* A report by the Broadband Commission. ITU and UNESCO, September. Available at http://www.broadbandcommission.org/Reports/Report_1.pdf.

——. 2011. *Broadband: A Platform for Progress* A report by the Broadband Commission. ITU and UNESCO, June. Available at http://www.broadbandcommission.org/Reports/Report_2.pdf.

BSG (Broadband Stakeholder Group). 2008. *A Framework for Evaluating the Value of Next Generation Broadband,* June. London: Plum Consulting. Available at http://broadband.cti.gr/el/download/BSG_Value_of_next_generation_broadband_06_2008.pdf.

——. 2012. *Demand for Superfast Broadband: Understanding Demand in Europe, the US and Asia; How the UK Is Currently Performing; and What Might Impact Take-Up in the UK in the Future.* London: Broadband Stakeholder Group. Available at http://www.broadbanduk.org/wp-content/uploads/2012/11/superfastbroadband.pdf.

BT. 2010. *BT Group plc Annual Report 2010.* Available at http://www.btplc.com/Sharesandperformance/Annualreportandreview/pdf/BTGroupAnnualReport2010.pdf.

——. 2011a. "Everything Everywhere and BT Wholesale to Deliver the UK's First Live Customer Trial of 4G High Speed Broadband Technology." BT Press Release, May 25. Available at http://www.btplc.com/news/Articles/ShowArticle.cfm?ArticleID=30F2E8DB-DFEC-4D1F-90E8-77D089DCD576.

——. 2011b. "Everything Everywhere and BT Wholesale Kick-Off 4G Live Trial." BT Press Release, October 6. Available at http://www.btplc.com/news/Articles/ShowArticle.cfm?ArticleID=0B0E2C53-C4B2-4595-8BE7-B5E41C799023.

——. 2012. *BT Annual Report and Form 20-F2012.* Available at http://www.btplc.com/Sharesandperformance/Annualreportandreview/pdf/BTAnnualReport2012_smart.pdf.

Charlesworth, A. 2010. "Fibre Boosts Cornish Bid for Digital Business." computing.co.uk, October 1. Available at http://www.computing.co.uk/ctg/news/1863412/fibre-boosts-cornish-bid-digital-business.

Cisco. 2011. " Guldborgsund Municipality Enhances Citizen Services via Pervasive Video." Cisco. Available at http://www.cisco.com/en/US/solutions/collateral/ns813/guldborgsund_cStudy.pdf.

Cruickshank, J. 2012. *Telehealth: What Can the NHS Learn from Experience at the US Veterans Health Administration?* London: 2020health.org. Available at http://www.2020health.org/2020health/Publication-2012/publications-2012/Telehealth.html.

du Rausas, M. P., J. Manyika, E. Hazan, J. Bughin, M. Chui, and R. Said. 2011. *Internet Matters: The Net's Sweeping Impact on Growth, Jobs, and Prosperity,* May. McKinsey Global Institute. Available at http://www.mckinsey.com/insights/mgi/research/technology_and_innovation/internet_matters.

Empirica, Work Research Centre, and the Institute of Integrated Study, Vienna University of Technology. 2009. *ICT & Ageing: European Study on Users, Markets and Technologies.* Study funded by the European Commission. Bonn: Empirica. Available at http://www.ict-ageing.eu/?page_id=1325.

Ericsson. 2011. "New Study Quantifies the Impact of Broadband Speed on GDP." Press Release, September 27. Available at http://www.ericsson.com/news/1550083.

European Commission. 2010a. *Europe 2020: A Strategy for Smart, Sustainable and Inclusive Growth.* Brussels: European Commission. Available at http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf/.

——. 2010b. *Digital Agenda for Europe: A Europe 2020 Initiative.* Available at http://ec.europa.eu/digital-agenda/.

GOV.UK. DCMS (Department for Culture, Media & Sport). 2013. Policy: Stimulating Private Sector Investment to Achieve a Transformation in Broadband in the UK by 2015. Published February 27. Available at http://www.culture.gov.uk/what_we_do/telecommunications_and_online/7763.aspx.

Jackson, M. 2012. "BT Makes its 80Mbps Superfast FTTC Broadband Upgrade Available to ISPs." *ISPreview.* Posted April 10. Available at http://www.ispreview.co.uk/index.php/2012/04/bt-makes-its-80mbps-superfast-fttc-broadband-upgrade-available.html.

Maes, J. 2012. "G.fast: Shifting the Limits of Copper." *At the Speed of Ideas,* January 19. Bell Labs, Alcatel-Lucent. Available at http://www.uknof.org.uk/uknof21/Maes-Gfast.pdf.

Ofcom. 2010. "Review of the Wholesale Local Access Market: Statement." Ofcom, July 10. Available at http://stakeholders.ofcom.org.uk/consultations/wla/statement.

Regeneris Consulting. 2012. *Superfast Broadband: Boosting Business and the UK Economy.* Report commissioned by BT. London: BT. Available at http://www.btsocialstudy.co.uk/investing_in_broadband.html.