Contents

Section 1

Executive summary

1.1 This report examines how and why the availability of communications services varies across the UK, and how it could be improved. We consider the availability of seven communications services: fixed voice, fixed broadband, mobile voice, mobile broadband, digital television, radio and post.

1.2 The availability of communications services matters because of the increasing integration of digital communications within daily life. Communications services provide consumers with access to vital political, educational, cultural and economic resources. They provide businesses with the opportunity to increase efficiency, develop new services, and to reach new markets. And they make possible new and more effective means of providing public services to citizens.

1.3 At the heart of this change is widespread use of the internet. Broadband access to the internet, both fixed and mobile, is critical to ensuring that these benefits can be maximised and enjoyed by as many members of society as possible.

1.4 This report shows that some communications services are widely available across the UK:

1.4.1 Fixed telephony and postal services are subject to universal service obligations and therefore available across almost all the UK.

1.4.2 Digital terrestrial television is also available across almost all the UK, now that digital switchover is complete, thereby ensuring the widespread availability of free-to-air public service broadcasting. Satellite television is also very widely available.

1.5 There are however significant variations in the availability of other communications services:

1.5.1 The availability and speed of fixed broadband internet access is subject to much greater variation. This is partially because of variability in the speed provided by current generation broadband, and partially because the deployment of superfast broadband is still underway, especially in more rural areas

1.5.2 The same is true of mobile services, both voice and data. Even where the outdoor mobile coverage delivered to households is good, there can be particular challenges associated with providing coverage inside buildings, on roads and on rail.

1.5.3 In radio, whilst analogue coverage is near ubiquitous, DAB digital-radio is not.

1.6 The variations are most evident between urban and rural areas, and also between the different nations and regions of the UK

Findings

1.7 Perhaps unusurprisingly, most of the variability between nations and regions is essentially due to parts of the UK being more rural than others. Once factors such as population density and the nature of the landscape (hills, valleys and buildings) are taken into account, the probability of good coverage is relatively similar between different parts of the UK.

1.8 Our approach is to promote well functioning, competitive markets as the principle means through which to deliver low prices, choice and quality for consumers and spur innovation among providers. The dynamics of competition can also deliver high levels of availability, particularly in more urban areas, as is illustrated by the recent rapid deployment of superfast broadband to roughly two thirds of the country.

1.9 However, where markets do not deliver optimal outcomes for society as a whole, different public bodies can and do take action. This report looks at several case studies, in order to consider the effectiveness of such interventions.

1.10 This analysis suggests that well designed and delivered interventions can make a very significant difference in a short period of time. The Department of Enterprise, Trade and Investment's (DETI) intervention to deliver super fast broadband in Northern Ireland stands out as a particularly clear example of this. DETI estimated that next generation broadband would only reach 50-60% of businesses in Northern Ireland without intervention. As a result of intervention, 95% superfast broadband coverage has been achieved. This provides an early indication of the potential outcome of the UK-wide programme being managed by BDUK.

Observations

1.11 Areas that have not previously benefited from commercial rollout are more likely to experience market shortfalls in the future. Consequently, public bodies that have intervened to extend availability in the past may expect to face the same pressures to do so again in the future. If this can be successfully anticipated, it may be possible to plan interventions at a sufficiently early stage that those areas do not always have to play catch-up with the rest of the UK.

1.12 Where public bodies do intervene the key challenge is to ensure sustainability and value for money. Interventions should be carefully targeted at areas where the market will not deliver availability, without distorting competition in areas where the market functions well. Interventions do not always have to be about spending public funds. Changes to planning laws, for example, can also reduce the costs of building communications networks, improving availability.

1.13 The frameworks for addressing universal availability remain best set by elected representatives. Ofcom's role in this context is to ensure that the necessary information is available to inform the debate, and we recognise the importance of this role.

1.14 Within this framework, the responsibility for acting to improve availability will depend on the nature of the intervention being considered. Where public funds and subsidy are required to extend availability then this is a decision for central, devolved and local government. Similarly universal service obligations (USO) are set by elected officials who must consider what services should be subject to USO in the future and at what level. The planning regime is another area where responsibility lies with elected officials.

1.15 Ofcom does have a duty to secure the availability throughout the UK of a wide range of electronic communications, television, radio and postal services. And whilst we do not have the ability to deliver on this duty through the use of public funds, we have some important levers at our disposal, including for example the ability to impose coverage obligations on mobile licenses.

Key Initiatives

1.16 There are several significant Government initiatives to improve the availability of mobile and broadband services across the UK.

1.17 The first is the Government's commitment to provide superfast broadband to at least 90% of premises in the UK and universal access to standard broadband with a speed of at least 2 Mbit/s. They have allocated £530m between 2011/12 and 2014/15 to stimulate commercial investment in rollout, with individual projects in this Rural Broadband Programme the responsibility of local authorities and devolved administrations. The Government received state aid clearance in November 2012 for the framework agreements that local authorities can use to award contracts under this scheme, and contracts are now being signed.

1.18 The UK Government is also providing funding of up to £150m to address the 0.3% of premises in the UK that currently have no mobile coverage, under DCMS's mobile infrastructure project (MIP). MIP should ensure that around two thirds of these premises will receive a mobile service from 2015, and is expected to raise total 2G coverage to 99.9% of premises. MIP is also seeking to improve coverage along at least 10 of the busiest roads within the UK that still have poor coverage.

1.19 In order to reduce the costs of rolling out new infrastructure the Government have also announced a number of reforms to planning laws. These include measures to reduce the administrative burdens faced by companies when installing broadband street cabinets and when laying cables on public and private land. The Government is also working with mobile operators, local government and other interested parties to streamline the planning process to speed up the deployment of mobile infrastructure.

1.20 The recent 4G auction is an example of Ofcom using coverage obligations in licences to accelerate and expand roll-out. One of the lots of 800 MHz spectrum, —which is particularly well suited to providing high levels of coverage – carried an obligation to provide indoor coverage to 98% of UK premises and 95% of the premises within each nation. This licence was awarded to Telefónica (O2) and we anticipate this will deliver outdoor coverage of around 99.5% of all premises and 98-99% of the premises within each Nation. We expect this obligation will drive improvements in coverage in a number of ways:

1.20.1 Because Vodafone and Telefónica have reached an agreement to share infrastructure, Telefónica's coverage obligation should also improve Vodafone's coverage and thus reduce partial not-spots.

1.20.2 Consumers who care strongly about coverage will know that there is at least one operator that provides particularly good coverage across the UK. Telefónica's coverage advantage is likely to spur other operators to extend their own coverage to broadly similar levels in order to be able to compete effectively for consumers.

1.20.3 There is likely to be an increasing deployment of combined 2G/3G/4Gequipment by the industry. Therefore wherever 4G networks are rolled out, we also expect 2G and 3G equipment to be installed alongside, reducing voice not-spots.

1.21 In combination, we believe these measures will lead to material improvements in coverage and consumer experience for broadband and mobile services over the coming months and years.

Section 2

Introduction

2.1 Ofcom is the independent regulator and competition authority for the UK communications industries, with responsibilities across television, radio, telecommunications, wireless communications and postal services. Our principal duty under the Communications Act 2003 is to:

- further the interests of citizens in relation to communications matters; and
- further the interests of consumers in relevant markets, where appropriate by promoting competition.[1]

2.2 We are required to secure, among other things, the availability throughout the UK of a wide range of electronic communications, television and radio services. The Postal Services Act 2011 gave us the additional requirement to secure the provision of a universal postal service.[2]

2.3 In addition, we must have regard to the different interests of persons in the different parts of the UK, of the different ethnic communities within the UK and of persons living in rural and urban areas.

2.4 Because of these duties, we undertook to assess the provision of communications services in the nations as a priority in our 2012/13 annual plan.[3] We sought to understand differences between the nations and look at the way in which UK, devolved and local authorities, as well as communities themselves, are working to reduce them.

Communications services and the limitations of the market

2.5 The availability and quality of communications services varies across the UK. In part, this variation is a result of a largely market-led approach to provision. Once the cost to the provider of extending the infrastructure exceeds the revenues they generate, the provider no longer has an incentive to extend the infrastructure.

2.6 Revenues are lower where consumers' willingness and ability to pay is weaker (for example, where incomes are lower). Costs are higher where population density is lower and/or topography is more challenging. Often, both factors—lower revenues and higher costs—combine. This is most commonly an issue for rural communities and is a particular issue for Northern Ireland, Scotland and Wales, which have a higher incidence of rural populations than the UK as a whole.

2.7 Public intervention takes place to extend the availability of a range of services beyond that which the market alone would provide. It has, for example, supported the provision of air routes deemed vital to regional economic development but that are unable to sustain a purely commercial service.[4] In the case of fixed telephony and postal services, intervention takes the form of a universal service obligation (USO) –

[1] www.legislation.gov.uk/ukpga/2003/21/contents.
[2] www.legislation.gov.uk/ukpga/2011/5/contents.
[3] www.ofcom.org.uk/about/annual-reports-and-plans/annual-plans/annual-plan-201213/.
[4] "Air services at UK regional airports: an update on developments," Civil Aviation Authority, 15 November 2007, www.caa.co.uk/docs/33/CAP775.pdf.

a provision in law that guarantees a certain basic level of service to all (or nearly all) customers. UK-wide public-service broadcasters are subject to licence conditions that require a similar outcome for digital terrestrial television (DTT). For mobile networks, coverage obligations are set as licence obligations. Superfast-broadband availability, meanwhile, is the result of public funding in some areas. Intervention can also take softer forms, facilitating market- or community-based solutions.

2.8 The state intervenes in these ways because it believes the total value of the availability of communications services extends beyond private benefits to consumers and provides wider value, both to the economy and society as a whole.

- The economy benefits from cost and efficiency savings, for example by moving public services online. Studies also suggest investment in infrastructure in general, and in communications infrastructure in particular, can have a positive impact on economic growth.[5]

- Society benefits from civic participation. Access to communications services is increasingly discussed in the language of "rights" as more services move online and concerns arise regarding the implications for those who remain offline. Without access to communications services, both individuals and communities may be excluded from participating in society—be that children learning in the most effective way or people knowing what is going on in their locality and the wider world. Moreover, communications services provide access to a wide range of resources and information sources, resulting in a better educated and more informed society.

2.9 Even where the state intervenes, the appropriate level may not be universal. This could be because the case is not sufficient—or sufficiently clear—to justify the cost of its provision. For example, the case for standard-broadband access for all may be clearer than the case for ultrafast broadband access for all if the former enables civic participation and delivers citizen benefits at a lower cost than the latter. Equally, the benefits of universal availability might be delivered by other services that are already available. For example, where there is coverage by all mobile network operators (MNOs), there may be less need for payphones.

Roles and responsibilities

2.10 As noted above, the Communications Act explicitly requires us to secure the availability throughout the UK of a wide range of electronic communications, television and radio services. We must also have regard to the desirability of encouraging the availability and use of high-speed data-transfer services throughout the UK, while the Postal Services Act requires us to secure the provision of a universal postal service.

2.11 We noted in our draft annual plan for 2013/14 we would continue to promote the opportunity to participate in society for consumers and citizens through the availability and use of a wide range of communications services. Key activities in this area include:

[5] See Roller, L. H. and Waverman, L., "Telecommunications Infrastructure and Economic Development: a Simultaneous Approach," *American Economic Review*, vol. 91, no. 4, pp. 787-814, published in 2001. This found evidence of a significant positive causal link between telecommunications infrastructure investment and economic growth, especially when a critical mass of infrastructure is present. The critical mass appeared to be at a level of infrastructure that delivered near-universal service.

- securing private investment in widespread networks by maintaining efficient incentives for investment through competition and associated policy, reflecting the potentially higher risk of investment in new networks where appropriate;

- supporting the delivery of widespread mobile services, including mobile broadband, across the UK and its nations by setting licence obligations for 4G services and supporting public-sector intervention to address mobile not-spots;

- securing the ongoing delivery and evolution of effective and efficient universal services in telecommunications;

- securing the provision of the universal postal service through work on financial sustainability, efficiency, ongoing monitoring and research and economic regulation;

- actively promoting understanding of availability, take-up and network performance among policy makers in England, Scotland, Wales and Northern Ireland to stimulate debate and policy development to deliver against governments' availability and inclusion goals; and

- helping the UK Government make effective policy decisions to deliver widespread availability and inclusion, with a focus on superfast broadband and the switchover to digital broadcasting technologies.[6]

2.12 Our role in this area is therefore an important one, but we are not the only public body charged with, or interested in, promoting the availability of communications services. In particular:

- the UK Government is investing around £680 million to extend broadband and mobile coverage, delivered in part via devolved and local authorities. It also initiated the digital switchover programme (DSO) that phased out analogue terrestrial television in favour of DTT;

- the Northern Ireland Department of Enterprise, Trade and Investment (DETI),[7] the Scottish Government[8] and the Welsh Government[9] are implementing their own action plans, with key interventions to extend the availability of broadband and mobile services in particular; and

- the European Commission has set targets for the availability of broadband in the European Union (EU), while minimum USOs for fixed telephony and postal services are defined in EU legislation.

2.13 Consideration of the availability of communications services therefore needs to take into account the actions of market players as well as a wide range of public bodies.

[6] http://stakeholders.ofcom.org.uk/binaries/consultations/annualplan1314/summary/condoc.pdf.
[7] "A telecommunications action plan for Northern Ireland 2011-2015," 7 March 2011, www.detini.gov.uk/tpu_action_plan_2011-2015_-_branded_consultation_document_-_final.pdf.
[8] "Scotland's Digital Future—Infrastructure Action Plan," 31 January 2012, www.scotland.gov.uk/Resource/0038/00386525.pdf.
[9] "Digital Wales: delivery plan," 30 March 2011, http://wales.gov.uk/docs/det/publications/110427deliveryplan.pdf.

Scope

2.14 This report considers the availability of communications services provided through six core networks:

- fixed telephony;
- fixed broadband;
- mobile (voice and data)
- digital television;
- radio; and
- post.

2.15 Access to the internet, and in particular broadband, is the most important area of concern. This is partly because the availability and quality of fixed and mobile access are subject to some of the greatest variation across the UK. For example, fixed telephony is subject to a USO, but existing mobile coverage is subject to licence conditions that do not require universality, resulting in some parts of the UK having limited or no availability. It is also because the benefits of internet access are numerous and growing in significance, with ever fewer suitable alternatives.

2.16 Of course, access to communications services also incorporates the perceived need for, affordability of and ability to use those services. Although these factors are not considered in detail in this report, our annual Consumer Experience reports consider the extent to which consumers take up communications services and devices,[10] the Communications Consumer Panel has conducted research into the main barriers to participation in the online world,[11] and Go On UK explicitly aims to make the UK the most digitally capable nation in the world by focusing on skills and helping those who do not have the requisite basic knowledge to get up to speed.[12]

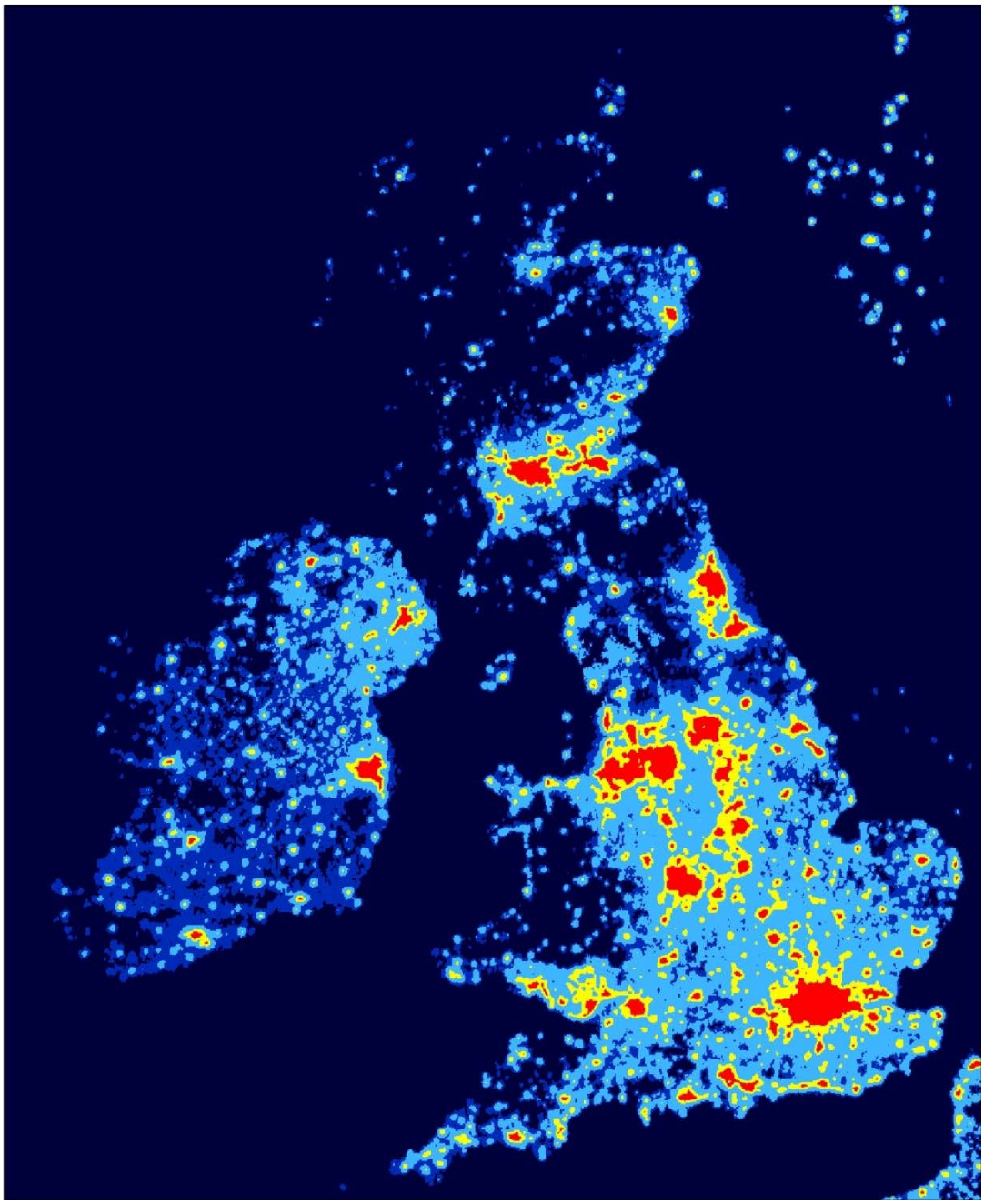
2.17 Our draft annual plan for 2013/14 indicated we would undertake follow-up research into the effect of communications-infrastructure availability, complementing this report by focusing on higher-density geographic areas including cities and towns.

Population density

2.18 The population of the UK is not distributed evenly across its landmass. This is readily illustrated by figure 1, which shows light pollution in the UK.[13] Essentially, where there are lights, there are people.

[10] http://stakeholders.ofcom.org.uk/market-data-research/market-data/consumer-experience-reports/.
[11] "Bridging the gap: sustaining online engagement," 31 May 2012, www.communicationsconsumerpanel.org.uk/Bridging%20the%20gap%20and%20cover.pdf.
[12] www.go-on.co.uk/.
[13] See also, for example, www.avex-asso.org/dossiers/pl/uk/index.html.

Figure 1. Light pollution in the UK



Source: Campaign to Protect Rural England.

2.19 Figure 1 also shows the population in each of the nations of the UK is not distributed evenly. For example, Scotland's population is concentrated in a "J" shape that runs across the Central Belt (Glasgow and Edinburgh), up the east coast (Dundee and Aberdeen) and then along the Moray Firth (to Inverness). There are other reasonably dense centres of population across the rest of Scotland, but these are small and widely spaced. Even between the bigger centres, there are large areas with a very low population density—for example, the 100 miles of A9 trunk road that join Perth and Inverness. This contrasts with England, where there is much more of a grid effect with large centres of population and gradually diminishing population densities between them.

2.20 This report analyses the availability of communications services for three classifications of population density:

- Urban—comprising towns and cities with a population greater than 100,000;
- Semi-urban—comprising small towns with a population between 2,000 and 100,000; and
- Rural—comprising villages, hamlets and open countryside with a population less than 2,000.

2.21 We have derived these from UK Geographics' LOCALE classifications.[14] We have excluded a number of unclassified residences, so the figures used to calculate splits may not always equal the totals. Taking this into account, we have classified the landmass of the UK as shown in table 1.

Table 1. Classification of the landmass of the UK (km^2)

	Total	Urban	Semi-urban	Rural
UK	247,266	6,040 (3%)	23,048 (9%)	218,178 (88%)
England	132,398	5,315 (4%)	18,130 (14%)	108,952 (82%)
Northern Ireland	14,002	128 (1%)	863 (6%)	13,011 (93%)
Scotland	79,714	376 (1%)	1,946 (2%)	77,392 (97%)
Wales	21,153	221 (1%)	2,109 (10%)	18,822 (89%)

2.22 As table 1 shows, even though we have classified 82% of England's landmass as Rural, the 18% that is Urban or Semi-urban contrasts sharply with Wales (11%), Northern Ireland (7%) and Scotland (3%).

2.23 Table 2 shows how we have classified the population of the UK.

Table 2. Classification of the population of the UK (percentage)

	Urban	Semi-urban	Rural
UK	35	51	14
England	37	50	13
Northern Ireland	19	49	32
Scotland	24	59	18
Wales	19	59	22

2.24 As table 2 shows, England has the highest proportion of its population resident in areas classified as Urban. Scotland and Wales have a relatively high proportion of their populations in Semi-urban areas. Northern Ireland has the highest proportion living in Rural areas.

2.25 We have not attempted more detailed analysis, although this is possible. For example, when the Royal Society of Edinburgh assessed the distribution of Scotland's population, it noted most people lived at comparable population densities

[14] www.ukgeographics.co.uk/images/locale.pdf.

to those in England.[15] Based on this, our Advisory Committee for Scotland has calculated the final 10% of the population of England lives at an average density of around 40 people per km^2, while in Scotland the comparable population density is on average six people per km^2. Equally, disaggregation of the Rural classification could enable further meaningful comparisons between different locations to be made.

2.26 Notwithstanding these differences, many of the challenges faced by those in rural or remote locations are common whether they live in north Devon, Fermanagh, mid-Wales or the Scottish Highlands. For example we carried out regression analysis to assess factors that might account for the availability of 3G mobile services. Our results appear to show much of the variation in coverage between different parts of the UK can be explained by the size, density and composition of the local population, the topography of the landscape as well as rurality.

Data

2.27 Much of the data in this report is classified by region of the UK according to the Nomenclature of Territorial Units for Statistics (NUTS) developed by the EU. There are 12 such regions, as shown in figure 2: nine in England (East Midlands, East of England, Greater London, North East England, North West England, South East England, South West England, West Midlands and Yorkshire & the Humber) and each of Northern Ireland, Scotland and Wales.

Figure 2. NUTS regions of the UK

Source: Eurostat.[16]

[15] "Digital Scotland," 26 October 2010, www.rse.org.uk/886_DigitalScotland.html.
[16] http://circa.europa.eu/irc/dsis/regportraits/info/data/en/uk.htm.

Structure of this report

2.28 The remainder of this report is structured on the whole by service rather than jurisdiction so information can be compared across geographic boundaries, recognising common of experiences felt by citizens and consumers wherever they live in the UK.

- Section 3 explains why the availability of communications services matters to citizens and consumers, both individuals and businesses.
- Section 4 uses data we already publish to describe the availability of communications services in the UK and its component nations.
- Section 5 describes the role of markets, why they may not deliver universal availability of communications services and the factors—both general and specific—that drive availability in practice.
- Section 6 considers the role of interventions to extend the availability of communications services beyond what is commercially viable, the forms such interventions can take and how they have occurred in the communications sector, illustrated by a series of real-life case studies.
- Section 7 contains further findings and makes a number of observations that we hope, together with the rest of this report, will stimulate further consideration by those with an interest in these issues. This includes regression analysis to assess what might account for the variability in availability of 3G mobile services,
- Annex 1 contains further data underpinning the findings in section 7.
- Annex 2 lists the references cited in this report.
- Annex 3 contains a glossary of the abbreviations used in this report.

Section 3

Why availability matters

Introduction

3.1 This section explains why the availability of communications services matters to citizens and consumers, both individuals and businesses. Communications services provide access to vital political, educational, cultural and economic resources. Moreover, the increasing integration of digital communications within daily life is generating a growing dependency on access to them. The internet is particularly important, delivering convenience and inclusion for individuals, efficiency and flexibility for businesses, and education and democratic engagement for society. The rollout of superfast-broadband networks, the increasing speed of mobile internet access and the move to deliver public services online will only entrench this.

Communications services provide access to vital resources

3.2 Communications services provide people with access to political, educational and cultural activities and resources. The availability of such services matters because a lack of availability results in reduced (or non-existent) access to such resources. Reduced access can be compounded, typically in rural and remote areas, by a lack of other public services, such as libraries or public transport.

3.3 Access to communications services provides benefits to both individuals (for example, by providing the means to stay in touch with friends and family), businesses (for instance as a means to engage with suppliers and customers) and society as a whole (for example, by providing educational resources that result in a more skilled and informed population). The development of digital communications services and the movement into the digital age have made communications services an increasingly integral part of our daily lives. The UK Government estimated "the typical British consumer spends nearly half of their waking hours engaged in one form or another with the products and services of the communications sector."[17] Digital communications services are used increasingly to participate in civil society, to learn and develop, to keep in touch, to share information and for entertainment, among other activities. The increasing integration of digital communications services within daily life has resulted in both an increase in the scale and significance of their associated benefits and the implication that increasingly fewer adequate substitutes are available to those who do not access them.

Internet

Access to the internet is a particular concern

3.4 The most important area of concern regarding the availability of communications services is internet access. The benefits of internet access are numerous and growing in significance, with ever fewer suitable alternatives, as an increasing number of services move online. Broadband availability is also subject to some of the greatest variation across the UK of all communications services. Although broadband internet delivered over a fixed telephone line is available to nearly all UK homes and

[17] "Digital Britain: Final Report," 16 June 2009, www.official-documents.gov.uk/document/cm76/7650/7650.pdf.

commercial properties (see section 4), there is considerable disparity in the quality of access across the UK. This variation has important implications as the quality and speed of connection determine the activities and resources a user can access adequately.

3.5 A lack of sufficient access to the internet has the potential to disadvantage citizens and consumers by excluding them from potentially important content, resources and cost savings.

3.6 For the purpose of detailing the total value of the internet, it is useful to consider consumer benefits (individuals and business) and wider benefits to the economy and society.

Why internet availability matters to consumers

Individual consumers

Efficiency and convenience

3.7 The internet enables people to do what they already do but more productively and with greater ease. For example, people can carry out their grocery shopping online. Not only does this save time, it also gives consumers greater flexibility over when they shop, plus the opportunity to multitask with other activities while shopping.

3.8 Similarly, the internet opens up the possibility of more flexible working patterns, particularly working from home. This opportunity saves on both travel time and costs for individuals. It also has important social and economic impacts by boosting employment opportunities.

Transactions

3.9 Individuals may find they cannot buy the most competitively priced products without the internet. Online comparison tools enable individuals to find the best deals for goods and services. Many retailers and utility companies offer online-only discounts, and there are a number of internet-only banks. For example, most energy companies give discounts of 4-9% to those who pay their bills online. The effect of missing out on such opportunities as a result of a lack of internet availability is compounded for those in rural and remote areas whose access to services and retailers is already more limited.

> Race Online 2012 estimated offline households are missing out on average consumer savings of £560 per year and 3.6m low-income households are missing out on total savings of over £1bn a year from shopping and paying bills online.

Source: "Manifesto for a Networked Nation," 15 July 2010.[18]

Attachment

3.10 Internet services are increasingly considered to be essential. The internet is perceived to help people meet their core life and consumer needs, and high value is placed on it.

[18] www.microsoft.com/en-us/download/details.aspx?id=24773.

The Communications Consumer Panel found 73% of people with broadband at home describe it as essential or important and 84% of people agree it should be possible to have broadband at home regardless of where people live.

Source: "Not online, not included: consumers say broadband essential for all," 3 June 2009.[19]

Business consumers

Communication

3.11 Businesses may find it difficult to remain competitive if they cannot access particular communications services of sufficient quality. High-quality internet connections allow businesses to engage with the market by communicating with suppliers and customers effectively (for example, sending and receiving email attachments in a timely manner).

Efficiency

3.12 Booz & Company estimated small and medium-sized enterprises (SMEs) could reduce costs by 54% through back-office automation and electronic communications and achieve 51% increased sales due to effective marketing and wider geographic reach brought about by use of the internet.[20]

Training

3.13 A further advantage offered by internet availability to businesses is the opportunity for employees to develop skills with minimal disruption to the business. Small employers in particular may be reluctant to release staff for training, but access to online training allows employees to develop their skills in the workplace or at home.

Flexible working

3.14 Flexible working patterns enabled by internet availability, such as working from home, make it possible for individuals to pursue employment opportunities further from home or otherwise not previously considered. A more flexible and mobile workforce has a positive effect on the economy by enabling the supply of labour and skills to flow more freely toward the demand for it.

Innovation

3.15 The internet has also allowed the development of completely new services that were not available in the pre-internet world, social media being the obvious example. Businesses providing these new services also have access to a greater market and the most successful have gone from start-up to global corporation in less than a decade.

[19] www.communicationsconsumerpanel.org.uk/downloads/not%20online%20-%20not%20included%20-%20June%202009.pdf.
[20] "This is for everyone: the case for universal digitisation," 8 November 2012, www.booz.com/media/uploads/BoozCo_This-Is-for-Everyone.pdf.

Why internet availability matters for citizens

3.16 Race Online 2012 has argued, "The economic and social case for a networked nation is overwhelming."[21] As detailed in section 5, the existence of positive externalities produced by communications services means society as a whole benefits from individuals accessing the internet.

Public services

3.17 Internet availability supports and enhances participation with public services, increasing convenience for users and potentially giving them more control over the services they receive. Internet availability becomes increasingly important in ensuring individuals are not restricted from access to these services as the focus of service and information provision moves online.

3.18 The move to online public services has the additional benefit of making it easier to reach some citizens, such as those in rural areas who may find it more difficult to access physical public services. For example, individuals can access NHS Direct services online, reducing the need for a visit to their doctor.

3.19 An example of how the internet is central to new ways of delivering essential health services is the Whole System Demonstrator programme. This is a two-year research project funded by the UK Government's Department of Health (DH) to find out how people can manage their own health while maintaining their independence. Trials have used internet connectivity to explore ways of making public services more accessible, for example by allowing diabetics to send in daily blood-sugar readings to nursing teams via a connected set-top box.

Communication

3.20 The internet offers a range of communications services, including email, voice over IP and social networking, the majority of which are free to use. The internet is perceived to have made the world smaller by enabling people to stay in touch wherever they are.

3.21 Strong communications links, as fostered by the internet, potentially lead to greater interaction and enhanced social inclusion. This effect is especially important with regard to individuals who are otherwise socially excluded (for example, as a result of disability or location). Indeed, the Commission for Rural Communities has argued, "Today's technology is so tightly woven into the fabric of society that digital deprivation can rightly be considered alongside, and strongly linked to, more traditional social deprivations, such as low income, unemployment, poor education, ill health and social isolation."[22]

Education

3.22 The internet provides a wide range of informational and educational resources. Higher education is increasingly provided through online mechanisms, most notably through the Open University. The internet is also becoming a more important resource for younger age groups. Schoolchildren who do not have access to the

[21] "Manifesto for a Networked Nation."
[22] "Mind the gap: digital England—a rural perspective," 23 June 2009, http://crc.staging.headshift.com/files/CRC104%20Digital%20Inclusion%20Report.pdf.

internet at home may find it harder to carry out assignments (for example, researching subjects) than those who do.

3.23 The impact of internet availability on education extends beyond schooling and exam results and is linked to future prospects. Internet proficiency is an increasingly common requirement for an increasing range of occupations, and a lack of internet availability denies individuals the opportunity to gain such skills.

Finding work

3.24 The internet provides a wide range of tools that can inform and educate job seekers, with respect to both their skill set and successful job applications. Job seekers may find it harder to gain employment if they cannot access the wealth of opportunities listed online. Many employment opportunities are now *only* listed online.

Democratic engagement

3.25 The internet encourages increased democratic participation by improving citizens' access to information. Internet access allows government data to become increasingly available to the public. This availability allows more extensive public scrutiny and challenge, which in turn allow individuals to increase their democratic engagement.

3.26 The introduction of internet services also helps drive democratic engagement beyond simply the provision of information. For example, e-petitions allow citizens to create and sign online petitions about anything for which the UK Government is responsible. Any e-petition that receives over 100,000 signatures is then considered for debate in the House of Commons.

The Communications Consumer Panel found one in three internet users has used the internet for civic participation, such as contacting a government department or council or signing an online petition.

Source: "Not online, not included: consumers say broadband essential for all."

Access to information

3.27 The internet provides individuals with quick and easy access to a plurality of information on news and current affairs, enabling them to access news relevant both to their local community and to wider society and helping contribute to a more informed population.

3.28 Internet availability not only improves the range of information available to individuals but also reduces the search costs of finding it.

Communities

3.29 The internet brings numerous benefits to communities, including geographic communities and communities with common interests or experiences (for example, the deaf community). In these cases, in addition to the benefits to individuals, there are benefits to society as a whole from such communities using the internet to communicate and share resources effectively.

Geographic communities

3.30 Exemplifying the positive impact of internet availability on rural populations, the Commission for Rural Communities stated the internet has led to businesses relocating to villages and market towns for business owners and employees to enjoy a better quality of life and also to people moving out of cities on the basis they can work from home, shop and continue to use public services online. The Commission claimed rural manufacturers and retailers have tapped into worldwide markets, generating new sales, as a result of digital access.[23]

3.31 Indeed, in a number of ways, rural communities are more heavily dependent on internet services than their urban counterparts. The Office of Fair Trading found remote communities tend to experience limited provision of public transport and higher fuel prices.[24] Lack of access to resources such as shops or libraries increases the dependency on alternative resources available online. Furthermore, the Commission for Rural Communities found those in rural areas are more likely to watch films or television online because other forms of entertainment, such as the theatre and cinema, are less accessible.[25]

> The Commission for Rural Communities found approximately 75% of rural internet users use the internet for transactions, higher than the UK average of 69%.

Source: "Mind the gap: digital England—a rural perspective."

Other communities

3.32 Access to communications channels and resources is a particular benefit for disabled and other disadvantaged groups. We have previously acknowledged disabled people in particular may find it easier to get goods and services online than on the high street.[26]

3.33 A number of charities for the disabled have also endorsed the view broadband provides significant benefits for such users. Hearing Concern Link has emphasised the "great potential" broadband has for disabled people "in terms of email, instant messaging . . . and improved internet-based relay."[27]

Why internet availability matters to the economy

3.34 Internet availability is potentially key to supporting sustainable economic growth, particularly for small businesses and those based in rural areas. By allowing businesses greater flexibility, supporting innovation and improving their competitiveness, the internet helps to maximise economic resilience. This, in turn, supports the competitiveness of the economy as a whole.

[23] "Mind the gap: digital England—a rural perspective."
[24] "Price and choice in remote communities: call for evidence," 8 June 2012, www.oft.gov.uk/shared_oft/consultations/remote-communities/OFT1420.pdf.
[25] "Mind the gap: digital England—a rural perspective."
[26] "Access and inclusion: digital communications for all," 15 October 2009, http://stakeholders.ofcom.org.uk/binaries/consultations/access/statement/ai_statement.pdf.
[27] http://stakeholders.ofcom.org.uk/binaries/consultations/access/responses/hclink.pdf.

Provision of public services

3.35 Moving public services online offers economic as well as societal benefits. The internet enables public bodies to deliver "more for less" as online delivery methods are less costly than traditional methods such as the post and telephone. Online information about public services reduces the number of telephone or personal enquiries about such services, freeing up staff resources.

3.36 DH's Whole System Demonstrator programme has exemplified the potential for connectivity in the provision of public services. The programme, which uses technology to help individuals manage their health while maintaining independence, resulted in 20% fewer emergency admissions and a 15% fall in visits to accident and emergency.

> Race Online 2012 estimated annual savings of £900m if all offline adults began using the internet to contact the UK Government each month instead of a telephone call or face-to-face contact.

Source: "Manifesto for a Networked Nation."

The digital economy

3.37 It is not just individual businesses that might find it difficult to remain competitive without quality communications services. The UK Government argued "those countries and governments that strategically push forward their digital communications sector will gain substantial and long-lasting competitive advantage."[28] Booz & Company estimated UK SMEs could unlock as much as £18.8bn in incremental revenue from digital technology.[29]

3.38 For some rural communities, internet availability is seen as essential to arresting economic decline and avoiding further marginalisation. Labour Members of the Scottish Parliament for the Highlands and Islands cited the Western Isles as a community facing major economic challenges, including securing a diverse range of employment opportunities, and population decline. They argued such communities "need every economic advantage they can obtain if they are to retain and grow population, widen employment and prosper into the future. Modern, fast digital communications is a vital part of that future."[30]

Why mobile internet availability matters

3.39 Mobile internet access is possible using mobile phones and mobile modems (also known as dongles). These devices use 2G, 3G and now 4G technologies, delivering increasingly faster connections.

3.40 Accessing the internet on mobile devices is increasingly important to both individuals and businesses. Our research found 39% of UK adults owned a smartphone (a mobile phone specifically designed for data services) by the first quarter of 2012,[31]

[28] "Digital Britain: Final Report."
[29] "This is for everyone: the case for universal digitisation."
[30] http://stakeholders.ofcom.org.uk/binaries/consultations/access/responses/highlandisland.pdf.
[31] Communications Market Report (CMR) 2012, 18 July 2012, http://stakeholders.ofcom.org.uk/market-data-research/market-data/communications-market-reports/cmr12/.

while the volume of data transferred over the UK's mobile networks increased by 119% between March 2011 and June 2012.[32]

We found 94% of UK adults own/use a mobile phone and 42% access the internet over a mobile connection (either on a computer or a mobile phone).

Source: CMR 2012.

3.41 The importance of mobile internet services is evident in the changes to modern working patterns. An increase in working away from a fixed location (such as an office) increases the demands for mobile internet connections. For many, there is an increasing expectation of being "available" and accessible at all times and the line between working hours and personal life has become blurred.

85% of individuals take part in work-related phone calls during personal time, while 81% of smartphone users have their mobile switched on all the time, even when they are in bed.

Source: CMR 2011, 4 August 2011.[33]

Internet availability and quality of service are likely to matter even more in the future

3.42 In 2009, the UK Government considered, "We are at a tipping point in relation to the online world. It is moving from conferring advantage on those who are in it to conferring active disadvantage on those who are without."[34] The Commission for Rural Communities has warned against underestimating "the pace, depth and scale of technological change."[35]

3.43 The direction of travel is clear: an increasing number of vital services will in the future be either only available online or provided offline in a way that penalises those who access them in this way (for example, at a higher cost). It is also likely online services will increasingly require faster connections as they become increasingly sophisticated.

3.44 Variation in the quality of communications services available is therefore an increasingly significant issue. The divide between those who have access to high-quality online services in particular and those who do not appears to be growing. The average speeds delivered to urban consumers are increasing much more rapidly than those delivered to rural consumers. Our research showed urban consumers received average fixed-broadband download speeds that were 15% faster than those received by their rural counterparts in 2008.[36] By May 2012, the average speed for urban consumers had risen to over two and a half times that for rural consumers.[37]

[32] "Infrastructure Report, 2012 update," 16 November 2012, http://stakeholders.ofcom.org.uk/market-data-research/other/telecoms-research/broadband-speeds/infrastructure-report-2012/.
[33] http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr11/UK_CMR_2011_FINAL.pdf.
[34] "Digital Britain: Final Report."
[35] "Mind the gap: digital England—a rural perspective."
[36] "UK Broadband Speeds 2008," 8 January 2009, http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/bbspeed_jan09.pdf.
[37] "UK fixed-line broadband performance, November 2011: the performance of fixed-line broadband delivered to UK residential consumers," Ofcom, 2 February 2012, http://stakeholders.ofcom.org.uk/binaries/research/broadband-research/Fixed_bb_speeds_Nov_2011.pdf.

3.45 In June 2012, superfast broadband networks offering download speeds of 30 Mbit/s or higher were available from commercial providers to 65% of UK premises.[38] As internet services evolve, the importance of extending the availability of these services will increase.

Other communications services

Mobile telephony

The growing importance of mobile communications

3.46 Mobile networks are an important delivery platform for voice services and text messages. Between 2000 and 2010, time spent on mobile voice calls increased by 350%, while the volume of text messages increased by around 2,000%.[39]

93% of UK adults own or use a mobile phone, and 15% of UK adults live in mobile-only homes.

Source: CMR 2011.

Dissatisfaction with current levels of availability

3.47 Research by the Communications Consumer Panel found quality of coverage to be an important concern for consumers. Problems with signal and reception were a primary source of consumer concern in unprompted feedback—as significant in importance as the cost of services.[40]

3.48 Coverage is particularly important to people who are working. As above, individuals highly value the ability to use communications services on the go, and changes in lifestyle and working patterns mean people expect to be able to contact others, and to be contacted, at almost any time.

3.49 The Welsh Government has cited evidence of citizens who state they are unable to access mobile services where they live and this may affect their ability to call the emergency services.[41] Emergency roaming between all mobile operators is available across the UK, which means consumers can make an emergency call using any available network when they are not within the coverage of their own.

Future use

3.50 Mobile devices are set to become even more important as they are increasingly used for a variety of activities, including democratic engagement (for example, as a tool for voter registration or questioning electoral candidates), health (for example, receiving text reminders about appointments) and transport (for example, up-to-date travel information). As a consequence, those without access to mobile services may find themselves disadvantaged or marginalised.

[38] "Infrastructure Report, 2012 update."
[39] CMR 2011.
[40] www.communicationsconsumerpanel.org.uk/CCP_response_to_mostly_mobile_061009.pdf.
[41] "Access and inclusion: digital communications for all."

Digital television

3.51 Television is not just a means of entertainment. It is also a key source of news and provides access to political, educational, cultural and community-based programmes. The value placed on television by individuals is reflected by high levels of viewing—an average of four hours per day.[42]

3.52 DSO has had important implications for those left without a DTT signal. With analogue television, households without reception sufficient to be classed as covered could often still tolerate the lower picture quality they did receive. In the case of DTT, the outcomes are far more binary: the picture quality is either good or nonexistent, and the constant on/off reception that occurs in areas of highly marginal reception is far less acceptable to viewers than poor analogue reception. We have previously estimated broadly similar numbers of households—about 250,000—would move in and out of 'fully reliable' DTT coverage at DSO (though only around 75,000 households are unable to receive any usable DTT signal at all).[43]

Radio

3.53 Radio also provides access to news, political, educational, cultural and community programmes and is a valued source of entertainment. Digital radio offers benefits to consumers in terms of the number of channels available, the quality of the audio, improved station selection and enhanced features such as scrolling radio text and the potential (with compatible equipment) to pause or rewind live programming.

3.54 However, the most popular radio channels are also available via analogue radio, which provides near-ubiquitous service. Moreover, the availability of DAB digital radio is not necessarily required for most digital radio channels as they are available via digital-television platforms and the internet (although these do not provide access to services in as portable and mobile a manner as DAB).

Post

3.55 The UK postal service is highly valued by both businesses and households. Nearly all businesses use the postal service, including for delivering or receiving goods, sending bills or marketing. Richard Hooper noted 87% of all mail in the UK in 2009 was sent by businesses: 60% to domestic consumers and 27% to other businesses.[44] Our research has found residential consumers say they receive an average of 7.8 items per week but claim to send an average of only 5.9 items each month, also indicating the majority of mail in the UK is sent by businesses. Furthermore, when asked about the type of mail they had received in the past week, a larger proportion of residential consumers had received transactional mail (84% of respondents), addressed direct mail (49%) and other communications from

[42] CMR 2012.
[43] "Ofcom fact sheet on coverage no 2: what will the coverage of the public service TV multiplexes be after switchover?" March 2008, http://stakeholders.ofcom.org.uk/binaries/research/tv-research/no2factsheet.pdf.
[44] "Saving the Royal Mail's universal postal service in the digital age: an update of the 2008 independent review of the postal services sector," 10 September 2010, www.gov.uk/government/uploads/system/uploads/attachment_data/file/31808/10-1143-saving-royal-mail-universal-postal-service.pdf.

businesses than greetings cards and invitations (35%) or personal letters (27%) from other consumers.[45]

3.56 Many people still rely on the postal service as an important means of communication. TNS BMRB found over half of business customers use mail as a communication method, with usage levels not far below that of text messages.[46] Despite residential customers expecting the volume of mail they send to decline over the next few years, they still say there will always be some things that can only be sent by post. Our research provides evidence many users rely on postal services as a means of communication, with three in five respondents stating they were either "very" or "fairly" reliant on the post as a means of communication. Furthermore, over half (58%) of residential customers said they would feel cut off from society if they could not send or receive post.[47]

3.57 Parcel delivery and collection are particularly important to rural communities and those living in remote locations. Those in rural areas may have access to less variety of goods and services than those in more urban areas, and online services, particularly internet shopping, increase the range of goods and services available. The Office of Fair Trading found limited or expensive public-transport services were an additional problem for remote communities and can therefore increase the appeal of online shopping and deliveries.[48]

Take-up

3.58 Although the focus of this report is the availability of communications services, access also incorporates the perceived need for, affordability of and ability to use those services. It is therefore important to consider take-up metrics alongside assessments of availability.

3.59 Measuring and assessing the take-up of internet services is of particular importance, both because of the growing role of the internet in driving social and economic inclusion (see above) and because access to the internet can be constrained by affordability (including the requirement to own a computer or other connected device) and a lack of competencies to use online services.

3.60 In the first quarter of 2012, 80% of UK households had home internet access (including via a mobile phone), an increase of three percentage points on the previous year.[49]

3.61 Our annual Consumer Experience report provides demographic analysis of households that do not take the internet. Our 2011 report found older people were much less likely to have internet access. In the second quarter of 2011, 27% of over-75s and 55% of 65 to 74 year-olds had home broadband access, compared to 86% of 25 to 44 year-olds. Lower-income households are also less likely to have home broadband access: 55% of households in the DE socioeconomic group, compared to 88% of AB1 households. Although the quality of internet network provision is not

[45] "The Consumer Experience of 2012," 8 January 2013, http://stakeholders.ofcom.org.uk/binaries/research/consumer-experience/tce-12/Consumer_Experience_Researc1.pdf.
[46] "Business customer needs from a sustainable universal postal service in the UK," 8 November 2010, http://stakeholders.ofcom.org.uk/binaries/post/1184.pdf.
[47] "The Consumer Experience of 2012."
[48] "Price and choice in remote communities: call for evidence."
[49] CMR 2012.

typically as high in rural areas as in urban areas, there is no significant difference in the take-up of broadband between households in rural and in urban areas.[50]

3.62 Failure to take up broadband occurs for a number of reasons. Broadly, these can be divided into voluntary and involuntary reasons. Voluntary reasons are those such as choosing not to take up broadband because the individual cannot see the relevance of it or simply does not want to use the internet. Involuntary reasons include not having the skills or knowledge to be able to use the internet or not being able to afford the cost.

3.63 The Communications Consumer Panel identified two main barriers to participation in the online world.[51] The first is the "gravitational hold of the offline world," experienced by those who see the offline world as considerably easier, faster, familiar, more accessible and user-friendly. The second is "fear of technology and its complexity," experienced by those do not relate to, or identify with, the image and language of technology.

3.64 We found 6% of households in the second quarter of 2010 voluntarily chose not to have internet access at home, generally because they felt they had no need for it. This was highest for older people, with 27% of over-75s not accessing the internet for voluntary reasons. A higher proportion of households (10%) claimed not to have the internet for involuntary reasons, with 23% of DE households claiming either the costs or their lack of skills prohibited them from having home internet access.[52]

3.65 Go On UK (whose objectives were formerly carried out by Race Online 2012) aims to make the UK the most digitally capable nation in the world by focusing on skills and helping those who do not have the requisite basic knowledge to get up to speed.

3.66 The UK has recently experienced success with switchover to another digital communication service, DTT. DSO has now been completed and was achieved with the help of Digital UK, a not-for-profit organisation set up at the request of the UK Government to help people prepare for the switch.

[50] "The Consumer Experience 2011," 6 December 2011, http://stakeholders.ofcom.org.uk/binaries/research/consumer-experience/tce-11/research_report_of511a.pdf.
[51] "Bridging the gap: sustaining online engagement."
[52] "The Consumer Experience 2011."

Section 4

The availability of communications services

Introduction

4.1 As discussed in section 3, the availability of communications services is not ubiquitous in the UK. This section describes the extent of availability for each of the following services:

- fixed telephony;
- fixed broadband;
- mobile (voice and data);
- digital television;
- radio; and
- post.

4.2 We provide a figure for the availability of each service for the UK as a whole, as well as breakdowns by nation and English region. On the whole, these are data we already publish. Where possible, new analyses further break the data down into Urban, Semi-urban and Rural areas as described in section 2. Because of differences in the granularity of those data, we have had to make assumptions that mean the analyses for DTT and DAB digital radio are less accurate than for broadband and mobile services. We have nonetheless included them because of the general—and generally consistent—picture they paint.

4.3 It is important to remember each of the six communications services under consideration has a different history with different legacies. Fixed telephony and postal services are subject to USOs and therefore available across practically all the UK. Digital satellite television and analogue radio are similarly ubiquitous, and there is a high level of availability of public-service broadcasting (PSB) on DTT now DSO has taken place. However, the availability of broadband, mobile and DAB digital-radio services is subject to much greater variation.

Fixed telephony

4.4 Fixed telephony is available across almost all the UK. A USO ensures a basic service for all citizens, with BT and, within Hull, KCom designated as the universal service providers. This obliges them to provide a fixed telephone line supporting voice, fax and “functional” internet access to any household on request. The USO services must be offered at prices that are affordable for all end-users and uniform throughout the UK, unless we have determined there is clear justification for not doing so.

4.5 Under the USO, both BT and KCom are required to connect a telephone line at a standard price unless this would incur an unreasonable cost, currently set at £3,400 by BT. BT reports typically fewer than 0.25% of requests for new telephone lines

exceed this limit. Additional costs are charged to the consumer if s/he chooses to proceed with the order. This means more than 99.9% of requests for new BT lines are fulfilled. KCom reports it has not turned down any requests for a telephone line.

Fixed broadband

4.6 Headline download speeds of at least 2 Mbit/s are available in almost all premises in the UK.[53] This report therefore focuses on two key definitions of broadband:

- Standard - affording actual download speeds of at least 2 Mbit/s and generally delivered using Asymmetric Digital Subscriber Line (ADSL) technology. This is the minimum for streaming live video and is consistent with the UK Government's definition in its ambition of providing near-universal access by 2015; and

- Superfast - affording headline download speeds of at least 30 Mbit/s and most commonly provided at least partially through fibre-optic cable in the form of fibre to the cabinet (FTTC), fibre to the premises (FTTP) or cable.[54]

4.7 Table 3 shows there are significant variations in the availability of standard broadband in the UK. We estimate approximately 1.2m homes cannot receive this service: just over 900,000 in England and around 100,000 in each of Northern Ireland, Scotland and Wales. (Detailed figures, broken down by location and rurality, are in annex 1, along with figures for the other services considered in this section.)

Table 3. Standard-broadband availability (percentage of households)

	All	Urban	Semi-urban	Rural
UK	95.3	98.3	96.9	80.1
England	95.8	98.5	97.1	80.6
Northern Ireland	87.4	96.0	95.6	66.5
Scotland	95.3	98.0	96.8	85.9
Wales	91.9	96.4	95.2	77.0
East Midlands	94.5	98.5	97.4	76.1
East of England	94.0	97.6	96.9	79.0
Greater London	99.2	99.3	100	87.4
North East England	95.1	97.4	96.1	80.5
North West England	96.3	98.1	97.3	79.0
South East England	95.7	97.1	97.6	85.3
South West England	94.7	98.5	97.9	81.4
West Midlands	96.1	98.8	97.1	79.6
Yorkshire & the Humber	94.5	96.9	95.8	78.9

Source: Ofcom estimates. Note: The overall availability figure for the UK differs from that in the "Infrastructure Report, 2012 update" because of methodological differences.

4.8 Table 4 shows there are also significant variations in the availability of superfast broadband in the UK (expressed as the proportion of homes that theoretically have FTTC coverage because the closest telecommunications cabinet is connected to the

[53] "Infrastructure Report, 2012 update."
[54] This is consistent with the definition used by the European Commission. An alternative definition is 24 Mbit/s, which we have used in some previous publications and the UK Government uses in its ambition of providing access to at least 90% of premises by 2015. Due to the very small proportion of superfast-broadband services that operate between 24 and 30 Mbit/s (approximately 3%), the difference in reported availability if the 24 Mbit/s definition was used here would be very small.

local exchange by fibre-optic cable). We estimate approximately 8.5m homes cannot receive this service: 6.5m in England, 1.3m in Scotland and almost 800,000 in Wales but fewer than 30,000 in Northern Ireland.

Table 4. Superfast-broadband availability (percentage of households)

	All	Urban	Semi-urban	Rural
UK	67.9	86.0	67.0	21.2
England	70.9	86.7	70.5	19.1
Northern Ireland	96.0	98.4	97.1	92.4
Scotland	47.6	72.3	48.3	6.3
Wales	39.8	90.1	33.8	6.6
East Midlands	67.1	93.5	68.8	17.9
East of England	68.5	94.0	74.4	14.0
Greater London	87.9	87.9	95.0	58.5
North East England	71.2	79.1	74.4	23.4
North West England	72.9	84.3	74.1	18.0
South East England	70.8	90.7	75.8	25.4
South West England	52.3	89.9	46.5	16.0
West Midlands	75.0	86.4	75.9	18.8
Yorkshire & the Humber	63.6	70.9	67.0	20.0

Source: Ofcom estimates. Note: The overall availability figure for the UK differs from that in the "Infrastructure Report, 2012 update" because of methodological differences.

4.9 Tables 3 and 4 are also presented at administrative-authority level in the form of interactive maps at http://maps.ofcom.org.uk/broadband/.

4.10 It is notable Northern Ireland has the lowest availability of standard broadband in the UK but significantly greater availability of superfast broadband than elsewhere (for reasons set out in section 6). Wales is relatively poorly served by both standard and superfast broadband. It is also notable how sharply the availability of superfast broadband across the UK falls with increased rurality. Again, only in Northern Ireland are the differences small. In Wales, Rural locations are more than 13 times less likely than Urban locations to have superfast broadband. Broadly speaking, availability varies more greatly in this way within NUTS regions than between different parts of the UK with similar population density.

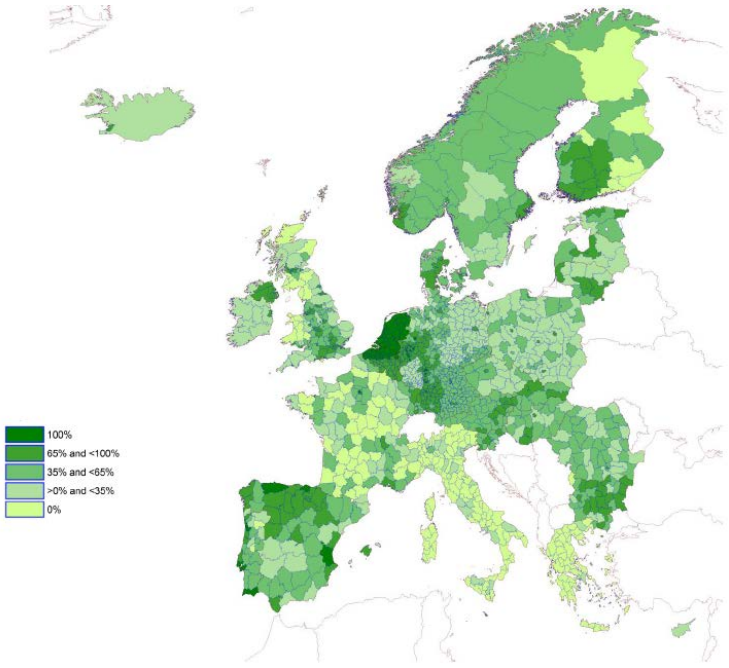
4.11 Figure 3 specifically maps the availability of superfast broadband, clearly showing this does not yet extend to predominantly rural areas in Great Britain.

Figure 3. Availability of superfast broadband in the UK

Source: "Infrastructure Report, 2012 update."

4.12 The UK is far from unique in this pattern of availability. Figure 4 shows the picture in Europe at the end of 2011.

Figure 4. Availability of superfast broadband in Europe



Source: "Broadband coverage in Europe in 2011: mapping progress towards the coverage objectives of the Digital Agenda," Point Topic, 27 February 2012, produced for the European Commission.[55]

[55] http://ec.europa.eu/information_society/newsroom/cf//document.cfm?doc_id=1102.

4.13 For businesses, leased lines—transmission facilities privately leased from a public communications provider—are a common way of connecting to the internet. Jigsaw Research found 42% of respondents used leased lines, while this figure was 68% among larger companies.[56] We subsequently concluded the service is in theory generally available across the UK: "BT's physical network is ubiquitous in the UK and BT can deliver leased lines almost everywhere in the country except in Hull, where KCOM operates the only ubiquitous physical network."[57]

Mobile (voice and data)

4.14 2G technologies are used for mobile telephone calls and text messaging. It is possible to access the internet using 2G services, but 3G technologies are required for a reasonable quality of connection. We consider 2G coverage as broadly equivalent to voice coverage and 3G coverage as broadly equivalent to data coverage.

4.15 Table 5 shows 2G mobile coverage of premises in the UK. We estimate approximately 80,000 homes cannot receive this service: just over 40,000 in England, around 20,000 in Scotland and 10,000 in each of Northern Ireland and Wales. These and other mobile premises coverage figures in this report refer to coverage outside premises from at least one network operator. Coverage inside premises is likely to be lower because mobile signals weaken as they pass through walls. As the thickness and make-up of walls vary between buildings, indoor mobile coverage also varies and so it is difficult to provide meaningful indoor-coverage figures.

Table 5. 2G mobile coverage (percentage of premises served by at least one operator)

	All	Urban	Semi-urban	Rural
UK	99.7	99.9	99.5	99.1
England	99.8	99.9	99.7	99.6
Northern Ireland	98.7	99.5	98.2	97.8
Scotland	99.2	99.7	99.2	97.9
Wales	99.2	99.8	99.1	98.1
East Midlands	99.8	99.9	99.8	99.8
East of England	99.8	99.8	99.7	99.6
Greater London	100.0	100.0	100.0	100.0
North East England	99.6	99.8	99.3	99.3
North West England	99.9	99.8	99.8	99.6
South East England	99.9	99.9	99.9	99.9
South West England	99.5	99.7	99.3	99.3
West Midlands	99.9	99.9	99.7	99.6
Yorkshire & the Humber	99.8	99.9	99.7	99.2

Source: Ofcom.

[56] "Business Connectivity Services Review 2011," October 2011, http://stakeholders.ofcom.org.uk/binaries/consultations/business-connectivity/annexes/business-review.pdf.

[57] "Business Connectivity Market Review: review of the retail leased lines, wholesale symmetric broadband origination and wholesale trunk segments markets," 18 June 2012, http://stakeholders.ofcom.org.uk/consultations/business-connectivity-mr/summary.

4.16 Table 6 shows 3G mobile coverage of premises in the UK. We estimate over 200,000 homes cannot receive this service: more than 80,000 in Northern Ireland, around 70,000 in each of England and Scotland and 30,000 in Wales.

Table 6. 3G mobile coverage (percentage of premises served by at least one operator)

	All	Urban	Semi-urban	Rural
UK	99.1	99.7	98.5	96.6
England	99.7	99.9	99.5	99.2
Northern Ireland	88.3	96.4	81.7	78.5
Scotland	97.0	98.9	97.0	91.7
Wales	97.6	99.5	97.4	94.2
East Midlands	99.9	99.9	99.8	99.8
East of England	99.7	99.8	99.5	99.4
Greater London	100.0	100.0	100.0	100.0
North East England	99.4	99.7	99.0	98.3
North West England	99.8	99.9	99.5	99.0
South East England	100.0	100.0	100.0	100.0
South West England	99.2	99.6	99.0	98.6
West Midlands	99.7	99.9	99.4	99.2
Yorkshire & the Humber	99.6	99.8	99.5	98.5

Source: Ofcom. Note: Tables 5 and 6 were produced by matching residential and SME premises to a database of 200×200m pixels detailing mobile coverage across the UK. This approach is slightly different to the process of matching coverage data to postcodes used in the regression analysis in annex 1. There are therefore small differences between the figures produced by the two approaches.

4.17 Those areas with greater geographic and economic challenges tend to have coverage from only one or two operators. In larger centres of population, consumers tend to be able to choose services from most or all mobile operators.

4.18 Table 7 shows 2G and 3G mobile coverage by at least one network operator by geography. This is important because our research shows people make many of their mobile phone calls when they are not at home or work.[58]

[58] "Mobile phone usage: attitudes towards mobile phone functions including reception," 23 January 2013, http://stakeholders.ofcom.org.uk/binaries/consultations/mobile-voice-data-experience/annexes/usage.pdf.

Table 7. Mobile coverage (percentage of landmass)

	2G	3G
UK	87.2	75.8
England	95.8	94.0
Northern Ireland	91.5	52.1
Scotland	72.5	49.2
Wales	85.7	77.9
East Midlands	98.8	98.7
East of England	99.1	98.4
Greater London	100.0	100.0
North East England	84.6	77.1
North West England	92.1	89.8
South East England	99.0	99.4
South West England	96.3	94.0
West Midlands	97.6	95.7
Yorkshire & the Humber	91.7	88.2

Source: Ofcom.

4.19 Tables 5, 6 and 7 are also presented at administrative-authority level in the form of interactive maps at http://maps.ofcom.org.uk/mobile-services/. Additional information on population and geographic coverage for each administrative authority is also available here.

Digital television

4.20 Consumers in the UK receive their television services via a variety of digital platforms: digital terrestrial, satellite, cable and internet.

4.21 The main free-to-air brand is Freeview on DTT. Freesat, a joint venture launched by the BBC and ITV in 2008, provides access to free-to-air channels by satellite. These channels are also available on Sky receivers without the need for a subscription.

4.22 Pay TV is available on all digital-television platforms. Sky retails services on digital satellite, Virgin Media is the largest cable operator, and pay services are also available on DTT from both BT Vision and Top Up TV.

DTT

4.23 With DSO now complete in the UK, DTT services are transmitted from the network of land-based transmitter masts that formerly carried analogue-television channels. The network comprises 1,156 transmitters—80 large and almost 1,000 smaller ones—operated by Arqiva. The services are based on a “multiplex” structure, with each multiplex containing a number of concurrent television services (currently up to 11) as well as radio stations and text services. These services are digitally combined into a single signal to form the transmitted multiplex. Each multiplex occupies the same amount of spectrum as one analogue-television channel.

4.24 The DTT platform currently consists of six multiplexes. Two are operated by the BBC, two by Arqiva, one by Digital 3&4 (a company jointly owned by ITV and Channel 4) and one by SDN (a subsidiary of ITV).

4.25 The two BBC multiplexes and the Digital 3&4 multiplex are designated as PSB multiplexes. These carry standard-definition (SD) digital versions of the historic five analogue-television channels as well as 11 other SD television channels. One of the PSB multiplexes carries four high-definition (HD) television channels using advanced transmission standards. These three multiplexes transmit from all 1,156 transmitters, achieving near-universal coverage, as a result of conditions in their licences.

4.26 The remaining three, commercial multiplexes (operated by Arqiva and SDN) contain approximately 30 concurrent television channels. The commercial multiplexes are transmitted only from the 80 large transmitter sites. Due to the high cost of building out transmission networks on a purely commercial basis and the constraints on the availability of spectrum in some areas, further extensions to commercial multiplex coverage are unlikely.

4.27 Table 8 shows DTT coverage by the three PSB multiplexes as a proportion of UK households. We estimate over 300,000 homes cannot receive this service: more than 260,000 in England, nearly 30,000 in each of Scotland and Wales and almost 20,000 in Northern Ireland.

Table 8. DTT coverage by PSB multiplexes (percentage of households)

	All	Urban	Semi-urban	Rural
UK	98.7	99.8	98.8	96.0
England	98.8	99.8	98.6	97.0
Northern Ireland	97.5	100.0	98.8	93.6
Scotland	98.8	100.0	99.8	94.0
Wales	97.8	99.8	99.4	92.0
East Midlands	99.7	99.7	99.8	99.6
East of England	96.9	98.5	96.7	95.9
Greater London	98.7	99.8	98.8	96.0
North East England	98.8	99.8	98.6	97.0
North West England	97.5	100.0	98.8	93.6
South East England	98.8	100.0	99.8	94.0
South West England	97.8	99.8	99.4	92.0
West Midlands	99.7	99.7	99.8	99.6
Yorkshire & the Humber	96.9	98.5	96.7	95.9

Source: Ofcom. Note: These data were gathered shortly after the completion of DSO and do not include subsequent changes to the DTT coverage model.

4.28 Table 9 shows DTT coverage by all six multiplexes as a proportion of UK households. We estimate some 2.7m homes cannot receive this service: nearly 1.8m in England, 400,000 in Wales, 300,000 in Scotland and 200,000 in Northern Ireland.

Table 9. DTT coverage by all multiplexes (percentage of households)

	All	Urban	Semi-urban	Rural
UK	89.9	97.1	88.0	79.3
England	92.0	97.0	90.0	85.5
Northern Ireland	74.1	97.8	71.1	62.4
Scotland	86.6	98.2	87.5	67.6
Wales	71.0	98.0	69.5	52.2
East Midlands	93.5	95.9	93.6	89.9
East of England	86.8	90.0	85.3	88.0
Greater London	98.8	98.8	99.9	98.7
North East England	95.4	97.1	96.1	87.3
North West England	94.5	99.4	94.5	79.3
South East England	85.3	93.2	82.6	87.5
South West England	83.3	88.9	83.6	76.4
West Midlands	97.5	99.0	97.4	92.2
Yorkshire & the Humber	95.3	99.4	94.5	87.1

Source: Ofcom.

4.29 Tables 8 and 9 are also presented at administrative-authority level in the form of interactive maps at http://maps.ofcom.org.uk/dtt/.

4.30 There are no extreme variations in the availability of the PSB multiplexes between Urban and Rural areas. Even in Rural Wales and South West England, 92.0% of households can receive the channels they carry. However, the availability of all six multiplexes falls from 98.0% in Urban Wales to 52.2% in Rural Wales. There is a similar pattern in Northern Ireland and Scotland. In England, all-multiplex variability is greatest in North West England, with South West England generally less comprehensively served. Section 5 explains the reasons for these variations.

Local TV

4.31 After the UK Government decided to introduce local-TV services, we advertised licences for 21 stations and the multiplex operator for all the services. The locations for those stations were Belfast, Birmingham, Brighton, Bristol, Cardiff, Edinburgh, Glasgow, Grimsby, Leeds, Liverpool, London, Manchester, Newcastle, Norwich, Nottingham, Oxford, Plymouth, Preston, Sheffield, Southampton and Swansea.

4.32 We received no applications for two stations: Plymouth and Swansea. For the remaining 19 stations, we received 57 applications. On 1 March 2013, we announced we had awarded the licences for all 19 stations as well as the multiplex licence and so had completed the first phase of local-TV licensing.[59] In total, the first phase of local-TV channels will reach almost 12m households.

4.33 Local services can begin broadcasting as soon as the multiplex is built out but must begin within two years of licence award. It is hoped some channels may be on air before the end of 2013.

4.34 We are now preparing for the second phase of licensing as the successful multiplex applicant proposed further locations it would be able to cover. Any such licences will be selected from a list of locations where we have said local TV is technically

[59] http://media.ofcom.org.uk/2013/03/01/ofcom-awards-preston-local-tv-licence/.

possible (it is constrained by spectrum availability) and there is interest from a local operator. We will publish details shortly.

4.35 Maps of potential local-TV coverage can be found on our website.[60]

4.36 Local-TV licences are awarded with regard to statutory criteria that require the service to serve the local area and be sustainable. We have said we consider local news to be the most important type of local content and will have particular regard to applicants' proposals for this. It is highly likely each local service will broadcast at least one hour of local news every day.

4.37 As part of the statutory framework for local TV, these services are designated as PSB and will be given appropriate prominence on electronic programme guides.

Satellite

4.38 Digital satellite television services have been available in the UK since 1998 from Sky and from 2008 from Freesat. These satellites have been positioned to give coverage to the whole of the UK, although individual premises may not be able to receive services due to line-of-sight issues or because it is not possible to install receiving equipment on premises. Planning permission may be required in some locations, although planning laws permit a minimum size and number of dishes in most areas, subject to certain requirements.[61] Sky has reported approximately 2% of homes visited could not have the equipment installed since July 2009.[62]

4.39 In addition to SD and HD services, Sky offers a 3D television channel. Sky's video-on-demand (VOD) services are provided via broadband.

Cable

4.40 Digital television services are transmitted using dedicated 8 MHz channels across cable broadband networks. On Virgin Media's network, these frequencies are used to carry SD, HD and VOD services.

IPTV

4.41 IPTV is a system through which television services are delivered using the internet-protocol (IP) suite over a packet-switched network such as the internet. As such, it requires access speeds sufficient to stream live video.

4.42 IPTV services may be classified into three groups:

- live television, with or without interactivity related to the current show;
- time-shifted television—catch-up (replays a show that was broadcast hours or days ago) and start-over (replays the current show from its beginning); and
- VOD—a catalogue of content not necessarily related to television programming.

[60] http://licensing.ofcom.org.uk/tv-broadcast-licences/local/apply/.
[61] For example, see www.breconbeacons.org/the-authority/planning/applications/before-you-apply/planning-advice-notes-1/planning-advice-note-14-october-2009.
[62] "Infrastructure Report," Ofcom, 1 November 2011 (updated 20 December 2012), http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/bbspeeds2011/infrastructure-report.pdf.

Radio

4.43 Three main types of technology are used to deliver radio in the UK:

- AM. This is susceptible to atmospheric and electrical interference. Most AM stations offer "gold" (primarily 1960s-80s) music services, but there are also several speech-based services and stations aimed at ethnic minorities;
- FM. This method of broadcasting is less susceptible to interference and is able to deliver higher-quality audio. As a result, most music-playing radio stations use FM to deliver their services; and
- DAB. This has several advantages over analogue (AM and FM) technologies. It can offer additional features such as automatic tuning and radio text. It also allows the delivery of more stations using the same amount of spectrum.

4.44 UK-wide analogue radio services are nearly universally available. There is slightly more variability for local services, though these are still generally available. 61.1% of radio listening was via analogue platforms in the second quarter of 2012.[63]

4.45 Digital radio is equally available near-universally via DTT and the internet. This is not the case for the DAB platform. Table 10 shows BBC DAB digital-radio coverage as a proportion of UK households. We estimate approximately 1.5m homes cannot receive this service: just over 1m in England, around 200,000 in each of Scotland and Wales and just over 100,000 in Northern Ireland.

Table 10. BBC DAB digital-radio coverage (percentage of households)

	All	Urban	Semi-urban	Rural
UK	94.2	98.4	94.1	84.2
England	95.4	98.7	94.7	88.3
Northern Ireland	84.7	99.7	84.8	74.1
Scotland	90.8	93.7	94.5	75.5
Wales	85.8	98.4	88.9	67.1
East Midlands	96.1	99.3	95.6	93.5
East of England	91.8	96.6	91.3	88.2
Greater London	99.5	99.5	82.1	95.6
North East England	93.2	99.1	94.4	72.7
North West England	96.8	98.4	97.3	86.6
South East England	94.4	96.0	94.3	93.5
South West England	91.8	99.3	91.8	83.1
West Midlands	97.2	98.3	97.5	92.2
Yorkshire & the Humber	95.5	99.0	95.6	85.2

Source: Ofcom.

4.46 Table 11 shows commercial (Digital One) DAB digital-radio coverage as a proportion of households in Great Britain. We estimate some 3.3m homes cannot receive this service: over 2m in England, 600,000 in Scotland and more than 500,000 in Wales.

[63] "The Communications Market: digital radio report—Ofcom's third annual digital progress report," 17 October 2012, http://stakeholders.ofcom.org.uk/binaries/research/radio-research/drr-2012/2012_DRR.pdf.

Table 11. Commercial DAB digital-radio coverage (percentage of households)

	All	Urban	Semi-urban	Rural
Great Britain	87.4	96.7	84.8	73.3
England	90.4	97.4	87.8	80.3
Scotland	75.0	86.5	78.0	50.2
Wales	59.3	98.6	52.9	42.8
East Midlands	92.4	97.8	91.4	88.2
East of England	87.2	94.4	86.5	81.2
Greater London	99.8	99.8	87.6	99.5
North East England	78.5	83.3	79.8	58.6
North West England	94.7	99.6	94.8	78.5
South East England	88.3	95.6	86.6	87.6
South West England	78.9	96.4	74.9	67.3
West Midlands	95.8	98.6	94.6	89.0
Yorkshire & the Humber	88.7	91.9	88.3	81.3

Source: Ofcom.

4.47 The Digital One multiplex is not currently available in Northern Ireland. Commercial DAB digital radio is provided there by a local multiplex operated by Bauer Digital Radio. This covers 72.9% of households in Northern Ireland. However, Digital One has recently applied to extend the coverage of its multiplex to include Northern Ireland. We recently consulted on its proposal and our initial view it would be calculated to maintain or promote the development of digital sound broadcasting in the UK.[64]

4.48 Tables 10 and 11 are also presented at administrative-authority level in the form of interactive maps at http://maps.ofcom.org.uk/dab/.

4.49 England is the nation best served by both BBC (95.4%) and commercial (90.4%) DAB digital radio, and Greater London has the highest rate of coverage of all, with near-universal coverage by both BBC and commercial services. South West England is relatively poorly served (91.8% and 78.9%) and Wales (85.8% and 59.3%) even more so.

4.50 20% of radio listening among adults for the year up to the first quarter of 2012 took place in vehicles.[65] Table 12 shows the proportion of miles of UK major roads and motorways covered by BBC and commercial DAB digital radio.

[64] "Extending DAB services in Northern Ireland: request to extend coverage area of national radio multiplex service," 14 February 2013, http://stakeholders.ofcom.org.uk/binaries/consultations/dab-services/summary/condoc.pdf.
[65] CMR 2012.

Table 12. DAB digital-radio coverage (percentage of miles of roads)

	BBC	Commercial
Great Britain	73.7	63.8
England	82.6	78.3
Northern Ireland	63.8	76.1
Scotland	54.9	41.5
Wales	53.3	36.4
East Midlands	77.4	75.6
East of England	71.8	71.1
Greater London	98.7	99.3
North East England	77.0	61.9
North West England	85.3	83.4
South East England	89.0	84.5
South West England	79.2	68.8
West Midlands	82.4	83.2
Yorkshire & the Humber	85.6	78.8

Source: Ofcom.

4.51 As with household coverage, England's road network is the best served by both BBC (82.6%) and commercial (78.3%) DAB digital radio, and Greater London has the highest rate of coverage (98.7% and 99.3% respectively) of all. All nine regions of England have better coverage than Northern Ireland, Scotland and Wales, with Wales the poorest served nation for both BBC and commercial services (53.3% and 36.4% respectively).

4.52 In July 2012, the UK Government, the BBC and commercial radio operators reached agreement on a framework for new investment to extend local DAB digital-radio coverage. In accordance with this agreement, and as part of the UK Government's Digital Radio Action Plan,[66] we are currently carrying out work with the BBC and commercial radio stakeholders to plan the further rollout of local DAB digital-radio coverage over the next five years. In addition, new local radio multiplex services will launch in 11 locations by the end of 2014.

Post

4.53 As with fixed telephony, postal services are subject to a USO, so they are available to all UK residents. As required by the USO, Royal Mail collects six days per week from a network of collection points consisting of over 115,000 post boxes and 11,818 post offices.[67] It also collects mail from around 90,000 businesses. Over half (54.6%) of those post offices are classified as rural, and over 99% of the UK population lives within three miles of a post office.[68] The collected mail is then sorted at the local mail centre and distributed between the 48 mail centres. It is then sorted for delivery and transported onward to a network of about 1,400 local delivery offices and more than 950 sub-delivery offices. The mail is then delivered to approximately 29 million individual postal addresses Monday to Saturday.

[66] www.culture.gov.uk/what_we_do/broadcasting/7228.aspx.
[67] Royal Mail Holdings, "Annual Report and Financial Statements 2011-12," 29 June 2012, www.royalmailgroup.com/sites/default/files/Annual_Report_2012.pdf.
[68] Post Office Limited, "The Post Office Network Report 2012," 18 July 2012, www.postoffice.co.uk/sites/default/files/Post%20Office%20Network%20Report%202012.pdf.

4.54 There are a number of exceptions for delivery where access is difficult (for example, an island without a daily crossing) or there are health and safety concerns (such as a dangerous dog). In 2012, 3,000 exceptions were allowed, including voluntary exceptions. 2,165 of these were due to difficulty of access, 388 to long-term health and safety and 447 to short-term health and safety. In total, these exceptions represented 0.01% of UK addresses.[69] Affected consumers can appeal against an exception decision, and an alternative delivery point can be arranged.

[69] "Annual Report and Financial Statements 2011-12."

Section 5

The role of markets

Introduction

5.1 This section describes the role of markets, why they tend not to deliver universally available communications services and the factors that drive availability in practice.

5.2 Well-functioning, competitive markets generally deliver low prices, choice and quality for consumers and spur innovation among providers. But markets will not always capture the full benefits of widely available communications services such as the benefits to society from increased civic participation. Equally, firms sometimes acquire dominant positions that protect them from effective competition.

5.3 Moreover, commercial viability will always be more challenging where low population density or household income mean there is low demand for services and/or where the costs of supply are high. This section examines how the latter are influenced by the different technologies used to deliver communications services.

The benefits of competitive markets

5.4 Well functioning and competitive markets are often the best way to deliver widespread availability of services. They help consumers get a good deal as they drive down prices ensuring goods and services are more affordable to consumers, thus increasing availability. They are also more efficient in a dynamic sense. Competition between firms causes them to bear down on their costs, increase productivity and innovate to provide more attractive products and services over time.

Market imperfections

5.5 Although competitive markets are often the best available method for delivering services, in practice, they can and do suffer from imperfections. This could be because, left to their own devices, they will fail to deliver an economically efficient outcome, leading to the under or overprovision of services. It could also be because they will produce an economically efficient outcome that nonetheless falls short of addressing non-economic demand or a desired public-policy goal. Such imperfections are often tolerated because of the fear a regulatory intervention could cause unintended additional costs. As a consequence, intervention is usually considered in cases where market imperfections are large enough to cause market failure.

5.6 A high level of fixed costs in providing communications services can have a particularly limiting effect on availability and take-up. Externalities, pricing inflexibility and market power can also contribute to this. We discuss each of these imperfections, and their effects, in turn below.

High fixed costs

5.7 Fixed costs are those a firm must incur to produce any output at all. They remain unaffected by the volume of output produced. For example, the cost of constructing a fibre access network to deliver broadband, is largely fixed and does not vary with the number of households within range.

5.8 In general, high costs of any kind will result in higher prices and lower take-up. In the extreme, where costs are very high and demand is low, the market may not be served at all. However, the structure of costs can also affect outcomes, and high fixed costs in particular can lead to inefficient outcomes.

5.9 Where fixed costs are small relative to the size of the market, there will be little impact on outcomes in the market. Higher fixed costs will reduce the number of firms that can survive in the market. Large fixed costs relative to the size of the market will raise prices above the level some customers will pay for the service even though the marginal cost (the cost of supplying to additional customers) is low.

Externalities

5.10 Externalities are a cost or a benefit to a third party following a transaction between two individuals. Where there are positive externalities (that is, third parties benefit as a result of the transaction), markets tend to produce too little. This is because the individuals who operate in the market act on the basis of their own costs and benefits and and do not consider any wider social benefits that may accrue to third parties.

5.11 There are often positive externalities in communications services because of network effects. For example, a consumer benefits from purchasing a telephone service in terms of his/her ability to make and receive calls, but other telephone users also benefit since the service becomes more useful the more people have a telephone. Equally, the value of a 3D television set to an individual depends in part on the amount of 3D television and film content that is available, and content providers will have greater incentives to produce more 3D content if other viewers also purchase 3D television sets.

Pricing inflexibility

5.12 In many industries, firms can vary the prices and the level of service they offer consumers. This type of behaviour is called price discrimination. For example, train companies discriminate their offer by selling first-class, standard-class, advance and discounted student tickets. In general, where firms can price-discriminate effectively, this will improve market coverage and take-up. By charging higher prices to customers with a high valuation of the service and lower prices to customers with lower valuations, firms can more efficiently recover their fixed costs, resulting in fewer customers being excluded and also allowing firms to make a positive return in markets that would not otherwise be viable.

5.13 In many industries, firms cannot vary their prices at a local level because regulation prevents them, the transaction costs of offering local prices are prohibitive or any attempt to offer different local prices would be circumvented by consumers. Where this is the case, take-up rates and coverage are likely to be reduced in local areas where demand is smaller and/or the costs of supply are higher.

5.14 Under local pricing, firms can charge prices that reflect local conditions. For example, in areas that are difficult and costly to serve, firms will have incentives to charge a higher price than in areas that are easy to serve. Under national pricing, the firm must charge the same price in all the local areas in which it is active. This means the price the firm charges in each local market will be inefficient as it reflects cost and demand conditions over its whole estate rather than the local area in question. The larger the differences between individual local markets in terms of costs and demand conditions, the greater this inefficiency. Firms may find it is more profitable not to

supply small and costly markets at all because the resultant change in the national price would reduce its profits in larger and more lucrative markets.

Market power

5.15 Market power is the ability of one or more firms to raise and maintain prices above a competitive level. Firms with market power are able to raise prices without losing customers to competitors. High prices are likely to reduce take-up and many customers will be inefficiently excluded.

5.16 In the longer term, competition can also have an effect on availability. Vigorous competition will, over time, give firms incentives to drive down their costs so they can undercut their rivals. Firms with market power face little competitive pressure and, as a consequence, can become inefficient. Markets that might be viable for an efficient firm may not be viable for an inefficient firm to supply profitably.

What drives local availability in practice?

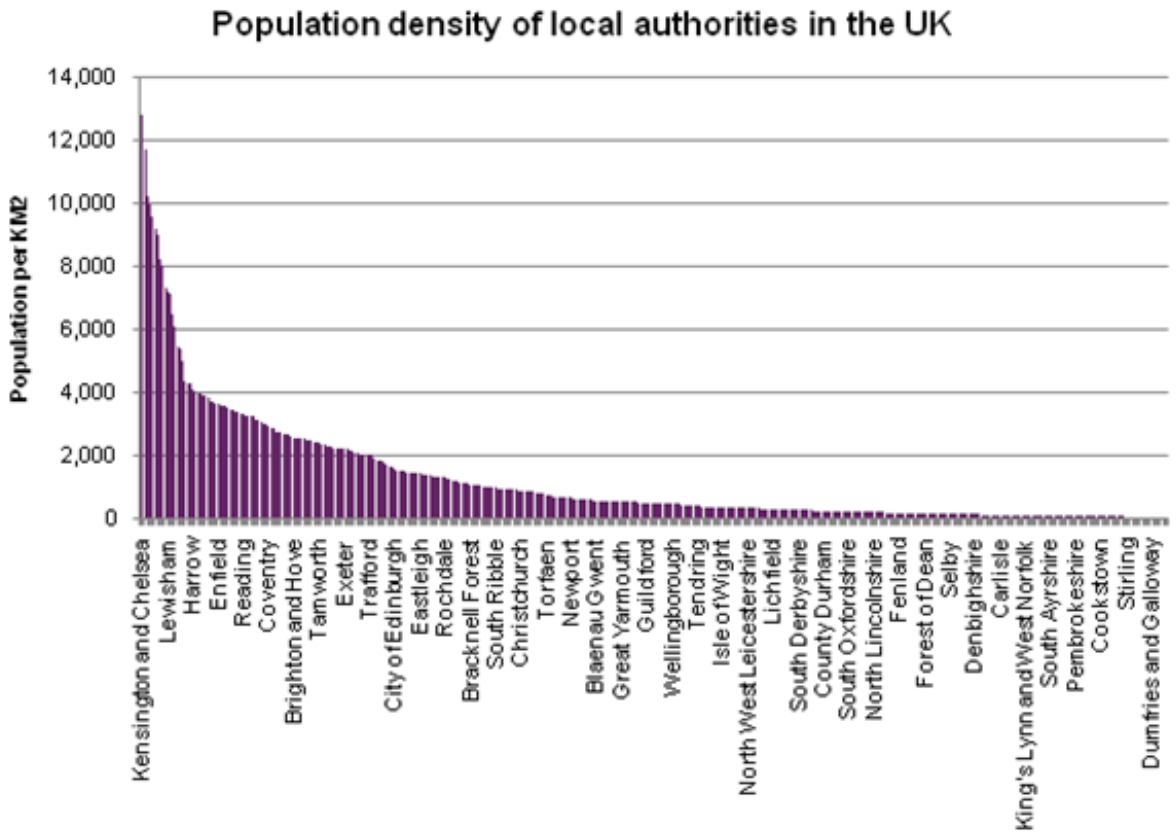
5.17 In practice, a number of different factors will affect whether a particular local market is supplied with a communications service. In particular, factors that increase the size of local demand will increase the likelihood a local market is supplied, and factors that increase the costs of providing a service will reduce the likelihood the local market is supplied.

The size of demand in a particular local area

5.18 The level of demand in a local market will affect the profitably and thus supply to the market. Demand will be influenced by the size and density of the local population and the average willingness to pay across this local population. Table 2 showed how we have classified the population of the UK into Urban, Semi-urban and Rural areas.

5.19 Figure 5 shows the population density of individual local authorities in the UK.

Figure 5. Population density of local authorities in the UK

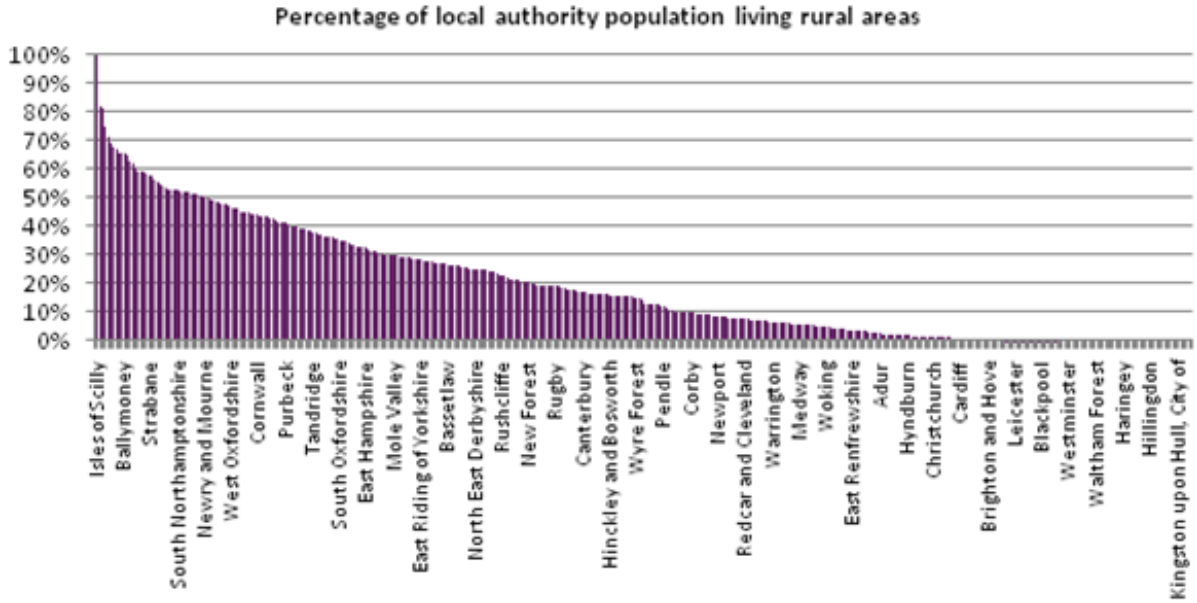


Source: Ofcom based on Office for National Statistics (ONS) data. Note: Not all locations named on X-axis.

5.20 Figure 5 shows there are large variations in population density across the UK. Local authorities with large urban populations in particular, such as Kensington and Chelsea, Leicester and Birmingham, have very high population densities.

5.21 However, these average figures mask still greater variation in population densities at a more local level. The average population per square kilometre in urban areas is 2,464, but in rural areas the population density is on average only 38 people per square kilometre. Figure 6 shows the proportion of the population living in areas classified as Rural also varies widely in the UK.

Figure 6. Percentage of local-authority population living in areas classified as Rural



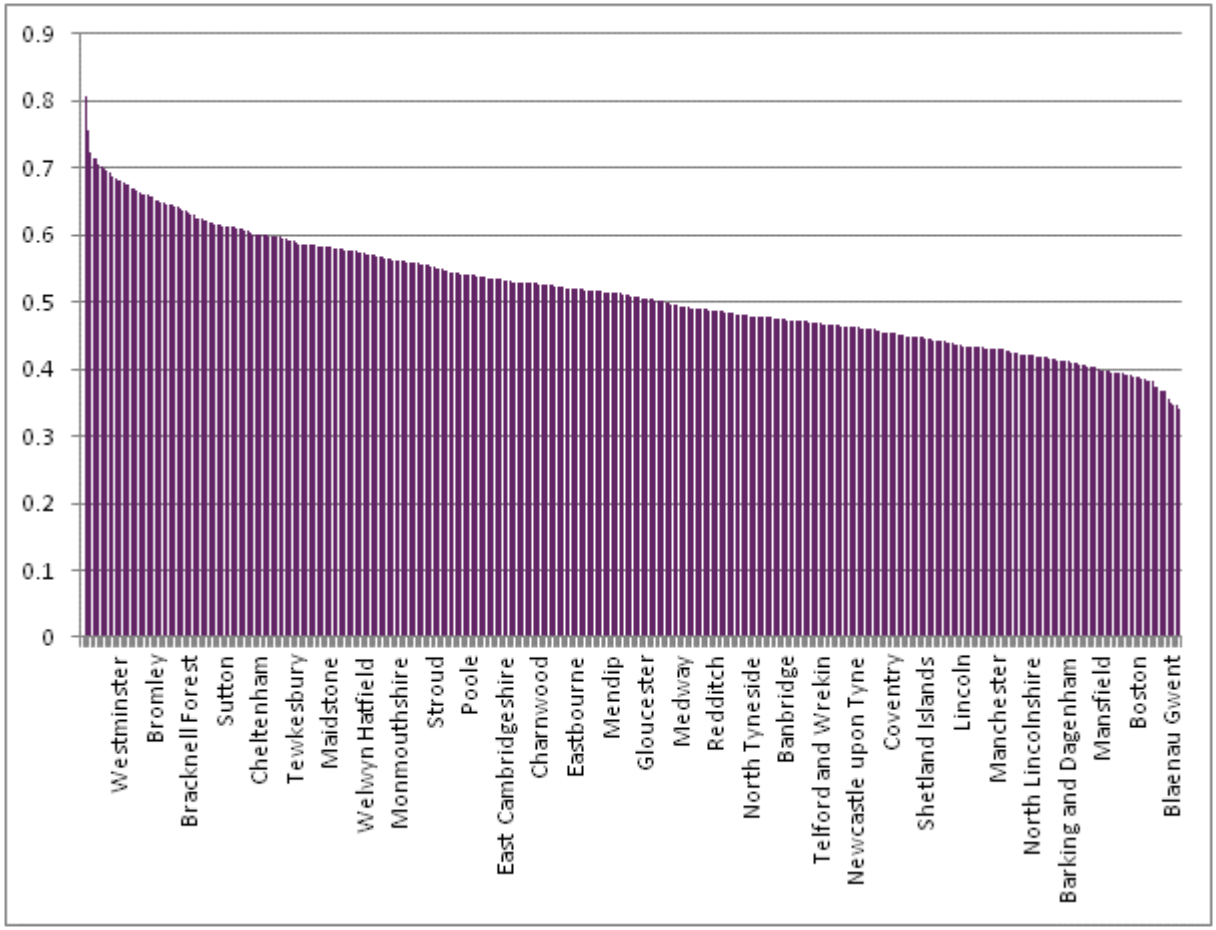
Source: Ofcom based on ONS data. Note: Not all locations named on X-axis.

5.22 In areas covered by the Isles of Scilly, Shetland Islands, Eilean Siar and Ceredigion local authorities, more than 75% of the population lives in areas classified as Rural. In contrast, there are more than 80 local authorities where less than 1% of the population lives in a Rural area.

5.23 In addition to the density of the local population, demand for communications services is also likely to vary due to differences in income and consumption habits. Figure 7 illustrates the differences in the composition of the populations of local authorities in the UK by social grade.[70]

[70] NRS social grades are based on the occupation of the head of the household. Those in higher, intermediate and junior managerial/administrative/professional occupations are classified in categories A, B and C1 respectively. Those in skilled manual, semi- and unskilled manual and casual occupations are classified as C2, D and E respectively.

Figure 7. Proportion of local-authority population classified as ABC1



Source: Ofcom based on ONS data. Note: Not all locations named on X-axis.

5.24 The proportion of the population employed in managerial, administrative and professional occupations is highest in the City of London, Richmond upon Thames and Elmbridge in Worcestershire, where more than 72% of individuals are classified in socioeconomic groups A, B or C1. The proportion is lowest in Sandwell in the West Midlands, Stoke on Trent and the City of Kingston upon Hull, at less than 35%.

5.25 In the UK as a whole, 51% of the population lives in households where the head of the household is employed in a managerial, administrative or professional occupation. Individuals in Rural areas (56%) are more likely than those in Urban and Semi-urban areas (50%) to reside in a household classified in a higher social grade.

5.26 Other differences in the composition of the local population are also likely to have an impact on demand for communications services. For example, the age profile of the local population may also have an effect. Younger individuals tend to be heavier users of communications services in general and make greater use of newer communications services such as mobile or broadband in particular. Older individuals tend to be relatively light users of communications services, with a greater focus on older technologies such as fixed telephony and post.

5.27 In summary, demand for communications services is likely to be highest where the local population is large, densely distributed and relatively affluent. There are large variations across the UK in these factors. Notably, Rural areas are in general

relatively affluent when compared to Urban and Semi-urban areas but also likely to display considerably lower population densities.

The cost of providing services

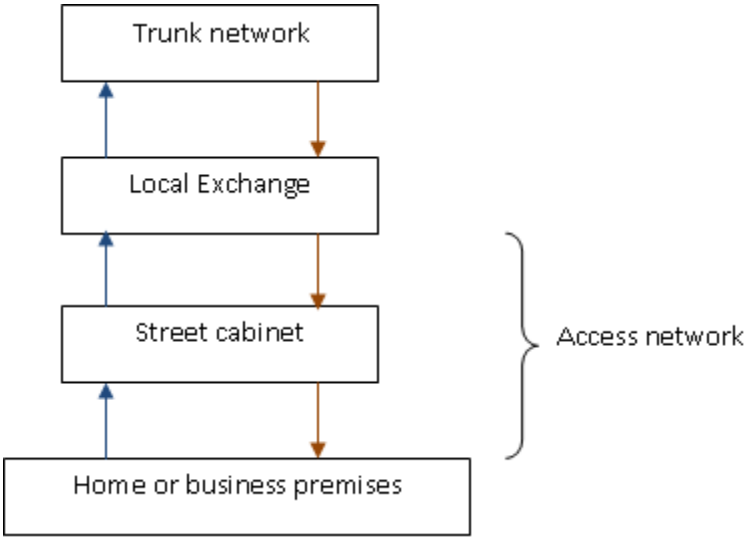
5.28 In addition to demand, the likely cost of supplying customers in a local area is likely to affect the ability of firms to supply a local area profitably. Services that are more costly to supply are less likely to be viable in smaller local markets. In addition, there may be features of particular local markets that make them more costly to supply.

5.29 Each of the different communications services considered in this report uses one or more different technologies, so the structure and level of costs differs between them. We discuss the technologies used, and the key drivers of the cost of supply, for each of the different services below.

Fixed telephony

5.30 The fixed telephone network in the UK is made up of two broad levels: the trunk network and the access network. Its basic structure is illustrated in figure 8.

Figure 8. Basic structure of the UK fixed telephone network



5.31 At its most disaggregated level, individual homes and businesses are connected to a nearby street cabinet. Street cabinets are in turn connected to a local exchange, and local exchanges are connected to the trunk network. There are more than 90,000 cabinets in the UK fixed telephone network, each connected to an average of 290 individual telephone lines. Local exchanges are fewer in number, with around 5,600 across the entire network. This means approximately 5,000 individual telephone lines on average connect to each local exchange. However, exchanges vary in size considerably, with the largest connecting 65,000 individual telephone lines and the smallest connecting fewer than 100.

5.32 There are large economies of scale and density in the provision of fixed telephony. The main cost drivers include the cost of laying and maintaining the telephone lines and the cost of infrastructure and equipment in exchanges. As a result, the costs per subscriber of supplying fixed telephone services are much lower in densely populated areas. The largest 1,000 exchanges in the UK cover approximately 65% of

the UK population, the largest 2,000 cover around 90% and the remaining 3,600 are required to reach the final 10% of subscribers.

5.33 Once the telephone lines and equipment are in place, the incremental cost of individual calls is relatively small.

5.34 Fixed telephone services are also provided by Virgin Media over its cable network. This uses a system of optical fibre to street cabinets and coaxial cable from the cabinets to individual subscribers' homes and business premises. Virgin Media is not subject to any coverage regulations, so network rollout has focused on more densely populated areas, where more customers can be served by the same investment.

Possible future developments

5.35 While traditional fixed telephony still constitutes a significant proportion of revenue for communications providers, there has been a noticeable decline over the years in the revenues generated by such services, mainly as a result of the decline in use. Declining fixed-telephony volumes may result in greater per-unit costs in the future, which has led providers to think about the cost savings available through integrating fixed-telephony and -broadband networks.

Fixed broadband

5.36 In large part, fixed broadband services are delivered over the same physical infrastructure as fixed telephony services, namely the telephone network operated primarily by BT and the cable network operated by Virgin Media. Many of the costs of broadband provision are therefore common to the provision of fixed telephony.

5.37 For the BT network, there are three types of technology over which broadband can be delivered, each of which has a different cost structure.

- ADSL technology provides broadband services over the standard copper wire of the fixed telephone network. The main cost involved, over and above providing the telephone network on which it is based, is the equipment in the exchange. These costs are relatively small, and the cost per subscriber is low. ADSL therefore represents a very cost-effective way of providing broadband services. The incremental cost of greater use by subscribers is generally very small until use becomes so high, capacity limits of the ADSL equipment in the local exchange are reached.

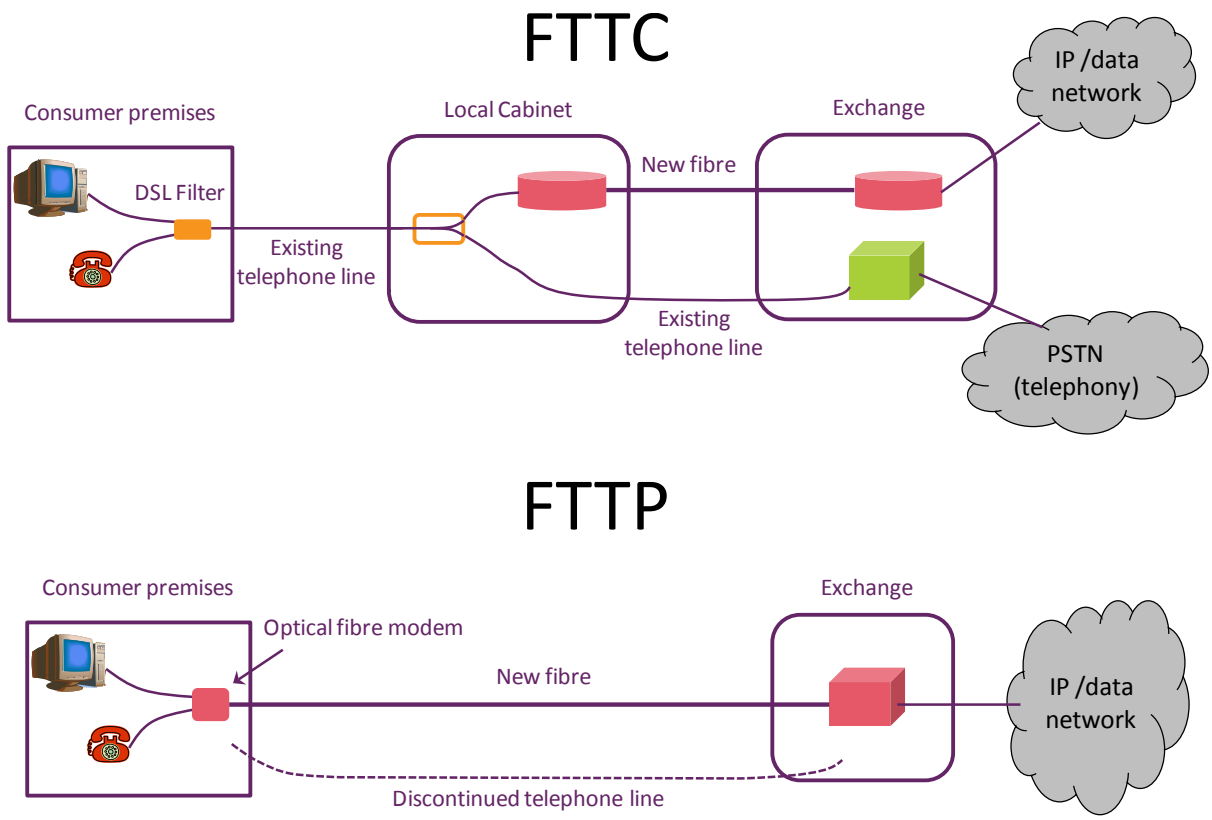
- FTTC technology provides broadband services using optical fibre to replace copper wire between the local exchange and the street cabinet. The main costs associated with FTTC are pulling through fibre, installing equipment at the cabinet (which usually requires the installation of a new separate cabinet) and providing power to the cabinet and the new equipment at the exchange. These costs will vary depending on the characteristics of the cabinet itself. In rural areas, the distance between the cabinet and the exchange is often greater, and there may be difficulties in establishing a power supply. Consequently, the cost of installing FTTC to cabinets in rural areas is higher. Once FTTC is installed in a cabinet, the incremental costs per subscriber and the incremental costs of increased use are very low.

- FTTP technology provides broadband services using an optical fibre to the home or business premises of the subscriber. This effectively replaces BT's existing copper network. The main costs to the provider are incurred when pulling through

fibre to the premises. However, unlike FTTC, there is no need for equipment or power in the street cabinet. The costs of FTTP are much higher than FTTC as fibre needs to be pulled through to each individual home or business premises rather than just to the street cabinet. The main cost drivers for FTTP are the distance of fibre that needs to be pulled through and the number of subscribers per line. In densely populated areas, distances are typically relatively short and there are many larger premises, so some subscribers may be able to use the same line. In less densely populated areas, premises are generally smaller and further apart. The cost of providing FTTP is therefore considerably higher in rural areas.

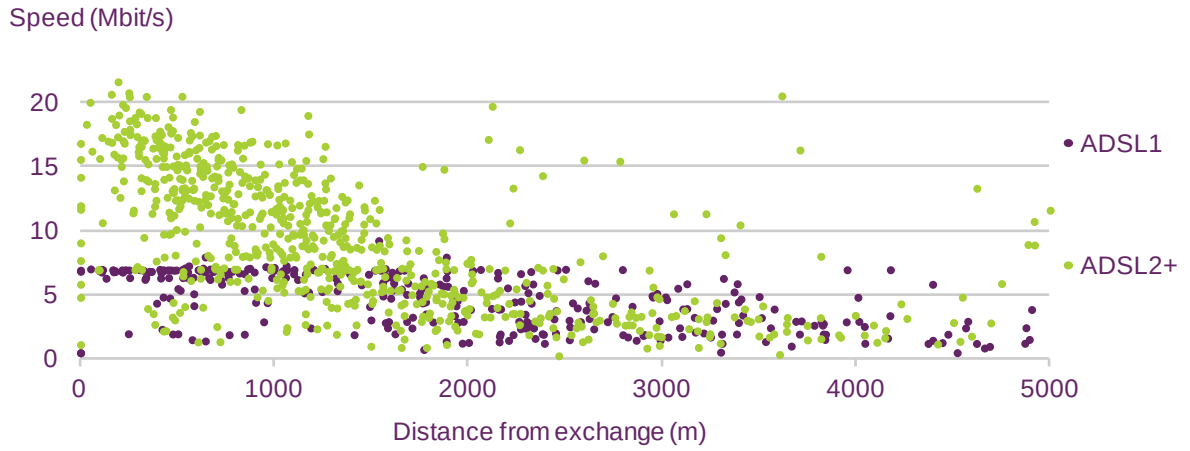
5.38 Figure 9 shows simplified schematics of FTTC and FTTP network architecture.

Figure 9. FTTC and FTTP network architecture



5.39 In addition to the costs of supplying broadband services, the distance between the premises and the exchange also has an impact on the quality of service received and in particular the speed of a user's connection. This is illustrated in figure 10. Consumers who live in more densely populated parts of the UK are more likely to live closer to the exchange and therefore achieve higher broadband speeds.

Figure 10. Distance from exchange and maximum download speeds



Source: SamKnows measurement data for all panellists with an ADSL connection in May 2012. Note: data are unadjusted and so are not directly comparable with data elsewhere in this report, which have been weighted for line length.

5.40 Nearly all exchanges in the UK are now enabled for ADSL, delivering speeds of up to 8 Mbit/s. ADSL2+ can deliver speeds up to 24 Mbit/s. The resistance of copper wire increases with the length of the wire, so ADSL broadband speeds decay as the distance between premises and the exchange increases. ADSL speeds start to decay between 1 and 2 km from the exchange, and ADSL speeds are reduced considerably at distances more than 3.5 km.

5.41 FTTC-based broadband uses optical fibre to the cabinet, and therefore the length of copper wire is reduced. FTTC broadband can currently be delivered at higher speeds up to 80Mbit/s. However, as some copper wire remains between the cabinet and the premises, there can be some decay in speeds for customers located a long way from a cabinet. Customers located more than 300 metres from a cabinet can expect speeds to be reduced to less than half the maximum possible, and customers located more than 900 metres from a cabinet can expect speeds reduced to less than a quarter of the maximum rate.[71] However, consumers who live too far from the cabinet to receive superfast broadband services may still benefit from the upgrade at the cabinet as it will still bring about improvements to their broadband speeds from the reduction in the length of the copper access line.

5.42 While FTTP offers many attractions in terms of broadband speeds and operational savings due to the intrinsic reliability of fibre coupled with the potential to remove legacy copper lines, it remains an extremely expensive deployment option. FTTP installations remain a small proportion of the total superfast-broadband deployments in the UK.[72]

5.43 Although Virgin Media's cable network only serves more densely populated areas, the incremental costs of providing broadband over it are relatively modest. Because of the already extensive use of fibre, the higher quality of coaxial cable when compared to copper wire and the greater geographic density of its network, Virgin

[71] www.thinkbroadband.com/guide/fibre-broadband.html.
[72] www.superfast-openreach.co.uk/where-and-when/.

Media can currently offer broadband speeds of up to 120 Mbit/s to nearly all its cable subscribers. It has indicated it intends to increase these when the time is right.[73]

Possible future developments

5.44 Beyond the current programme of investment in FTTC and FTTP, further improvements in line speeds can be achieved through developments in access technologies. For its current rollout of FTTC, BT is using VDSL technology capable of delivering broadband services up to 80 Mbit/s.

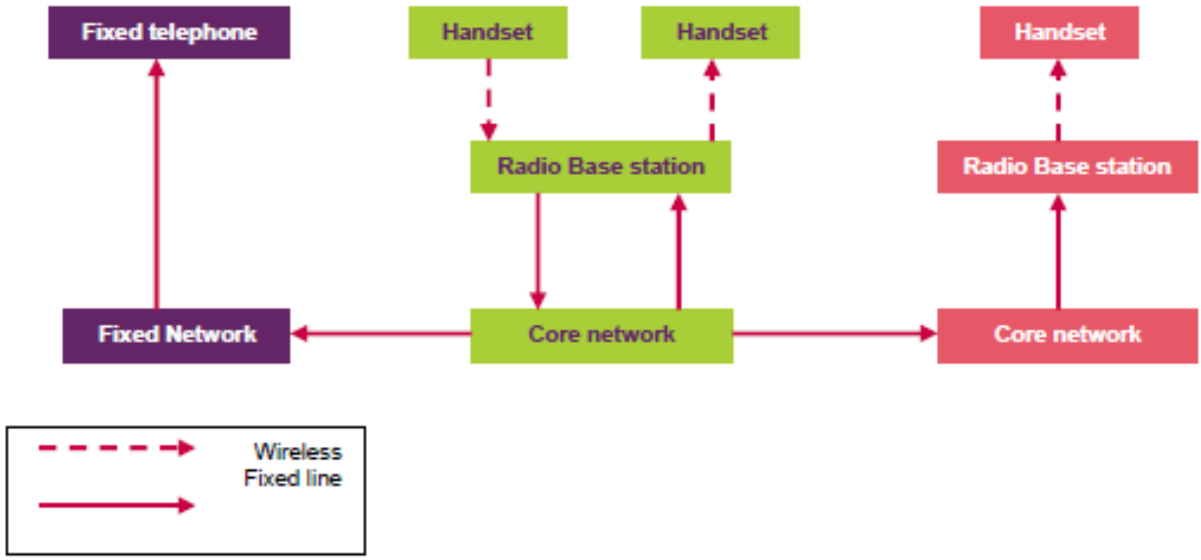
5.45 Other techniques can increase the access-line speed by reducing interference caused by other copper lines or by using multiple copper lines between the cabinet and the customer. These techniques could increase the access-line speed while reusing the copper access network without significant infrastructure deployment (except in the equipment in the street cabinet).

5.46 Alternatively, active electronics could be rolled out deeper into the network, beyond the cabinet and to the nearest distribution point, such as a telegraph pole or manhole. This equipment can be connected to the rest of the network via a fibre-optic link or wirelessly. Improvements in civil engineering could also reduce the cost of the work required to roll out new network infrastructure by around 10%.[74]

Mobile (voice and data)

5.47 A mobile network consists of a system of radio base stations linked to a core network by a backhaul network. Each base station provides mobile coverage to a particular geographic area, called a cell. Figure 11 illustrates the structure of a mobile network.

Figure 11. Structure of a mobile network



Source: Ofcom.

[73] www.ispreview.co.uk/index.php/2012/07/isp-virgin-media-uk-staying-stum-on-future-200mbps-broadband-service.html.
[74] "Review of civils technology and adoption," Analysys Mason, 10 August 2012, http://stakeholders.ofcom.org.uk/telecoms/policy/next-generation-access/civils-technology-adoption/.

5.48 When making a call or sending data, the mobile user's handset will transmit to a nearby base station. The signal is then passed to a concentrator node via a fixed backhaul circuit and into the operator's core network. The core network then connects to the networks of other mobile operators and to the fixed telephony network. Mobile networks are therefore something of a hybrid between wireless and fixed technologies, relying on wireless for communication between handsets and masts and on fixed for backhaul and core-network connections.

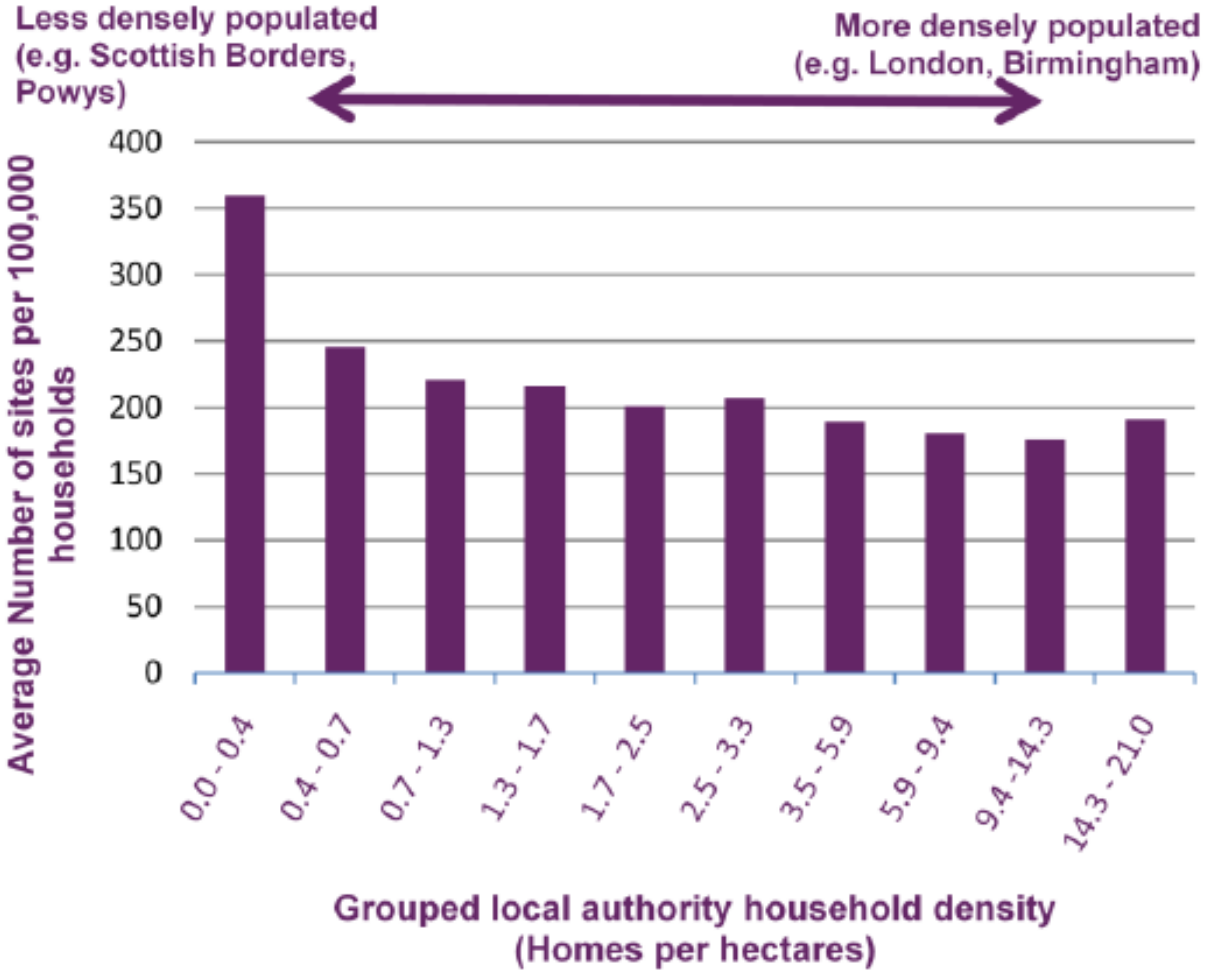
5.49 The main costs involved in the provision of mobile voice and data services that vary with geography are equipping, powering and maintaining the network of base stations and the cost of backhaul circuits to connect these base stations to the core network. In less densely populated areas, there are likely to be fewer users in range of a particular base station, which may result in higher costs per user. In addition, because of the relatively large distances involved, the costs of supplying power, maintenance and backhaul to more remote base stations is likely to be higher.

5.50 The range and quality of coverage provided by a particular base station will be affected by local topography. In hilly areas and in large cities where tall buildings can impede wireless signals, additional cells may be necessary to improve coverage. This will also vary with the type of spectrum the mobile operator is using. UK mobile networks currently use three spectrum bands: 900 MHz, 1800 MHz and 2100 MHz. (These will soon be supplemented by the 800 MHz and 2.6 GHz bands, as described in section 6.) Base stations using lower-frequency bands are able to achieve a greater range than those using higher frequencies.

5.51 Individual base stations are limited in the volume of traffic that can be transmitted through them. Consequently, in very densely populated areas, the level of traffic may exceed the capacity of the existing cells, and additional cells may need to be installed to cope with the demand for voice and data services.

5.52 Figure 12 shows our estimate of the average number of cell sites per 100,000 households by local authority in Great Britain. In less densely populated areas, more sites are needed to cover the same number of households because of the distances between them. As household density increases, the average number of sites per household decreases. However, in the most densely populated areas, the number of sites is slightly higher to cope with high volumes of voice and data traffic.

Figure 12. Average number of cell sites by local authority in Great Britain



Source: "Infrastructure Report." Household-density data was not available for Northern Ireland.

Possible future developments

5.53 There are currently two separate agreements in place between mobile operators to share transmission sites in the UK. EE (created following the merger of T-Mobile and Orange) and H3G currently share around 18,000 sites, which are now undergoing a modernisation programme. O_2 and Vodafone have also recently announced plans to consolidate their network infrastructure into a single infrastructure network, which should total around 18,500 sites. These developments could lead to a significant improvement in mobile coverage and quality over the next few years, particularly in less populated areas where there may currently be a more limited choice of provider.

5.54 More broadly, we observe three technology trends in mobile communications:

- the move to more efficient radio network technologies. For example, a study undertaken by Real Wireless on our behalf estimated early 4G (Long Term Evolution) networks with standard configurations will be over three times more spectrally efficient than today's standard 3G networks;[75]

[75] "4G capacity gains," 27 January 2011, http://stakeholders.ofcom.org.uk/market-data-research/other/technology-research/2011/4G-Capacity-Gains/.

- better integration of networks. An increasingly prevalent approach is to divert (or "offload") traffic from mobile networks and onto Wi-Fi networks. Many households are also using femtocells, small mobile base stations that provide a mobile signal in the home and to the mobile networks using an existing fixed broadband connection. Over 207,000 femtocells have been deployed;[76] and

- more intelligent use of spectrum. One new approach to spectrum management exploits "white space," frequencies not used by a network at specific times in specific locations and therefore reusable by lower-power devices. Attention has focused on the spectrum used by DTT, and we are currently putting in place the necessary regulatory framework to allow so-called white-space devices (WSDs)—already being trialled by industry—to access this spectrum.[77] Potential applications for WSDs include rural broadband, metro-area wireless networking and machine-to-machine communications (for example, to monitor traffic conditions, environmental monitor stations or utility meters).

Digital television

5.55 DTT is delivered via a network of land-based transmitter masts that formerly carried analogue television. The majority of costs incurred in transmitting DTT are driven by the number of transmitters that need to be built. Once a transmitter is up and running, costs vary less with the number of viewers, although there are some significant differences depending on the type of transmitter and its location.

5.56 Each transmitter is able to deliver DTT to households in a given geographic coverage area. As a result, the cost per household of delivering DTT services will vary with the population density within the transmitter's broadcast range. In densely populated areas, the same transmitter can deliver DTT to many households, and consequently the costs of delivery per household will be relatively low. In more sparsely populated areas, fewer households will be served, and consequently the cost of delivery per household will be higher for a given size of transmitter.

5.57 The range of each transmitter is affected by the topography of the local area. The radio signals that carry DTT can be blocked by hills or other obstacles such as large buildings. As a result, in areas with many obstacles, more transmitters may be necessary to deliver DTT coverage to all households than in "flatter" areas. The cost per household of delivering DTT is therefore much higher in areas with challenging topography.

5.58 Transmitters serving larger geographic areas necessarily operate at higher power levels than transmitters covering smaller areas. Therefore, while a larger transmitter's absolute operating costs (including, for example, electricity use) are relatively high, the operating cost per viewer will tend to be much less than for smaller transmitters.

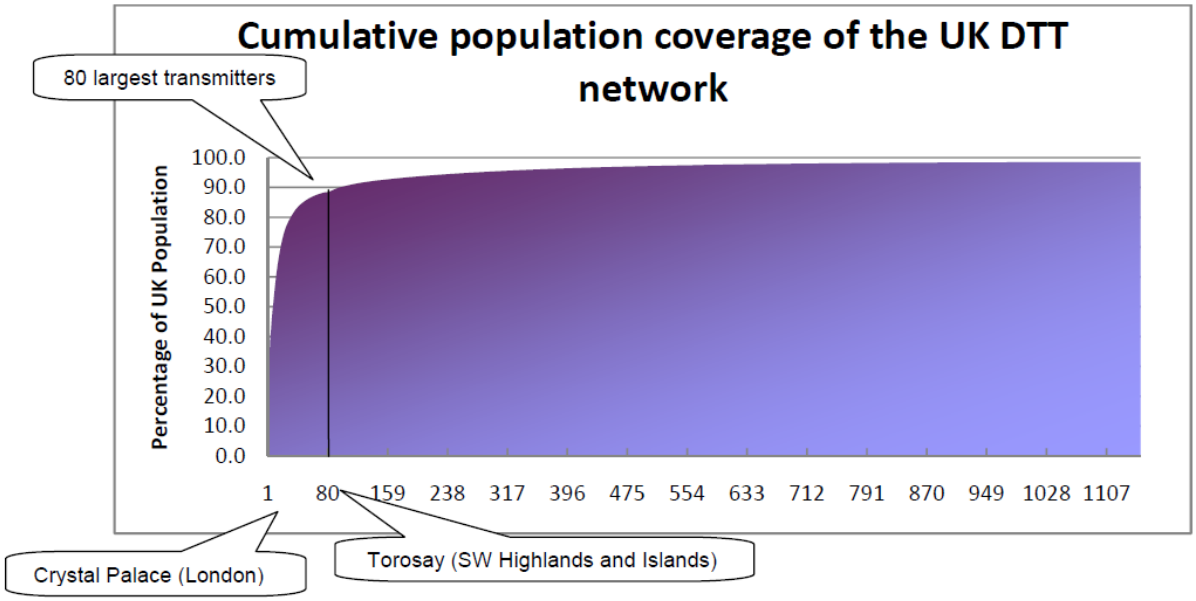
5.59 As a result of these factors, the cost of delivering DTT to households varies significantly across the UK. Just eight transmitters cover more than 50% of the population, while 80 principal transmitters deliver DTT to approximately 90% of the population. The final 10% of the population lives in areas that are considerably more difficult to serve. 8.5% is served by 1,156 smaller "relay" transmitters. While it is possible to extend coverage beyond this combined 98.5%, universal coverage is impractical due to technical constraints (for example, the self-interference between

[76] "Infrastructure Report, 2012 update."
[77] http://stakeholders.ofcom.org.uk/spectrum/tv-white-spaces/.

transmitters that would occur if a significant number of new transmitters were added to the network).

5.60 Figure 13 illustrates the coverage of the UK's DTT transmitter network.

Figure 13. Cumulative population coverage of the UK DTT network



Source: "Infrastructure Report."

5.61 DTT is, of course, not the only way to receive broadcast television in the UK:

- digital satellite television services are available anywhere in the UK within line of site of the satellite transponder. The satellites providing television services to the UK have been positioned to give coverage to the whole country. Only those premises with line-of-sight issues (for example, where it is blocked by a hill) or where satellite receiving equipment cannot be installed will be unable to receive these services;

- cable television services are available where there is coverage from a cable network; and

- IPTV is available where there is a broadband connection. Some online video services require a minimum connection speed of 1 or 2 Mbit/s,[78] while others might operate with a slower connection.[79] Managed IPTV services may require higher broadband-connection speeds.[80]

Possible future developments

5.62 Some of the low frequencies DTT uses are likely to meet the requirement for more spectrum to satisfy the huge growth in demand for mobile data. By 2030, this

[78] The iPlayer requires a connection speed of at least 1 Mbit/s. See http://iplayerhelp.external.bbc.co.uk/help/using_bbc_iplayer/.
[79] YouTube requires a broadband connection of at least 500 kbit/s. See http://support.google.com/youtube/bin/answer.py?hl=en-GB&answer=78358&topic=17174&ctx=topic.
[80] TalkTalk requires a minimum connection speed of 3 Mbit/s for its Youview service. See https://sales.talktalk.co.uk/product/tv.

demand could be 80 times higher than today. Meeting this increase could deliver significant benefits to consumers, through new and improved mobile data services. It could also sustain wider growth in the economy by improving the capability of the UK's mobile infrastructure. The spectrum in question (known as the 700 MHz band) is already used in the US and Asia to provide mobile broadband services and is set to become globally allocated for mobile use as well as broadcasting after the next World Radio Conference in 2015.

5.63 While using the 700 MHz band will bring more low frequency spectrum for mobile broadband, we will seek to ensure the DTT platform can access alternative frequencies.[81] This could be facilitated if there is sufficient platform transition to the more efficient DVB-T2 transmission standard and MPEG-4 video compression. In the longer term, future improvements in efficiency could be achieved through use of a technique called Multiple Input Multiple Output (MIMO) and high-efficiency video coding (HEVC).

5.64 Many, if not most, new television sets now include IPTV features as standard. Using MPEG-4, it is possible to deliver SD television with as little as 600 kbit/s of bandwidth, albeit at modest quality. In future, improvements such as HEVC could enable higher-quality video to be delivered over lower-quality connections to customers with compatible equipment. With replay television and other video-on-demand services becoming more popular and higher-speed domestic connections becoming widely available, use of IPTV is likely to become widespread. Indeed, IPTV delivery could replace DTT in the very long term should high-speed access become ubiquitous.

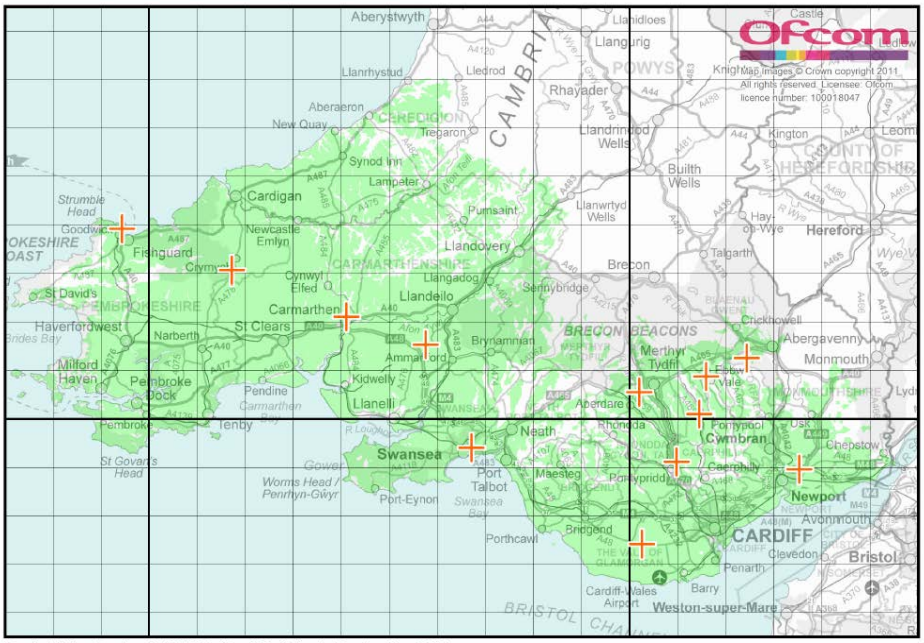
Radio

5.65 AM, FM and DAB radio is similar to DTT. The main costs involve transmitters and so are relatively fixed, and the cost per household of delivering radio services, all else being equal, is much higher in areas that are sparsely populated and exhibit challenging topography.

5.66 Figures 14 and 15 illustrate the difference between a challenging locality and one in which radio services can be delivered easily. The red crosses show the location of the transmitters.

[81] Ofcom, "Securing long term benefits from scarce low frequency spectrum: UHF strategy statement," 16 November 2012, http://stakeholders.ofcom.org.uk/binaries/consultations/uhf-strategy/statement/UHF_statement.pdf.

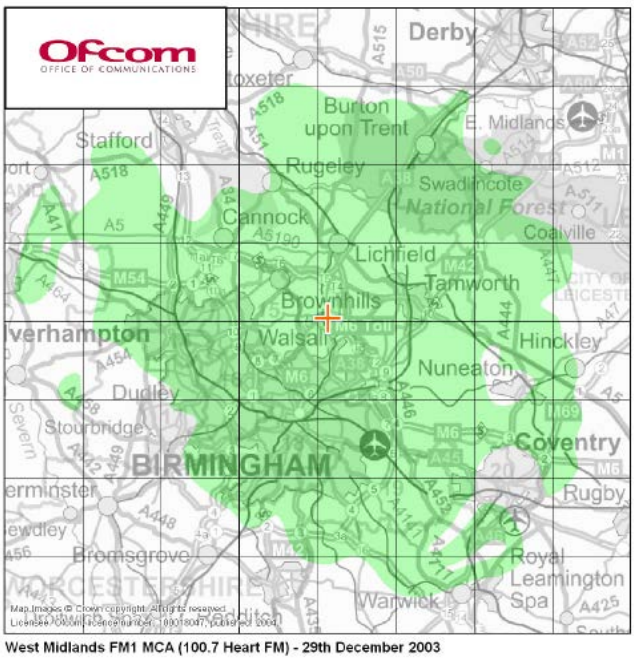
Figure 14. Transmitter sites and radio availability in South Wales



Source: Ofcom.

5.67 Figure 14 shows the location of the transmitters used to provide the Real Radio FM service in south Wales and the coverage they currently achieve. South Wales is relatively sparsely populated and hilly, with many settlements located in valleys. This makes south Wales a relatively expensive area to serve. The area covered by the 12 transmitters in figure 14 covers 1.33 million adults.

Figure 15. Transmitter sites and radio availability in Birmingham



Source: Ofcom.

5.68 Figure 15 shows the coverage currently achieved by Heart on FM in the West Midlands. The West Midlands is relatively flat and densely populated. The cost per household of delivering radio in the West Midlands is relatively low as a consequence. Currently, only one transmitter is used to provide radio services to a population of 2.29 million adults.

Possible future developments

5.69 The UK Government has concluded major FM radio stations could only be switched over to DAB when two criteria have been fulfilled:

- 50% of all radio listening is via digital platforms; and
- national DAB coverage is comparable to FM and local DAB reaches 90% of the population and all major roads.[82]

5.70 The spectrum released by switchover may be used for more localised FM community radio.

5.71 To monitor progress against these criteria, we publish annual reports on the availability and take-up of digital radio. Almost three in 10 (29.5%) radio-listening hours were delivered over a digital platform in the 12 months to end of June 2012.[83]

5.72 DAB+ is an enhanced, more efficient version of DAB. It would enable compatible radios to receive even more stations and/or selected stations to transmit even higher audio quality.

Post

5.73 The significant majority of Royal Mail's costs are people costs.[84] In addition, more than half of all costs are incurred during delivery. Costs of processing and sorting mail are largely driven by its volume and mix.[85] The physical (outdoor) delivery costs are heavily influenced by factors such as the number of items for each delivery point, the number of deliveries per week, the number and distance between delivery points and the terrain.

5.74 Outdoor delivery costs therefore do not vary significantly due to the number of items delivered to each household or business address. For example, the cost of physically delivering the mail will not be significantly lower if the postman delivers five or only one or two letters to the same address on the same day. The cost of delivery is also generally higher in rural areas as there are greater distances between addresses so that fewer deliveries can be achieved in one delivery round.

5.75 This cost differential for different types of geographical areas (and London) can be seen in Royal Mail's zonal access prices. If access operators posting profiles do not meet a typical national geographic posting profile, they are charged prices that reflect the cost of delivery for the mail they hand over to Royal Mail. For example, for access Letter mail, urban areas (outside of London) have a discount of 12.9% but rural areas

[82] "Digital Radio Action Plan," 8 July 2010, www.culture.gov.uk/publications/7227.aspx.
[83] "The Communications Market: digital radio report—Ofcom's third annual digital progress report."
[84] 64% of total mails costs in 2011-12 were people costs see www.royalmailgroup.com/sites/default/files/Regulatory%20Financial%20Statements%202011-12_audited.pdf, page 10.
[85] Certain items, such as hand-addressed Letters mail and packets and parcels, are more expensive to process.

have a surcharge of 13.9% applied. Zonal access prices for London also attract a surcharge of 9.9% due in part to higher labour and transport costs.

Possible future developments

5.76 **End-to-end competition.** In April 2012, TNT Post UK began trialling end-to-end delivery operations in west London and has since expanded this pilot to cover most of central London. At the end of December 2012, TNT Post was delivering 345,000 letters per week in London which equates to about 0.13% of the market.[86] PostNL (TNT Post's owner) is looking for £50 - £80 million of external investment to complete a full rollout of end-to-end services in the UK.[87]

5.77 End-to-end entrants are more likely to offer delivery services in more densely populated areas, where the costs of delivery are much lower than in more remote areas. In the UK some end-to-end competitors may also access Royal Mail's downstream delivery operations to deliver items where they do not offer delivery services themselves. As a result, Royal Mail's access prices for items to less densely populated zones are higher (as noted above). It is also likely the focus of end-to-end competition will remain on bulk mail, where an operator can collect large volumes from a small number of customers (for example, banks and utility companies) for delivery across the UK. There is little suggestion at present end-to-end competition might emerge for residential customers.

5.78 End-to-end competition has the potential to have both positive and negative effects on the universal service.. We considered TNT Post's plans and their potential impact on the universal service and published an update in July 2012 that set out our view that it was not necessary to intervene in relation to end-to-end competition at that point in time, but that we would continue to monitor the situation.[88] Following consultation we also recently published guidance on our future approach to assessing the impact of end-to-end competition on the universal service to give greater clarity and regulatory certainty.[89]

5.79 **Parcels are growing as letters decline.** The take-up of standard and superfast broadband has had both negative and positive benefits on mail volumes in the UK. Electronic substitution has been one of the main contributors to a decline of more than 25% in overall mail volumes since 2006.[90] However, the growth in e-commerce has resulted in higher parcel volumes (particularly in recent years). For example, Royal Mail's parcel volumes increased by 6% between 2010/11 and 2011/12.[91]

5.80 E-commerce in the UK comprises over 30% of the total across Europe and was valued at £1,083 per capita in 2011.[92] In May 2012, the British Phonographic Industry reported digital downloads of music in the UK overtook physical sales in revenue terms for the first time.[93] In August 2012, Amazon announced sales of e-books for the Kindle had overtaken sales of physical books for the first time. For each 100

[86] http://www.postnl.com/Images/20130225-postnl-2012-q4-press-release_tcm216-666131.pdf.
[87] http://www.postnl.com/Images/20130225-postnl-2012-q4-press-release_tcm216-666131.pdf.
[88] http://stakeholders.ofcom.org.uk/binaries/post/update.pdf.
[89] http://stakeholders.ofcom.org.uk/consultations/e2e-guidance/statement/
[90] Ofcom, Communications Market Review 2012, July 2012.
[91] Royal Mail, Annual Report and Financial Statements 2011-12.
[92] "International Communications Market Report 2012," 13 December 2012, http://stakeholders.ofcom.org.uk/binaries/research/cmr/cmr12/icmr/ICMR-2012.pdf.
[93] www.bpi.co.uk/media-centre/digital-revenues-overtake-physical-in-uk-recorded-music-market.aspx.

physical books, consumers had purchased 114 e-books.[94] The amount UK consumers spend online is expected to increase by around 10% in 2013 to £87 billion and this will result in increased packet and parcel volumes in the UK.[95].

5.81 There is significantly more competition in the packet and parcel delivery market than the Letters market. Royal Mail's universal service products (such as First Class and Second Class single piece products), bulk mail products and Parcelforce[96] compete against parcel operators such as Hermes and Yodel, courier companies such as UPS and DHL and local courier companies.

5.82 Many of these operators charge more for delivery to more remote areas than to the rest of the UK such as the Highlands and Islands. While Royal Mail is required to charge uniform prices for its universal service products (such as First and Second Class single piece items) that are used by residential and small business customers, it also has the commercial freedom to charge more cost reflective prices for delivery using any of its non-universal service products that are mainly used by larger businesses.

5.83 The higher cost of delivery charged by many packet and parcel operators (potentially including Royal Mail for non-universal service customers) was identified by Citizens Advice Scotland (CAS) in a 2011 report.[97] This report highlighted that when ordering goods online consumers in the remote areas of Scotland were often refused delivery or charged significantly more than consumers living in urban areas. This has resulted in particular retailers being avoided and a great deal of frustration amongst rural consumers. The CAS recommended that Royal Mail's USO is maintained to protect rural and remote consumers from high costs of delivery. It also urged retailers to clearly display delivery costs on their website prior to the point of sale, reform their delivery policies to ensure any charges were kept to a minimum and based on actual costs incurred and also offer delivery via Royal Mail wherever possible.

5.84 Additionally, the change in the proportion of mail (due to the decline in Letters and increase in parcels) brings its own challenges. Parcels are larger and bulkier to transport and generally heavier than Letters. Small parcels are mainly delivered alongside Letters, although they take up more space in the mailbag or trolley. Medium parcels (as defined by Royal Mail) are in general separately delivered by van. The sorting process for parcels is more costly as Royal Mail has not installed any parcel sorting machines to date and the manual sorting rate for parcels is significantly lower than the Letter manual sorting rate.

5.85 **Users' needs.** We published the assessment from our review on the reasonable needs of postal users, carried out to fulfil our obligations under the Postal Services Act 2011, on 27 March 2012. Our review included, in particular, a comprehensive study into the needs of both businesses and residential users of postal services.

5.86 We have concluded that the postal market is currently meeting the reasonable needs of users and is highly valued by residential users and businesses across the UK. Therefore, we have decided not to change the scope of the universal service. However, our research also indicates that while users generally are satisfied with the

[94] http://phx.corporate-ir.net/phoenix.zhtml?c=251199&p=irol-newsArticle_Print&ID=1722449&highlight=.
[95] Source: Interactive Media in Retail Group figures and estimates, January 2013
[96] Parcelforce is a wholly owned subsidiary of Royal Mail within the UK Parcels, International and Letters group (UKPIL).
[97] "Free Delivery*: problems with delivery of online purchases to consumers in remote and rural Scotland," 19 December 2011, www.cas.org.uk/system/files/publications/free-delivery.pdf.

current services available, different users rely on post to varying degrees, and users' needs and preferences are evolving. For example:

- Users would like more convenient options for the delivery of parcels. Given the steps Royal Mail is taking in this area and the competitive nature of this part of the market, we think that these consumer benefits are more likely to be delivered through innovation by Royal Mail and other postal operators than through additional regulation; and

- Some users indicated that there may be less need for next-day delivery (First Class), and others are less reliant on collections and deliveries six days a week, including Saturdays. At the same time however, over half of our research participants indicated that they would continue to use First Class, and nearly half of businesses believe their First Class mail should arrive next day.[98] Contrary to businesses, residential users attributed a high value to deliveries and collections six days a week.[99]

5.87 It is important for Ofcom to continue to understand the needs of users of postal services and how these needs may change in the future. This is an issue which we will keep under review as the postal market develops to meet users' evolving needs.[100]

[98] Over 80% of residential users agree they will always need to send things by post. Of those, 57% say they would use First Class. In addition, 46% of businesses say all/most of the post they send First Class has to arrive next day.
[99] Some businesses valued Saturday collections and deliveries, but this is offset by other businesses which do not value this aspect of the universal service.
[100] *Review of postal users' needs - An assessment of the reasonable needs of users in relation to the market for the provision of postal services in the United Kingdom,* 27 March 2013. http://stakeholders.ofcom.org.uk/consultations/review-of-user-needs/statement/

Section 6

The role of interventions

Introduction

6.1 This section considers the role of interventions to extend the availability of communications services beyond what is commercially viable, the forms such interventions can take and how they manifest in the communications sector.

6.2 Where markets do not deliver optimal outcomes for society as a whole, the state can and does intervene. This includes securing greater levels of availability of communications services than would otherwise be the case. Intervention can take many forms and come from a variety of sources, and this section considers the most commonplace, from public subsidies to community-based solutions. It goes on to consider real-life case studies in the communications sector, drawing in particular on work we commissioned from Analysys Mason that looked at a variety of interventions in different geographies—mostly in the UK but also elsewhere in Europe—to highlight the challenge of delivering services that would not otherwise be commercially viable.

Why intervene?

6.3 Section 5 discussed how, under certain conditions, markets can fail, leading to outcomes that are bad for consumers and for society as a whole. Where this is the case, there may be an opportunity for public bodies to step in, correct that market failure and improve outcomes.

6.4 Where imperfections lead to under-provision of services (for example, because there are positive externalities or firms have market power), some consumers are excluded from the market. If the wider social benefit of supplying these customers exceeds the costs of intervention, welfare can be increased by supplying them.

6.5 In some cases, the state can move markets toward delivering services to excluded consumers without any cost to taxpayers (for example, by reforming or removing unnecessary regulation). Effective interventions of this type can result in the largest welfare payoffs. However, in many cases, intervention involves costs (for example, a subsidy) that must be funded. Where market interventions require funding, the state must weigh up the costs and benefits. Intervening in this way could mean either reducing public spending elsewhere or increasing taxation, which can increase distortions and inefficiency in other parts of the economy. At the same time, interventions in one sector can underpin the ongoing delivery of economic and/or social benefits such as ensuring a well-functioning democracy, promoting social cohesion or protecting disadvantaged groups

6.6 Not every market imperfection justifies public intervention. In many cases, intervening will create distortions or costs. The measure may also have unintended consequences, resulting in regulatory failure. Consequently, only in cases where the market imperfections are serious enough to result in market failure will the state have the opportunity to improve outcomes through intervention.

Forms of intervention

6.7 Intervention can take many forms, may come at different levels (EU, UK, national, regional, county, local or community) and will depend on the specific imperfections that affect the market in question. Broadly, intervention to increase the availability of communications services takes the form of:

- subsidy or public procurement;
- service obligations on providers;
- facilitation of market-based solutions; or
- community-based solutions

6.8 We discuss each of these in turn below.

Subsidy or public procurement

6.9 One of the primary causes of reduced availability in sparsely populated, rural and remote areas is the high cost of supplying services.

6.10 As discussed in section 5, where the fixed costs of operation (for example, transmitters, cabling or other basic infrastructure) are large relative to the size of the local market, firms may be unable to supply the service profitably or only able to do so at very high prices. If this is the case, there may be many consumers who don't get the service as a result of the high fixed costs of providing the service in that area.

6.11 Where this is the case, it may be possible for the state to correct that market failure, leading to a more efficient outcome. In particular, it may be possible for public bodies to meet the costs of fixed assets in part or in full. However, where high incremental costs exceed the value consumers place on the service, such a subsidy will be less successful.

6.12 Public subsidy may also prove useful in markets affected by positive externalities (that is, where they will tend to under-provide services). Consumers' private valuations of the service do not capture the value of that service to wider society and, as a result, they purchase too little. One way in which public bodies can intervene to correct this type of market failure is through a direct subsidy. For example, to promote healthier journeys to work and reduce environmental pollution, the Finance Act 1999 introduced an annual tax exemption that allows employers to loan bicycles and safety equipment to employees as a tax-free benefit.[101]

6.13 Subsidies can take many forms. For example, public bodies could provide a subsidy direct to consumers through voucher schemes that increase consumers' willingness and ability to pay, pushing their valuations of the service toward the socially efficient level. Alternatively, public bodies can offer subsidies to firms in exchange for a reduction in prices, which in turn will encourage consumers to increase their purchases toward the socially efficient level.

6.14 Some communications services are subject to network externalities (that is, the value a consumer places on a service is dependent on the number of other users). The

[101] www.gov.uk/government/uploads/system/uploads/attachment_data/file/11305/cycle-to-work-guidance.pdf.

larger the number of users, the greater the attraction of the service. Where there are strong network externalities, it can be efficient to subsidise the service in its initial stages to enable it to grow and achieve a sufficient size for the network externalities to be realised. However, this does not necessarily mean a public body should provide this subsidy. Once the service has reached a sufficient size, the operating firms should be able to recover the costs of any initial subsidy, so there should be a positive commercial case for the producing firms to fund the subsidy themselves.

Obligations on providers

6.15 Another way in which the state can intervene to correct market failures is by imposing obligations on providers. Types of obligation include the provision of minimum service levels that fall short of universal coverage such as the coverage obligations set out in the 4G auction or specific behaviours (e.g. in relation to pricing) when providing those services. Another common form of obligation is a USO.

6.16 A USO usually takes the form of a series of interrelated obligations on a firm. The precise obligations that make up a USO vary from sector to sector and from country to country. However, some elements are common to all schemes. The most common element of a USO is the requirement for the firm to supply all users, although there may be some exceptions. Second, there is usually a minimum level of service requirement. Finally, there is usually a requirement to offer services at an "affordable" rate. The affordability criterion may include direct price controls as well as uniform pricing to all users. Without price and quality-of-service obligations, the firm subject to the USO may be able to circumvent it (for example, by failing to adequately maintain links to unprofitable consumers or setting prices so high, consumer groups are priced out of the service).

6.17 Policymakers may hope to achieve a number of aims with a USO:

- a USO is one way in which public bodies can correct for positive externalities. It ensures the network reaches its maximum size and therefore network externalities are realised;

- a USO can be used to achieve redistribution between different groups. The effects of a USO as a redistributive tool depend on how the USO is funded. A USO combined with national pricing means the firms subject to the USO must recover the costs of supplying uneconomic areas by raising prices to all consumers. The USO therefore redistributes income from low-cost areas to higher-cost areas. In addition, there may be obligations within the USO to offer lower prices to vulnerable consumer groups (for example, those on low incomes) to achieve redistribution between high- and lower-income consumers; and

- there may be particular social or political goals (for example, democratic engagement, public safety, crime reduction and social inclusion) public bodies can achieve through a USO.

Facilitation of market-based solutions

6.18 In some cases, there is a role for the state in facilitating market-based solutions. For example, in small markets where the fixed costs of providing a service are prohibitive for individual firms but there is significant local demand for a service, there may be a role for the state in encouraging or requiring infrastructure sharing by firms. Where this can be achieved without diminishing competition, it may be possible for several

firms to use the same infrastructure to supply the market and share the fixed costs, allowing greater coverage and/or lower prices.

6.19 Aggregating the demand for communications services in an area is another strategy for improving availability,[102] as is boosting adoption.

Community-based solutions

6.20 It may be possible for local residents who would benefit from coverage to organise to build some of the basic infrastructure or provide a community-funded subsidy that would allow firms to supply services profitably. There may be a role for public bodies in facilitating such solutions, but this is not always necessary or desirable.

Intervention in practice

6.21 Public bodies around the world have long put theory into practice by intervening to improve the availability of communications services. The circumstances, objectives and outcomes have been specific, if not unique, to each instance where this has happened. It is not enough simply to take one approach in one time and place and attempt to recreate it elsewhere.

6.22 At the same time, similar interventions in similar circumstances do afford opportunities for public bodies to learn from what has gone before and adapt approaches to their own needs. We therefore commissioned Analysys Mason to identify and prepare 12 case studies representing a variety of public-policy and other non-market interventions in different geographies—mostly in the UK but also elsewhere in Europe—to highlight the challenge of delivering communications services that would not otherwise be commercially viable.[103] Those and a number of other interventions are brigaded below according to their general purpose:

- to increase the pace of rollout to commercial levels;
- to increase coverage beyond commercial levels;
- to mimic the effects of competition; and
- for other purposes.

6.23 The interventions can be summarised as shown in table 13.

[102] www.broadbandmap.govt.nz/what-is-demand-aggregation.
[103] http://stakeholders.ofcom.org.uk/binaries/research/markets-infrastructure/annex.pdf

Table 13. Summary of interventions

	Form				Purpose				Geographic extent
	Subsidy/public procurement	Provider obligation	Community solution	Other	Increase pace	Increase coverage	Mimic competition	Other	
2G mobile expansion	●					●			Highlands and Islands
3G licence award		●				●			Sweden
4G spectrum auction		●			●				UK and nations
Alston Cybermoor project	●					●			Alston Moor
Analogue community radio	●			●		●			Pontypridd
Analogue-television self-help relays				●				●	Elliot's Hill
Broadband for the Rural North			●	●		●			Bowland and Lune Valley
Broadband Support Scheme	●					●			Wales
Community Broadband Scotland	●					●			Scotland
Fixed telephony		●				●			UK
Mobile Infrastructure Project	●					●			UK
Mobile termination rates		●					●		UK
National Broadband Scheme	●					●			Ireland

	Form				Purpose				Geographic extent
	Subsidy/public procurement	**Provider obligation**	**Community solution**	**Other**	**Increase pace**	**Increase coverage**	**Mimic competition**	**Other**	
Next Generation Broadband project	●					●			Highlands and Islands
Next Generation Broadband project	●					●			Northern Ireland
Norfolk Open Link wireless project	●					●			Norfolk
Post		●				●			UK
Postbus-services initiative				●				●	Scotland
PSB on DTT		●				●			UK
Rural Broadband Programme	●					●			UK
Rural Community Broadband Fund	●					●			England
Second Class stamps		●					●		UK
Super Connected Cities	●					●			UK
Superfast Cornwall	●					●			Cornwall
Urban Broadband Programme	●					●			UK
Wholesale broadband access		●					●		UK

Interventions to increase the pace of rollout to commercial levels

Service obligations

6.24 A current example of an intervention to increase the pace of rollout to commercial levels is our approach to releasing the 800 MHz and 2.6 GHz spectrum bands, which will be used for 4G mobile broadband services. We recognised this spectrum had an important role to play in promoting the wide availability of future mobile services in the UK and believed our proposals to promote competition through its release were likely to drive this. However, we felt these should be underpinned by coverage obligations to ensure a future mobile broadband service would be provided to a significant proportion of citizens and consumers on a reasonable timescale.

6.25 Following two consultations, we announced one lot of 800 MHz spectrum, which is particularly well suited to providing high levels of coverage, would carry an obligation to provide a mobile broadband service for indoor reception to users in an area within which at least 98% of the UK population lives by the end of 2017. Given it is easier to provide coverage outdoors than indoors, a network meeting this obligation is likely to cover an outdoors area within which over 99.5% of the UK population lives.

6.26 In addition to this UK-wide coverage obligation, we decided to require the same operator to provide the same indoor service to an area within which at least 95% of the population of each of the UK nations lives. A network meeting this obligation is likely to provide outdoor coverage to an area within which 98-99% of the population of each nation lives. We concluded it would not be proportionate to go further with these nations-level obligations because of the considerable cost of the significant number of new sites that would be required. For Scotland and Wales, 95% coverage would be delivered at an estimated incremental cost broadly within the range of £1,500-3,000 per additional premises, but costs rise very quickly beyond that level, to in excess of £10,000 per additional premises to achieve 96% coverage.[104]

Community-based solutions

6.27 Some interventions are not made by or at the behest of the state. Broadband for the Rural North is a not-for-profit community-benefit society.[105] It has been established by people living in Bowland and the Lune Valley with the aim of installing a fibre-optic superfast-broadband network that will be owned, managed and supported by members of the community. The initial aim is to connect properties across eight parishes in 2012, with further parishes being added in subsequent years. The network will be available to every property in its catchment area. There will be no exclusions because an individual property is too far away or too difficult to reach.

Interventions to increase coverage beyond commercial levels

USOs

6.28 Three of the services considered in this report— - fixed telephony, PSB delivered by DTT and post— - operate in the UK in the context of USOs. Sweden also

[104] "Assessment of future mobile competition and award of 800 MHz and 2.6 GHz: statement," 24 July 2012, http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/statement.pdf. Annexes 7-12 at http://stakeholders.ofcom.org.uk/binaries/consultations/award-800mhz/statement/Annexes7-12.pdf.
[105] See http://b4rn.org.uk/.

approached its award of 3G mobile licences with the intention of increasing coverage.

Fixed telephony

6.29 As described in section 4, the USO in fixed telephony ensures basic telephone services are available to everyone on reasonable request and at an affordable price. A case study on this is included in Analysys Mason's report. It notes:

> Basic telephone services are considered essential for everyone in current social and economic conditions, and risk not being provided under competition alone. The Universal Service Obligation (USO) is a regulatory mechanism that ensures (amongst other things) the accessibility and availability of affordable basic fixed-line telecommunications services to all citizens and consumers across the UK. The costs of this are currently borne by the designated universal service providers (USPs) BT and Kingston Communications (in the Hull area).
>
> The definition of the USO can change over time in response to changes in society, technological developments, and changes in the use of electronic communications services.
>
> Should there be an unfair burden placed upon the USP, there remains the option for the USO to be funded, either through a levy on the industry or through general taxation.

6.30 The UK USO for fixed telephony matches the minimum requirements of the EU Universal Service Directive.[106] The European Commission concluded in November 2011 there was no need to include mobile or broadband connections in the scope of the EU USO and it would not be appropriate at that stage to set at EU level a minimum broadband-connection speed.[107]

PSB delivered by DTT

6.31 Following the introduction of the BBC's first television service in 1936, the availability of analogue terrestrial television expanded throughout the 20th century. By the time the UK Government announced its decision to replace analogue transmissions with DTT in 2005, analogue coverage had reached 98.5% of the UK population, and all the public-service broadcasters were required to replicate that level of coverage when switching over to digital. Other broadcasters were not subject to the same coverage obligation, instead committing to continue to provide services from the UK's 80 main television transmitters and so achieving 90% population coverage.

Post

6.32 As described in section 4, Royal Mail is required by its USO to collect and deliver letters six days a week (and other postal packets five days a week) at prices that are affordable and uniform throughout the UK. It is also required to ensure 93% of First

[106] Directive 2002/22/EC (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:108:0051:0077:EN:PDF).
[107] "Universal service in e-communications: report on the outcome of the public consultation and the third periodic review of the scope in accordance with Article 15 of Directive 2002/22/EC," 23 November 2011, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0795:FIN:EN:PDF.

Class mail arrives the next day and 98.5% of Second Class mail within three days of posting.

6.33 The USO that applies to Royal Mail exceeds the minimum requirements of the EU Postal Services Directives in certain respects.[108] For example, the latter requires post to be delivered only five days a week, whereas the Postal Services Act requires delivery and collection of letters six days a week in the UK. This inevitably affects the costs of providing the universal service. Despite this, prices for UK postal services—in particular for First Class and Second Class mail delivery—have until recently been among the lowest in the EU.

Mobile

6.34 A case study on the 3G licence award in Sweden is included in Analysys Mason's report. It notes:

> The Swedish government 3G licensing process was a 'beauty contest', designed to ensure that almost 100% of Sweden would have access to affordable 3G services by 2003. By allowing for network sharing, and taking advantage of positive market sentiment, this succeeded in providing very high coverage levels (albeit several years later than promised).
>
> What is unclear is the level of coverage and delivery timescales that would have been achieved by operators on a commercial basis or by a different approach to licence award (or indeed a different approach to enforcement).
>
> The beauty contest approach effectively helped direct expenditure towards providing coverage to areas that were otherwise uneconomic to serve. However the extent of this indirect subsidy is not transparent (i.e. we do not know how much additional coverage over and above economic coverage was provided, or at what net cost).

Subsidy or public procurement

6.35 There are many examples of commercial providers being subsidised in part or in whole to roll out services in areas where they would not otherwise choose to do so. Many of the case studies included in the Analysys Mason report are examples of this type on intervention.

Broadband

6.36 In some cases, the approach is straightforward and easily implemented, as in the case of the Welsh Government's Broadband Support Scheme. A case study on this is included in Analysys Mason's report. It notes:

> The Broadband Support Scheme is a subsidy scheme to support the provision of accessible and affordable broadband services to the (mostly rural) areas of Wales that are 'not spots' and 'slow spots'. A 'not spot' is defined as an individual or business who either cannot receive any broadband at all or has a very poor service (512 kbit/s download or less) and a 'slow spot' is defined as an individual or business

[108] Directive 97/67/EC (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:015:0014:0025:EN:PDF), as amended by Directive 2002/39/EC (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:176:0021:0025:EN:PDF) and Directive 2008/06/EC (http://ec.europa.eu/internal_market/post/doc/legislation/2008-06_en.pdf).

that can receive a basic broadband connection of more than 512 kbit/s but less than 2 Mbit/s.

Via the scheme, anyone who requires a basic broadband service in these areas can access financial support to purchase a solution. Applications can be received from `residents, SMEs, voluntary/community sector organisations.

The scheme provides funding up to a maximum value of £1,000 per eligible applicant. The funding only covers the capital costs incurred during the installation of an improved broadband solution, and the consumer of the service is responsible for paying the monthly service charges which are offered at a similar rate to those of commercial operators.

Individual, SME or 3rd Sector organisation applicants are required to submit quotes from two ISPs or a supplier proposal if applying as a community, along with verification that they are in a slow spot or not spot. Following appraisal of the application, the Welsh Government awards funding for the applicant's chosen solution. The chosen solution is not necessarily the cheapest option: sustainability, future-proofing and the applicant's preference are also taken into account. As a minimum, all forms of connectivity must have service provision and contract duration of no less than one year. The scheme is neutral on both the technology and ISP.

To date, 2,900 applicants have been supported. A total of 18 community groups have been supported through the scheme by aggregating the £1,000 eligible payments to individuals in the group, with another five potential community applications being submitted and assessed.

The offer of meaningful funding to residents, SMEs, and voluntary/community sector organisations has seen substantial take-up and the scheme has observed an increase in competition between suppliers and a reduction in prices.

The scheme administrators have been careful to scrutinise the commercial sustainability of any solution offered by service providers before award of funding.

6.37 In other cases, lengthy and complex procurement processes must be undertaken and state-aid approval sought from the European Commission. Three case studies included in Analysys Mason's report are all successful examples of large-scale commercial deployments delivered with the aid of public subsidy. Of the Superfast Cornwall project, it notes:

The project aims to deliver superfast broadband to at least 80% of premises in Cornwall and the Isles of Scilly, and bring faster broadband than was previously available to all premises.

Cornwall Council leveraged £78.5 million of private sector investment, combined with £53.5 million of public funding. The chosen 'gap funding' PPP approach also allowed Cornwall Council to have some control over the programme of the network roll-out without the risks associated with operating the network itself and ensuring that sustainable take-up levels were achieved.

The sustainability of the Superfast Cornwall project has been enhanced by focusing on attracting a significant number of ISPs quickly, including those with significant UK market share. In this case, take-up is gaining momentum and a significant number of service providers are being attracted to compete for customers. So far, this model compares favourably to the South Yorkshire Digital Region (SYDR) project, which

opted for a shared operation and take-up risk and has struggled to attract ISPs and customers.

The project has also recognised the importance of demand stimulation in ensuring the sustainability of the project. Parallel investment has been made in demand stimulation activities to encourage service take-up alongside network roll-out.

Although the Superfast Cornwall project is not within the direct remit of the Broadband Delivery UK programme, the BDUK broadband intervention projects are adopting a similar commercial approach to that used for Superfast Cornwall.

6.38 Of the National Broadband Scheme in Ireland, it notes:

This was a project run by the Irish Department of Communications, Energy and Natural Resources (DCENR) with the support of regulator ComReg to address the issue of the last 10-15% of the Irish population that did not have and would not get access to basic broadband connectivity without intervention. The €223million required came from a combination of Irish Government funds, EU co-financing and the selected operator.

The end-user pricing through the scheme is the same regardless of the technology. The required outcome (minimum peak speeds, maximum contention ratios, latency) was specified in a technology-neutral way. A contractual obligation to upgrade services during the contract term helped future-proof the network and support its commercial sustainability. A small fraction of the sites are allowed to be served using satellite with different target speeds, contention ratios, and latency.

An open tender process was used following EU procurement rules to select a private sector partner. The mobile operator 3 was selected to implement and operate the NBS network with the objective of making the network available to service providers on an open access wholesale basis and for end users to receive broadband provision.

The scheme delivered network infrastructure to some of the most remote and sparsely populated areas of Ireland such that over 99% of the population has access to a broadband service, an outcome that wouldn't have happened without intervention.

The use of the Competitive Dialogue procedure as the preferred procurement approach for the NBS helped secure a viable technical solution and maximise the leverage of private sector funding.

6.39 Of the Next Generation Broadband project in Northern Ireland, it notes:

Northern Ireland's Department of Enterprise, Trade and Investment (DETI) estimated that without intervention, a commercial operator's investment in next generation broadband would only reach 50-60% of businesses in Northern Ireland.

The Next Generation Broadband (NGB) project aimed to increase the availability of next-generation broadband to 85% of all businesses in Northern Ireland.

It was one of four initiatives launched by the Department of Enterprise, Trade and Investment (DETI) to implement the policy objectives of Northern Ireland, as published in The Programme for Government 2008-2011 and Investment Strategy 2008-2018. The NGB project used investment by DETI, the Department of

Agricultural and Rural Development (DARD), the EU under the European Regional Development Fund (ERDF) Competitiveness Programme and the European Agricultural Fund for Rural Development (EAFRD) Programme, and BT.

The contract specified that 85% of business premises in rural areas (areas where there is a low density of businesses) should receive a minimum download speed of 2 Mbit/s and 85% of business premises in urban areas (areas where there is a higher density of businesses) should receive a minimum download speed of 10 Mbit/s. The download speed could be higher depending on the proximity to the exchange. BT deployed Fibre to the Cabinet (FTTC) technology to 1,265 cabinets in 169 exchange areas, and around 3,000km of cable was laid.

Whilst the intervention was focussed on business users, residential customers were also indirect beneficiaries.

Following successful roll-out of the project and delivering take-up at a sustainable level, further investments were made by BT in Northern Ireland's broadband infrastructure.

6.40 A similar model being used for the procurement of superfast broadband services being funded by Broadband Delivery UK (BDUK), part of the UK Government's Department for Culture, Media and Sport (DCMS). The UK Government is committed to delivering a transformation of broadband services by 2015. The Government aim is to provide superfast broadband to at least 90% of premises in the UK and universal access to standard broadband with a speed of at least 2 Mbit/s. The UK Government has allocated £530m between 2011/12 and 2014/15 to stimulate commercial investment in rollout, with individual projects in this Rural Broadband Programme the responsibility of local authorities and devolved administrations, as set out in BDUK's delivery model.[109]

- There are 41 projects in existence for England, and DCMS has committed a total of £297.1 m.

- In Northern Ireland, where the Next Generation Broadband project has already achieved 95% superfast-broadband coverage, BDUK has allocated a further £4.4m. Separately, DETI has identified areas where available speeds are less than 2 Mbit/s and/or the choice of broadband provision is limited,[110] and it has entered into a procurement process to address homes and businesses in these circumstances, particularly in rural areas.

- In Scotland, a total of £100.8m has been allocated and is additional to funding already earmarked by the Scottish Government. The Scottish Government is seeking speeds of 40-80 Mbit/s for 85-90% of premises by 2015 and the best possible speeds where delivery is not possible at this stage.[111] Part of the total funding will improve the availability of superfast broadband in the Highlands and Islands. Procurement of this project is being managed by Highlands and Islands Enterprise has recently concluded.

- In Wales, investment totalling £425m—£220m from BT, £89.5m from the ERDF, £58.6m from the Welsh Government and £56.9m from BDUK —will deliver fibre broadband to parts of the nation not covered by commercial plans. 96% of homes

[109] www.culture.gov.uk/images/publications/BDUK-Programme-Delivery-Model-vs1-01.pdf.
[110] www.detini.gov.uk/deti-telecoms-index/deti-telecoms-whats-new.htm.
[111] "Scotland's Digital Future—Infrastructure Action Plan."

and businesses are expected to have speeds about 15 times faster than those available in Wales today, with ultrafast broadband providing even faster speeds if businesses need it. The Welsh Government has set itself the goal of ensuring everyone has access to next-generation broadband by 2020.[112]

6.41 Maps and tables showing progress on Local Broadband Plans in the BDUK Rural Broadband Programme are available from the DCMS website.[113]

6.42 BDUK is also investing £150m in "Super Connected Cities" across the UK with ultrafast (80-100 Mbit/s) connectivity. Further information on this Urban Broadband Programme is available from the DCMS website.[114]

6.43 The UK Government's Department for Environment, Food & Rural Affairs (Defra) is administering a £20m Rural Community Broadband Fund targeted at rural communities in the 10% hard-to-reach areas of England that will receive standard broadband under the BDUK Rural Broadband Programme and where a need for a superfast solution can be demonstrated at a reasonable cost.

6.44 Similarly, the Scottish Government is investing £5m in a Community Broadband Scotland initiative to help kick-start community-led broadband projects in rural communities.[115]

6.45 Analysys Mason's report contains two case studies of smaller-scale interventions to promote broadband availability within England that have met with contrasting fortunes. Of the Alston Cybermoor project, it notes:

> Alston Moor has a challenging terrain and is regarded as one of the most remote and sparsely populated places in England. The costs of deploying broadband infrastructure to this area were substantial and a suitable business case for commercial investment could not be identified. Without some form of intervention, the area would have been at a disadvantage, by missing out on the economic benefits delivered through broadband and ICT infrastructure.
>
> The challenging terrain, remoteness and sparsely populated nature of the area has contributed to the need for the project to seek multiple sources of public sector funding for a variety of purposes over a number of years, as well as funding sought directly from the community itself.
>
> The Cybermoor project was originally created in 2001 to identify and deal with the issues of social exclusion in Alston Moor by providing free computers, websites and basic broadband access to the Alston Moor communities (using fixed wireless solutions), initially funded by a variety of public sources. Since then, the project scope has expanded to include the most recent intervention, the current £600,000 Cybermoor fibre network project, which initially covers the most densely populated parts of Alston Moor, but may be extended to cover the more remote areas depending on the availability of additional funding.
>
> The Cybermoor fibre network project uses funding from a public sector investment of £300,000 from Defra under the RDPE scheme and a £300,000 'match' will be secured through sponsorship funding from equipment vendors and a Cybermoor

[112] "Digital Wales: delivery plan."
[113] www.culture.gov.uk/what_we_do/telecommunications_and_online/8863.aspx.
[114] www.culture.gov.uk/what_we_do/telecommunications_and_online/8830.aspx.
[115] www.hie.co.uk/community-support/community-broadband-scotland/default.html.

Network Ltd. (CNL) contribution (raised from the issue of community shares and other revenue generating income). The £300,000 contribution from Defra is provided to CNL using state aid 'de minimis' rules.

CNL is a company set up to own and manage all the equipment and infrastructure currently used on the Cybermoor project including the operation of planned fibre network infrastructure. It is a co-operative and raises funds through the issue of community shares amongst other public and private sources.

The challenge of providing and sustaining services that are not commercially viable is starkly demonstrated by the Cybermoor project. The fibre network project has had to seek investment directly from the community to supplement public funding and other private funding sources; while this offers a higher level of involvement in the project for the community (including sharing benefits and risks), it also highlights the difficulty of leveraging private sector funding in a small deployment that interventions on a larger scale have managed to achieve.

6.46 Of the Norfolk Open Link wireless project, it notes:

The Norfolk Open Link (NOL) wireless project was a £1.1million two-year pilot project fully funded by the East of England Development Agency (EEDA) to provide free internet access to the public sector, business community and the general public in urban and rural settings in Norfolk.

The primary aim of the project was to evaluate the potential of wireless technology in the area and how this could have an impact on the economic development and delivery of public sector services in Norfolk.

The project involved installing just over 260 wireless transmitters (Wi-Fi access points) on Norfolk County Council-owned lampposts and other street furniture to form the NOL coverage area. Each access point had a reception radius of up to 300m, and was located to deliver maximum coverage in the required areas. The access points fed signals back via backhaul sites, which then linked to the Internet connection at County Hall. Any residents, businesses, visitors or public sector organisations with a Wi-Fi-enabled device within the coverage area could access the internet free of charge. There was a support line and website created to support users of the NOL wireless service.

The project did not focus on commercial sustainability and couldn't continue beyond its initial pilot phase because of a lack of funding to sustain the operation of the service. The project finished in June 2008 with the closure of the wireless and associated services including the websites and online support and decommissioning of the assets. The Council attempted to find a commercial service provider to use the assets to provide commercial services, but all attempts failed.

Other similar wireless schemes have had difficulties with commercial sustainability; for example, schemes have closed down or run into financial difficulties in Swindon (2009-2011) and Cumbria (2007-2012).

Mobile

6.47 BDUK is also responsible for delivering the UK Government's Mobile Infrastructure Project (MIP). This will see up to £150m of public capital invested to improve the coverage and quality of mobile voice and basic data network services. State-aid clearance was achieved in December 2012, and agreement has been brokered

between the key MNOs to share the costs of using infrastructure. The project will now progress to the procurement stage. On current timetables, the first masts could be in place by the end of 2013 and delivery completed by 2015.

6.48 A case study on 2G mobile expansion in Scotland is included in Analysys Mason's report. It notes:

> Public money part funded a mobile coverage expansion project in the Highlands and Islands region of Scotland to reach the areas not covered by commercial rollout of 2G mobile services.
>
> In this case, only a relatively small amount of public funding was needed, which unlocked significantly greater amounts of investment by the operators.
>
> The solution proved to be sustainable over the long term, avoiding the need for further public funding.

Radio

6.49 A case study on analogue community radio in Wales is included in Analysys Mason's report. It notes:

> GTFM, the first Community Radio Station in Wales, receives funding support from multiple sources including European funding, Welsh Government funding and Ofcom Community Grant funding, as well as advertising revenue, to continue broadcasting content and carry out activities that deliver community benefits to citizens of Pontypridd.
>
> Community radio is a distinctive separate tier of radio, sitting alongside BBC and commercial radio services. Core requirements are providing community benefits (social gain), opportunities for community participation, and accountability to the target community; services cater for communities that are otherwise underserved by local radio.
>
> The sustainability of the services is dependent on continuing public funding and the support of community volunteers.
>
> The radio station still faces the challenge of continuing to be a successful local advertising medium, given the competition from commercial radio outlets, which either operate on a large scale or are more attractive to businesses.
>
> Retention of volunteers can be an issue, due to unexpected factors such as illness.

Interventions to mimic the effects of competition

6.50 Many of our interventions take place where a communications service is being provided—whether commercially or as a result of public intervention—but competition in that market is not effective, to the detriment of consumers. Our objective in such circumstances is to mimic the effects of competition on those who are providing services, usually by imposing obligations on such dominant providers. Recent examples include our decisions to:

- control the prices BT can charge for wholesale broadband access (WBA) services in parts of the UK where it is currently the only provider;

- cap wholesale mobile termination rates (MTRs) mobile communications providers (MCPs) charge fixed and mobile operators when their customers call UK mobile numbers; and

- impose a safeguard cap on the price of Second Class stamps so Royal Mail continues to provide a basic universal-service product accessible to all, including the vulnerable.

Wholesale broadband access

6.51 In December 2010, we found there was effective competition in the provision of WBA services in areas covering almost 80% of premises in the UK.[116] However, in areas where BT was the only provider of these services present or forecast to be present, we decided its prices should be controlled. We believed the benefit of the wholesale price reductions resulting from this charge control could deliver lower retail prices and improve broadband users' experience in those areas. As average demand increased as more consumers sought to use higher-bandwidth services, we believed ISPs would reflect the benefits arising from the charge control in better quality of service as this was likely to be an important focal point for broadband retail competition in those areas.

Wholesale MTRs

6.52 When fixed and mobile operators offer their customers the ability to call UK mobile numbers, they pay MCPs a wholesale charge for terminating those calls on the relevant MCP's network. The rates operators pay are commonly called MTRs.

6.53 In March 2011, we set new rules applicable from 1 April 2011 that limit the MTRs of the four UK-wide MCPs and limit all other designated MCPs to "fair and reasonable" rates.[117] In most cases, the outcome is a single wholesale charge for MCPs on different networks, falling sharply over the first three years of the charge-control period. We also simplified the way in which the new price cap operates. This regime benefits consumers by promoting competition, and the simplified approach makes it easier for operators to comply. The new rules (which are currently subject to appeal) apply until 31 March 2015.

Second Class stamps

6.54 We consulted in October 2011 on proposals for a new regulatory framework for the postal services sector.[118] In broad terms, we proposed granting Royal Mail significantly greater commercial and operational freedom coupled with key safeguards to ensure it would have strong incentives to improve efficiency and protect vulnerable consumers, such as those on low incomes and the elderly. To ensure that a basic universal service was available to all we imposed a safeguard cap of 55p[119] on Second Class stamps for standard letters.[120] We also decided to

[116] "Review of the wholesale broadband access markets: statement on market definition, market power determinations and remedies," 3 December 2010, http://stakeholders.ofcom.org.uk/binaries/consultations/wba/statement/wbastatement.pdf.
[117] "Wholesale mobile voice call termination: statement," 15 March 2011, http://stakeholders.ofcom.org.uk/binaries/consultations/mtr/statement/MCT_statement.pdf.
[118] "Securing the universal postal service: proposals for the future framework for economic regulation," 20 October 2011, http://stakeholders.ofcom.org.uk/binaries/consultations/securing-the-postal-service/summary/condoc.pdf.
[119] To be increased by CPI over the seven year period of the regulatory framework.

extend the safeguard to include large letters and packets up to 2 kg in order to provide an important further level of protection for vulnerable consumers.[121]

Interventions for other purposes

6.55 Some interventions serve purposes other than increasing the pace of rollout to commercial levels, increasing coverage beyond commercial levels and mimicking the effects of competition. Analysys Mason's report contains two case studies of such interventions. Of analogue-television self-help relays in Northern Ireland, designed to restore coverage affected by a wind-farm project, it notes:

> Locally managed TV signal re-transmitters, which boost signal strength and allow improved local coverage, are known as 'self-help relays'.
>
> This is an intervention to enhance analogue television reception to c.90 homes affected by the installation of the Elliot's Hill wind farm project in Northern Ireland.
>
> In this case interference to analogue TV services was rectified by the wind farm developer at the developer's cost. It is not yet known whether digital terrestrial TV will need similar measures at this site.
>
> In this case, the "polluter pays" principle is in operation. Builders of structures which affect service coverage can be required to fund restorative measures to maintain communications services; local planners can impose binding conditions to this effect.

6.56 Of the Postbus-services initiative, serving Scotland, North Yorkshire and Leicester, designed to provide public transport alongside mail collections and deliveries, it notes:

> The Postbus service initiative was introduced to serve some remote areas of the UK with public transport services while collecting and delivering mail. The Postbus services operations are subsidized by local government. Depending on the amount of subsidy, there is the possibility for this cost sharing to reduce the overall cost to Royal Mail of providing a universal postal service.
>
> Since 1967, Royal Mail has provided a number of Postbus routes in rural parts of Scotland, Wales and England, with over 200 routes at the peak of the Postbus service. However, in recent years the number of routes has fallen substantially, and the few remaining routes are concentrated in Scotland. There are a variety of factors suggested as to why the number of routes is so reduced, including reduced demand for bus services, the reduction to once-daily mail delivery in 2004 and the need for higher efficiency in Royal Mail.
>
> Royal Mail has said that it has clear, straightforward criteria that must be met if it is to consider delivering a Postbus service in a particular area including: the service must be based on a contract with the relevant local authority; it must not be loss-making for Royal Mail; and it must not impact upon the efficient delivery or collection of mail. When seeking a subsidy from a local authority to provide a Postbus service, Royal

[120] "Securing the universal postal service: decision on the new regulatory framework," 27 March 2012, http://stakeholders.ofcom.org.uk/binaries/consultations/review-of-regulatory-conditions/statement/statement.pdf.
[121] "Securing the universal postal service: safeguard cap for large letters and packets," 20 July 2012, http://stakeholders.ofcom.org.uk/binaries/consultations/postal-service-letters-packets/statement/statement.pdf.

Mail has said that it will only look to cover its costs for providing this service and indicated that it would not look to make a profit from running a Postbus service.

Cost sharing could still be a win-win for both Royal Mail and the council even if Royal Mail were to make "profit" from the service as long as the required council subsidy remains below the stand-alone cost of an alternative service (or if a different service is possible, then Postbus can still provide value for money up to a particular price).

State aid

6.57 For several of the case studies examined above, compliance with EU state-aid rules is described as a key prerequisite requirement. The purpose of these rules is to prevent Member States intervening through the use of public resources in a way that distorts competition. As a consequence, state aid is generally prohibited in the EU. However, there are some policy objectives with which state aid can be considered compatible.[122] The rollout of broadband networks is one such objective.

6.58 To clarify how it would assess the compatibility of state aid provided for broadband, the European Commission issued guidelines in 2009,[123] which it updated in 2012.[124] To ensure an effective and fair decision-making process and the achievement of desirable price and competition outcomes in the long term, the guidelines impose obligations on both the aid-granting authorities and the aid beneficiaries. These obligations cover the decision process as well as the expected characteristics of the subsidised network.

6.59 State aid can only be allowed where it is considered necessary to achieve the appropriate policy objectives, which include competition and investment considerations for "basic" broadband on the one hand and superfast broadband on the other hand. The guidelines define a differentiated approach based on three distinct types of area:

- in "black areas," where at least two competing broadband infrastructures are present, state aid is deemed to be incompatible;
- in "grey areas," where only one network infrastructure is available, state aid can only be compatible if it can be demonstrated the intervention would bring clear benefits to local users while causing limited competitive distortion due to local circumstances; and
- in "white areas," which lack broadband connectivity, state aid can be compatible.

6.60 In areas where state aid is acceptable for the type of broadband network to be subsidised (basic or superfast), the scheme must also be designed to minimise competitive distortions, operate efficiently to offer value for money and facilitate competition downstream in the value chain. A clawback mechanism must ensure the

[122] Article 107 of the Treaty on the Functioning of the European Union. See http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2008:115:0047:0199:EN:PDF.
[123] "Community guidelines for the application of state aid rules in relation to rapid deployment of broadband networks (2009/C 235/04)," 30 September 2009, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ%3AC%3A2009%3A235%3A0007%3A0025%3AEN%3APDF.
[124] "EU guidelines for the application of state aid rules in relation to the rapid deployment of broadband networks," 19 December 2012, http://ec.europa.eu/competition/state_aid/legislation/broadband_guidelines_en.pdf.

recipient of the state aid reimburses the aid-granting authority if it is later shown not all the state aid was needed.

6.61 The 2012 guidelines also open up the possibility of state aid to high-performance ultrafast broadband, even in superfast black areas, provided this results in a significant enhancement to the services currently available and there is clear demand for such products in the area. However, such a scheme can only be approved if the network is operated on a wholesale basis only (that is, the recipient of the state aid abstains from any retail activity in the area).

6.62 In 2011, the Commission approved about €1.7bn of state aid for broadband, the majority concerning superfast deployment. This continued a trend started in 2010, when the Commission approved approximately €2bn for broadband, more than four times the amount approved in 2009. However, these amounts are quite small compared to the Commission's estimates of the funds needed to achieve its broadband goals for 2020:[125]

- €38-58bn to achieve broadband for all by 2013 and connections above 30 Mbit/s for all by 2020; and
- €181-268bn to achieve 50% of households having connections above 100 Mbit/s by 2020.

Conclusions

6.63 The interventions discussed in this section are by no means exhaustive. Even if they were, it is highly unlikely any of them could be perfectly replicated in a different setting—there are simply too many factors to consider when constructing the right intervention for the circumstances. And our own expertise as a regulator does not always give us better insight into the kinds of approach that are likely to be successful than is available to elected institutions, service providers and the very communities who stand to benefit.

6.64 Section 7 contains some observations drawn from the interventions considered here. One thing is, however, clear: designed and delivered well, interventions can make a very significant difference in a short period of time. The Next Generation Broadband project in Northern Ireland stands out in particular, as the availability described in section 4—second in the UK only to Greater London—attests.

[125] "A digital agenda for Europe," 26 August 2010, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0245:REV1:EN:HTML.

Section 7

Findings and observations

Introduction

7.1 Section 4 of this report described the extent of availability of communications services provided through six core networks. Section 5 discussed the role of markets in providing those services, and section 6 considered the scope for intervention. This section sets out a number of findings and observations we hope, together with the contents of the rest of this report, will stimulate further consideration by those with an interest in these issues.

7.2 Our findings suggest:

- market-led rollout of communications services reflects differences in population size, density and composition as well as the topography of the landscape. This is to be expected given the economics of building and operating the networks that deliver them, although availability varies significantly from service to service. (For example, superfast broadband is available to nearly five times the proportion of Urban households as it is Rural households in England, but availability is more than 13 times greater in Urban than Rural households in Wales. In contrast, 2G mobile coverage exhibits very little difference between Urban and Rural premises across the devolved nations and the English regions.) Universal service obligations ensure some services are available to all, but it should be remembered this comes at a cost in the form of higher prices or taxes;

- availability of all services is good—and frequently near-universal—in Urban areas in all four nations of the UK. Rural locations are less well served, sometimes significantly so. This is true in England outside Greater London, but there is a generally greater and recurring lack of availability of communications services to premises in Scotland and Wales and, even more so, Northern Ireland. Moreover, these results persist when availability is analysed by rurality, suggesting this factor alone does not explain all the differences; and

- while the main issues of availability therefore relate to the economics of network deployment in Rural areas, not to factors specific to individual nations, there are exceptions to this. We used regression analysis to assess the availability of 3G mobile services, and our results appear to show much of the variation in coverage between different parts of the UK, and the relatively low levels of availability in Scotland and Wales, can be explained by the size, density and composition of the local population and the topography of the landscape as well as rurality. Different issues nonetheless seem to have restricted the availability of 3G mobile services in Northern Ireland, where low levels of 3G mobile coverage in seem instead to be associated with a stricter planning regime, community opposition and changing network plans by the mobile network operators themselves.

7.3 Based on this, we observe:

- areas that have not previously benefited from commercial rollout are more likely to experience market shortfalls in the future. Consequently, public bodies that have intervened to extend availability in the past may expect to face the same

pressures to do so again in the future. If this can be successfully anticipated, it may be possible to plan interventions at a sufficiently early stage that those areas do not always have to play catch-up with the rest of the UK;

- such interventions have long featured in communications markets. What is changing is the ever-shortening period before a commercial service is deemed sufficiently important for public bodies to face pressure to extend its availability, the tension between state-aid rules and availability targets at an EU level and the increasing challenge in ensuring sustainability and value for money when public bodies do intervene. Key to the success of such interventions is careful targeting to ensure value for money is achieved in areas where the market will not deliver availability without distorting competition in areas where the market will; and

- the frameworks for addressing universal availability remain best set by elected representatives. However, it is vital those representatives recognise the growing dependency on converged communications services and the increasing disadvantages faced by those who lack availability. Our own roles—as regulator and technical advisor, sometimes required to act in particular ways, other times with discretion about how we act—are important, but our powers do not enable us to secure widespread availability in all circumstances.

Findings

Less availability in more-rural locations

7.4 Section 4 clearly shows communications services generally become less available as locations become more rural. This is not always the case: USOs do ensure near-universal availability of fixed telephony and postal services. The coverage of premises by 2G mobile services also varies little between different parts of the UK, and a similar story is true of PSB delivered by DTT.

7.5 Nonetheless, superfast broadband is available to more than four times the percentage of Urban UK households as to those in Rural locations—in Wales, the difference is a factor of more than 13—while coverage by all six DTT multiplexes is significantly worse in many Rural parts of the UK compared to their Urban counterparts, and coverage by both BBC and commercial DAB digital radio is even more variable. Geographic coverage by 2G and 3G mobile services also lags—in some cases significantly—behind premises coverage.

7.6 This disparity is also evident in the number of homes in the UK that cannot receive both standard broadband and 3G mobile services (that is, homes without internet access). We estimate this at almost 50,000: more than 26,000 in Northern Ireland, 8-9,000 in each of England and Scotland and just over 5,000 in Wales. More tellingly, more than 98% of those homes are in Rural locations, less than 2% in Semi-rural locations and not one in Urban locations. (Detailed figures are in annex 1.)

A recurring lack of availability in the devolved nations

7.7 We have taken two approaches to considering whether different parts of the UK experience significantly different levels of service availability. Other analyses are clearly possible, and we hope the data we have published enable stakeholders to perform their own calculations.

Comparisons between administrative areas

7.8 At a simplistic level, we have compared the levels of availability for Northern Ireland, Scotland, Wales and the regions of England against each other. The results of those calculations are in annex 1. Broadly speaking, they show a recurring lack of availability in Northern Ireland, Scotland and Wales. Indeed, only the availability of superfast broadband in Northern Ireland positively stands out, and this as a consequence of DETI's intervention there (see section 6). Only Greater London consistently has significantly better availability than other parts of the UK. The remaining English regions exhibit some variations in availability of some services in some locations, but these tend to be much less pronounced and to even out when considered across a region as a whole.

Regression analysis

7.9 Using detailed data provided by MNOs, we have analysed 3G mobile coverage in the UK. We used a simple entry model to investigate the factors that affect MNOs' local coverage decisions. This allowed us to look behind raw averages and gain a fuller understanding of the drivers of 3G mobile coverage. The results of those calculations are in annex 1.

7.10 Our findings can be summarised as follows.

- coverage across the UK is generally very good, with a high probability, particularly in Urban areas, there will be good coverage by all four MNOs;
- a more densely distributed local population increases the likelihood of good 3G coverage. Our results indicate, all things being equal, an extra 1,000 people in a postcode sector will result in a 0.9-1.8 percentage-point increase in the probability of full coverage by all four MNOs. The difference between a densely populated and a sparsely populated area (as identified by the interquartile range within our sample) is around 5.9 percentage points;
- a younger and more affluent population increases the probability of good coverage. The difference in the probability of full coverage by all four MNOs, between low and high values of these variables (as identified by the interquartile range within our sample) is between 2.1 and 4.5 percentage points;
- local topography can also affect the probability of good coverage. All things being equal, the difference between a low-lying and an area high above sea level (as defined by the interquartile range in our dataset) is around 4.6 percentage points; and
- once population density and composition, topography and rurality are taken into account, the probability of good coverage is relatively similar between different parts of the UK, indicating much of the variation in availability can be explained by these factors. However, there appear to be other factors specific to Northern Ireland that negatively affect coverage there. We understand these to be:
    - changes to the planning laws for mobile phone masts. Announced on 11 April 2002,[126] these required every new mast and upgrades to existing masts to go through the full planning process. Up to that point, any developments under 15

[126] www.planningni.gov.uk/index/news/news_releases/news_newsreleases_archive/news_releases_2002.htm.

metres were deemed as having prior approval under permitted-development rights;

- local opposition to MNOs' seeming ability to build masts at will, fuelled by fears over health concerns of people living or working close to a mast; and

- network-planning decisions that initially focused on large urban areas and often prioritised sites in Scotland and the North and Midlands of England when the amount of money being spent on rollout declined in the mid-2000s.

7.11 While the results in annex 1 appear relatively robust (at least in a qualitative sense), they are preliminary and would benefit from further development. For some of the explanatory variables—in particular those concerning the age profile of the population—the magnitude of the effect is difficult to pin down. The geographic frame we have chosen to measure the characteristics of local population and topography is also less than ideal and may lead to some inaccuracy in our results. Further work based on a different geographic frame more closely related to the typical size of an individual mobile telephone cell may therefore prove fruitful. In addition, a more sophisticated entry model may yield more insight into the competitive dynamics of local mobile markets.

Observations

The enduring challenge of availability

7.12 There are many reasons why markets do not deliver all communications services to every consumer in the UK. As section 5 explains, this should not come as a particular surprise. Nonetheless, it is apparent those reasons lead to the same outcomes in the same locations across multiple services, meaning those who experience relatively poor mobile coverage are also more likely not to receive all six DTT multiplexes, DAB digital radio or superfast broadband. It is also likely the same consumers have been the last to receive each service as it has been rolled out across the UK. This is not limited just to those who live in large areas with low population densities but also affects, for example, the links between the densely populated settlements in much of the north, west and Border areas of Scotland.

7.13 The future is particularly hard to predict in a sector like communications where technology develops so quickly. But it may be reasonable to expect locations with poor or nonexistent availability of existing services to have the same experience with new services in the future. In turn, public bodies that have intervened to improve service availability in the past might expect to face the same pressures to do so again in the future. If this is so, it may be possible to anticipate market shortfalls at an early stage and plan suitable interventions that mean those locations do not permanently lag behind the rest of the UK. This is particularly important to the extent poor communications services are just one manifestation of a gap in economic performance more generally but where society already invests considerably to try and overcome that disadvantage (for example, through the activities of bodies like Highlands and Islands Enterprise).

7.14 At the same time, intervening too quickly increases the risk of regulatory failure, in particular by reducing the incentives for commercial providers to invest as quickly and to the extent they otherwise would.

Interventions

7.15 All six communications services considered by this report have been subject to one or more interventions within the UK. Those interventions have become more varied and complicated over time:

- USOs were imposed and remain in place for fixed telephony and postal services, but this approach has given way first to coverage obligations for mobile services and PSB on terrestrial television and subsequently to an increasing reliance on gap funding by public bodies, notably but not exclusively for superfast broadband;

- public bodies intervening to increase availability have made conscious choices about the changes they have sought to effect. Nowhere is this more evident than in relation to superfast broadband, where different bodies with different geographic remits—be they community, devolved, UK or EU—have set different targets to be achieved at different times, sometimes in different ways. Moreover, these targets can be overtaken by technological change before they are even reached. Where the EU Universal Service Directive required Member States to ensure no more than "functional" internet access in 2002, the UK Government set an ambition of universal access to standard broadband by 2015, with at least 90% of premises enjoying superfast broadband. But by last November we were already observing it may be appropriate to consider increasing the 2 Mbit/s target in due course, the costs of which could be reduced by a number of developments in wireless and fixed technologies;[127] and

- the focus of USOs on improving the availability of a minimum service has been supplemented—some would argue overshadowed—by concerns to ensure "better" services are widely available. This is true of both fixed broadband and mobile services. The balance between those objectives, which may be competing for scarce resources such as public funding, will differ from case to case but should always be informed by the extent to which one service meets the defined needs of end-users better than another.

7.16 It is also notable how interventions have historically followed the commercial launch of new communications services but the period between launch and intervention has shortened as those services have assumed an ever greater importance to daily life:

- the first USO for fixed telephony was introduced over a century after telephone services were first available in the UK, whereas BDUK's remit to improve the availability of standard and superfast broadband by providing gap funding was established just a decade or so after commercial launch of those services; and

- the UK Government's MIP was announced nearly 20 years after the first 2G mobile services started operating, whereas only one UK MNO was offering 4G mobile services before another became subject to the coverage obligations we introduced for one 800 MHz licensee.

7.17 The EU has become an increasingly important factor as the scope and scale of interventions have themselves increased:

- interventions within the UK that could affect trade between Member States need to secure the European Commission's agreement they comply with state-aid rules. The importance of this cannot be overstated. Even when successful, this

[127] "Infrastructure Report, 2012 update."

process can be time-consuming, as was the case for the UK Government's Rural Broadband Programme—Commission agreement took 9 months from the initial submission. Nor can agreement be taken for granted even when received—legal challenges now surround the Commission's decision to approve UK Government funding under its Super Connected Cities programme for Birmingham; while

- the introduction of EU-level targets for broadband availability have provided an additional spur to Member State activities and led to specific clarification of how EU state-aid rules apply to public support in this area.

7.18 The case studies in section 6 show public funding can be secured from a number of sources to support interventions. The sustainability and value for money of such funding is clearly important but may be complicated by a number of factors:

- approaches that complement the role of the market—particular partnerships with service providers—can minimise the levels of public funding required, unlock additional private-sector investment and reduce the risks of regulatory failure. However, the gap to be funded before commercial providers are prepared to invest can vary significantly depending on the circumstances. The Superfast Cornwall project unlocked £78.5m of private-sector investment with £53.5m of public funding, a ratio of approximately 1½:1. In Wales, £220m of private-sector investment in fibre broadband is being matched by £205m of public investment, closer to a 1:1 ratio;

- anecdotally, it seems interventions may be more successful where those who benefit have a financial stake in delivery rather than receiving fully funded services. This can be seen in Broadband for the Rural North;

- different bodies are better suited to undertaking different interventions. It is not the case any particular level of government, regulator or community organisation can—or should—be expected to resolve all issues related to the availability of all communications services. Sometimes several bodies may need to be involved, whether jointly engaged in delivering the same intervention or acting individually. Where this is the case, it is important they work with—and not against—each other. This is particularly important as convergence makes it possible for different technologies to deliver the same service. For example, wireless solutions may make a significant contribution to delivering broadband in locations where extending fixed networks is prohibitively expensive; and

- ensuring services are provided is only half the issue. There needs to be demand for those services if their delivery is to be sustainable beyond the period of intervention.

7.19 However, notwithstanding network economics, it is possible to design and deliver public interventions that mean the same parts of the UK need not always lag behind others in the availability of communications services as they do in other respects. Key to the success of such interventions is careful targeting to ensure value for money is achieved in areas where market failure will occur without distorting competition in areas where the market will deliver availability.

Roles and responsibilities

7.20 As the independent regulator and competition authority for the UK communications industries, Ofcom has important roles to play in addressing shortfalls in service availability:

- our duties determine where we must act. In particular, section 3 of the Communications Act requires us to secure the availability throughout the UK of a wide range of electronic communications services and a wide range of television and radio services that, taken as a whole, are both of high quality and calculated to appeal to a variety of tastes and interests. We must also have regard to the desirability of encouraging investment and innovation in relevant markets and of encouraging the availability and use of high-speed data-transfer services throughout the UK. Section 29 of the Postal Services Act requires us to secure the provision of a universal postal service;

- our powers nonetheless condition how we can act. In some cases, they are extensive—section 9 of the Wireless Telegraphy Act 2006[128] enables us to license spectrum use subject only to restrictions set out in the EU Authorisation Directive, which include the imposition of coverage obligations.[129] In others, they are much less so—our role in relation to the fixed telephony USO is to enforce the universal service order made by the UK Government,[130] while our ability to make grants (for example, to promote efficient spectrum use) is entirely dependent on our first receiving the necessary funds;

- for this reason, advising and supporting public bodies in activities relevant to our functions is critical to how we go about meeting our duties. We seek to maintain good relations with the UK Government and Parliament, and our offices in Northern Ireland, Scotland and Wales work equally closely with the devolved institutions in those nations. We also engage actively in EU and other international fora, often representing the UK under direction from the UK Government; and

- throughout, we take seriously our ability to act as the technical adviser, undertaking extensive research across the breadth of our responsibilities and publishing this both in bespoke reports (not least this one) and as part of our regular series that include the CMR and the Consumer Experience.[131]

7.21 Therefore, even where we are not the decision-maker, we are an important contributor to the debates from which others draw conclusions.

7.22 However, fundamental questions about the availability of communications services beyond the levels delivered by competitive markets remain best answered by elected institutions directly accountable to those—citizens, consumers and taxpayers—who reap the benefits and bear the costs. This can be seen in the UK Government's decision to require near-universal availability of PSB on DTT but not to impose similar coverage obligations on the commercial DTT multiplexes. Equally, while the Postal Services Act requires us to assess the extent to which the postal market meets the reasonable needs of users, the minimum requirements of the universal postal service can only be changed by the UK Parliament or, with its assent, by the UK Government. These questions extend more widely to considerations including entitlement, equality of treatment, democratic engagement, public services and access to information.

[128] www.legislation.gov.uk/ukpga/2006/36/contents.
[129] Directive 2002/20/EC (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:108:0021:0032:EN:PDF).
[130] www.legislation.gov.uk/uksi/2003/1904/contents/made.
[131] http://stakeholders.ofcom.org.uk/market-data-research/.

7.23 In this context, it is vital elected institutions fully recognise there is a growing dependency on converged communications services and this is increasing the disadvantages faced by those who lack availability in a world where public services are moving exclusively online.

Next steps

7.24 This report is not a formal Ofcom consultation. We would nonetheless be interested in reactions to its contents and particularly in any further analysis of issues related to the economic geography of communications services in the UK. We would be grateful if these could be brought to our attention in the first instance through our directors of nations:

- Graham Howell, Director for England—graham.howell@ofcom.org.uk;
- Jonathan Rose, Director for Northern Ireland—jonathan.rose@ofcom.org.uk;
- Vicki Nash, Director for Scotland—vicki.nash@ofcom.org.uk; and
- Rhodri Williams, Director for Wales—rhodri.williams@ofcom.org.uk.

Annex 1

Data used to support findings

Homes not served by communications services

A1.1 In the following tables, the number of homes in the "All" column does not always equal the sum of homes in the "Urban," "Semi-urban" and "Rural" columns. This is due to rounding percentage coverages and because there a small proportion of postcodes in our data set are not classifiable as Urban, Semi-urban or Rural.

A1.2 Areas in Greater London are classified as Rural where population density is relatively low (for example, some of the postcode areas in the vicinity of Richmond Park).

A1.3 Data on the availability of standard and superfast broadband differ from what was reported in the "Infrastructure Report, 2012 update." The estimates in this report were calculated by considering a postcode not to have standard broadband if the median or mean average speed of connected premises in that postcode was less than 2 Mbit/s. If a postcode had an average/median speed of less than 2 Mbp/s, all premises in it were assumed to be at risk of experiencing low speed. This calculation differs from the "Infrastructure Report, 2012 update," where a postcode was considered not to have standard broadband if any connected line in it experienced a speed below 2 Mbit/s. The underlying data file on broadband speeds provided information on the number of residential and small-business lines with a broadband connection in each postcode. This information was not provided for those postcodes with only large businesses or where there were fewer than three residential or small-business lines for reasons of confidentiality. The restriction to postcodes with a minimum of three connected lines also explains the slight discrepancies in the number of premises with superfast-broadband availability.

Table A1. Estimated number of homes that cannot receive standard broadband

	All	Urban	Semi-urban	Rural
UK	1,241,837	156,725	423,751	661,361
England	932,734	128,771	327,625	476,338
Northern Ireland	91,619	5,970	16,073	69,576
Scotland	113,182	12,732	42,820	57,630
Wales	104,302	9,252	37,233	57,817
East Midlands	106,001	6,986	31,052	67,963
East of England	144,381	12,710	45,364	86,307
Greater London	24,475	24,131	0	<100
North East England	55,738	5,579	32,228	17,931
North West England	114,171	14,125	57,181	42,865
South East England	155,156	18,580	57,155	79,421
South West England	119,093	9,297	24,241	85,555
West Midlands	90,934	13,798	27,876	49,260
Yorkshire & the Humber	122,785	23,565	52,528	46,692

Table A2. Estimated number of homes that cannot receive superfast broadband

	All	Urban	Semi-urban	Rural
UK	8,523,802	1,314,757	4,587,550	2,621,495
England	6,460,406	1,109,956	3,361,593	1,988,857
Northern Ireland	28,873	2,404	10,646	15,823
Scotland	1,259,371	176,861	700,880	381,630
Wales	775,152	25,536	514,431	235,185
East Midlands	632,884	29,612	369,834	233,438
East of England	759,942	32,092	374,765	353,085
Greater London	391,530	390,195	201	1,134
North East England	326,288	45,203	210,628	70,457
North West England	829,658	118,741	543,598	167,319
South East England	1,046,332	58,763	584,502	403,067
South West England	1,080,662	63,258	630,643	386,761
West Midlands	582,736	151,069	235,423	196,244
Yorkshire & the Humber	810,374	221,023	411,999	177,352

Table A3. Estimated number of homes that cannot receive 2G mobile

	All	Urban	Semi-urban	Rural
UK	79,770	9,372	69,463	29,929
England	44,349	8,324	34,176	9,834
Northern Ireland	9,456	755	6,634	4,571
Scotland	19,210	1,917	10,838	8,556
Wales	10,296	515	6,998	4,785
East Midlands	3,850	457	2,368	568
East of England	4,830	1,076	4,399	1,643
Greater London	0	0	0	0
North East England	4,531	433	5,768	644
North West England	3,062	1,515	4,201	816
South East England	3,586	635	2,411	541
South West England	11,332	1,879	8,256	3,224
West Midlands	2,328	1,111	2,927	967
Yorkshire & the Humber	4,455	759	3,741	1,774

Table A4. Estimated number of homes that cannot receive 3G mobile

	All	Urban	Semi-urban	Rural
UK	239,311	28,116	208,390	113,067
England	66,523	8,324	56,959	19,667
Northern Ireland	85,106	5,439	67,445	44,672
Scotland	72,037	7,030	40,642	33,815
Wales	30,888	1,288	20,216	14,608
East Midlands	1,925	457	2,368	568
East of England	7,245	1,076	7,332	2,465
Greater London	0	0	0	0
North East England	6,797	650	8,240	1,564
North West England	6,124	757	10,503	2,040
South East England	0	0	0	0
South West England	18,132	2,506	11,794	6,449
West Midlands	6,985	1,111	5,854	1,934
Yorkshire & the Humber	8,909	1,518	6,234	3,326

Table A5. Estimated number of homes that cannot receive DTT by PSB multiplexes

	All	Urban	Semi-urban	Rural
UK	345,671	18,744	166,712	133,019
England	266,094	16,648	159,486	73,753
Northern Ireland	18,185	<100	4,423	13,298
Scotland	28,815	<100	2,709	24,445
Wales	28,314	515	4,665	20,149
East Midlands	5,775	1,370	2,368	1,137
East of England	74,863	8,067	48,391	16,842
Greater London	42,003	6,449	<100	109
North East England	13,593	433	11,537	2,761
North West England	76,551	<100	25,206	13,058
South East England	43,038	<100	4,822	32,434
South West England	49,862	1,253	7,076	36,850
West Midlands	6,985	3,333	1,951	967
Yorkshire & the Humber	69,047	11,382	41,146	9,090

Table A6. Estimated number of homes that cannot receive DTT by all multiplexes

	All	Urban	Semi-urban	Rural
UK	2,685,601	271,786	1,667,122	688,376
England	1,773,957	249,725	1,139,185	356,472
Northern Ireland	188,396	3,324	106,512	78,124
Scotland	321,765	11,503	169,343	132,001
Wales	373,236	5,152	237,151	120,393
East Midlands	125,123	18,728	75,776	28,704
East of England	318,773	53,779	215,559	49,293
Greater London	38,772	38,691	<100	<100
North East England	52,108	6,285	32,138	11,687
North West England	168,412	4,545	115,528	42,235
South East England	527,211	43,173	419,517	67,571
South West England	378,496	69,536	193,417	108,707
West Midlands	58,212	11,110	25,368	18,859
Yorkshire & the Humber	104,685	4,553	68,576	28,600

Table A7. Estimated number of homes that cannot receive BBC DAB digital radio

	All	Urban	Semi-urban	Rural
UK	1,542,226	149,951	819,668	525,427
England	1,020,025	108,214	603,768	287,636
Northern Ireland	111,292	453	56,020	53,814
Scotland	220,914	40,262	74,511	99,815
Wales	182,757	4,122	86,307	82,865
East Midlands	75,074	3,197	52,096	18,473
East of England	198,026	18,285	127,575	48,471
Greater London	16,155	16,121	715	120
North East England	77,030	1,951	46,146	25,123
North West England	97,985	12,120	56,714	27,340
South East England	200,842	25,396	003137,428	35,137
South West England	185,848	4,385	96,708	77,845
West Midlands	65,198	18,887	24,392	18,859
Yorkshire & the Humber	100,230	7,588	54,861	32,812

Table A8. Estimated number of homes that cannot receive commercial DAB digital radio

	All	Urban	Semi-urban	Rural
Great Britain	3,258,702	304,289	2,055,668	832,428
England	2,128,748	216,429	1,389,805	484,311
Scotland	600,309	86,276	298,043	202,890
Wales	523,817	3,606	366,224	144,068
East Midlands	146,298	10,049	101,824	33,535
East of England	309,113	30,116	197,962	77,226
Greater London	6,462	6,449	495	<100
North East England	243,550	36,193	166,456	38,099
North West England	162,288	3,030	109,226	43,867
South East England	419,617	27,935	323,076	67,030
South West England	478,220	22,552	296,022	150,623
West Midlands	97,797	15,554	52,687	26,596
Yorkshire & the Humber	251,688	61,461	145,881	41,459

Table A9. Estimated number of homes that cannot receive both standard broadband and 3G mobile

	All	Urban	Semi-urban	Rural
UK	48,894	0	819	48,030
England	8,081	0	<100	7,989
Northern Ireland	26,629	0	727	25,857
Scotland	8,545	0	0	8,545
Wales	5,639	0	0	5,639
East Midlands	266	0	0	266
East of England	1,027	0	<100	954
Greater London	0	0	0	0
North East England	525	0	0	525
North West England	792	0	<100	784
South East England	155	0	0	155
South West England	2,733	0	<100	2,722
West Midlands	1,138	0	0	1,138
Yorkshire & the Humber	1,445	0	0	1,445

Comparisons between administrative areas

A1.4 This analysis took the availability of communications services reported by NUTS region in section 3 and compared them against the mean availability for those locations. In the tables that follow, results are colour-coded green if they are at least one standard deviation above (i.e. better than) the mean and red if they are at least one standard deviation below (i.e. worse than) the mean. The choice of one standard deviation for this purpose is arbitrary. (About 32% of data normally distributed around the mean would fall at least one standard deviation away. Only about 5% would fall at least two standard deviations away. Less than 0.3% would fall more than three standard deviations away.)

A1.5 Table A10 shows differences from the mean in standard deviations (σ) for all data.

Table A10. Differences from the mean for all data (σ)

	Standard broadband	Superfast broadband	2G mobile (premises)	3G mobile (premises)	2G (landmass)	3G (landmass)	DTT (3MUX)	DTT (6MUX)	DAB (BBC) (HH)	DAB (COM) (HH)	DAB (BB) (roads)	DAB (COM) (roads)
Northern Ireland	-2.53	+1.79	-2.32	-3.04	-0.11	-1.85	-0.76	-1.59	-1.88	-0.98	-0.93	+0.24
Scotland	+0.26	-1.27	-1.04	-0.41	-2.44	-2.01	+0.57	-0.21	-0.52	-0.80	-1.59	-1.68
Wales	-0.94	-1.77	-1.04	-0.23	-0.82	-0.40	-0.45	-1.94	-1.64	-2.14	-1.71	-1.97
East Midlands	-0.02	-0.04	+0.49	+0.47	+0.78	+0.77	+1.49	+0.55	+0.66	+0.70	+0.06	+0.22
East of England	-0.20	+0.05	+0.49	+0.41	+0.82	+0.75	-1.37	-0.19	-0.30	+0.25	-0.35	-0.03
Greater London	+1.64	+1.28	+1.00	+0.50	+0.93	+0.84	+0.47	+1.14	+1.42	+1.33	+1.63	+1.54
North East England	+0.19	+0.22	-0.02	+0.32	-0.96	-0.44	+0.57	+0.76	+0.01	-0.50	+0.03	-0.55
North West England	+0.62	+0.33	+0.74	+0.44	-0.04	+0.27	-0.76	+0.66	+0.82	+0.89	+0.64	+0.65
South East England	+0.40	+0.19	+0.74	+0.50	+0.81	+0.80	+0.57	-0.35	+0.28	+0.34	+0.92	+0.71
South West England	+0.05	-0.98	-0.28	+0.26	+0.48	+0.50	-0.45	-0.58	-0.30	-0.46	+0.20	-0.16
West Midlands	+0.55	+0.46	+0.74	+0.41	+0.64	+0.60	+1.49	+0.99	+0.91	+0.99	+0.43	+0.64
Yorkshire & the Humber	-0.02	-0.26	+0.49	+0.38	-0.09	+0.18	-1.37	+0.75	+0.53	+0.38	+0.67	+0.39

A1.6 Table A11 shows differences from the mean in standard deviations for Urban data.

Table A11. Differences from the mean for Urban data (σ)

	Standard broadband	Superfast broadband	2G mobile (premises)	3G mobile (premises)	DTT (3MUX)	DTT (6MUX)	DAB (BBC) (HH)	DAB (COM) (HH)
Northern Ireland	-1.72	+1.40	-2.35	-3.03	+0.68	+0.41	+0.89	N/A
Scotland	+0.28	-1.66	-0.83	-0.55	+0.68	+0.52	-2.46	-1.51
Wales	-1.32	+0.43	-0.06	+0.05	+0.31	+0.46	+0.16	+0.70
East Midlands	+0.78	+0.83	+0.70	+0.45	+0.12	-0.11	+0.66	+0.55
East of England	-0.12	+0.89	-0.06	+0.35	-2.09	-1.73	-0.84	-0.07
Greater London	+1.59	+0.17	+1.46	+0.55	+0.31	+0.68	+0.78	+0.92
North East England	-0.32	-0.87	-0.06	+0.25	+0.31	+0.22	+0.55	-2.10
North West England	+0.38	-0.25	-0.06	+0.45	+0.68	+0.85	+0.16	+0.88
South East England	-0.62	+0.50	+0.70	+0.55	+0.68	-0.85	-1.17	+0.15
South West England	+0.78	+0.40	-0.83	+0.15	+0.31	-2.03	+0.66	+0.30
West Midlands	+1.08	-0.01	+0.70	+0.45	+0.12	+0.74	+0.11	+0.70
Yorkshire & the Humber	-0.82	-1.83	+0.70	+0.35	-2.09	+0.85	+0.50	-0.53

A1.7 Table A12 shows differences from the mean in standard deviations for Semi-urban data.

Table A12. Differences from the mean for Semi-urban data (σ)

	Standard broadband	Superfast broadband	2G mobile (premises)	3G mobile (premises)	DTT (3MUX)	DTT (6MUX)	DAB (BBC) (HH)	DAB (COM) (HH)
Northern Ireland	-1.08	+1.49	-2.56	-3.12	-0.06	-1.69	-1.55	N/A
Scotland	-0.14	-1.12	-0.55	-0.13	+0.84	-0.05	+0.44	-0.44
Wales	-1.39	-1.90	-0.75	-0.05	+0.48	-1.85	-0.71	-2.54
East Midlands	+0.33	-0.02	+0.65	+0.42	+0.84	+0.56	+0.67	+0.69
East of England	-0.06	+0.28	+0.45	+0.36	-1.95	-0.27	-0.21	+0.27
Greater London	+2.37	+1.38	+1.06	+0.46	-0.06	+1.20	-2.11	+0.37
North East England	-0.69	+0.28	-0.35	+0.26	-0.24	+0.82	+0.42	-0.29
North West England	+0.25	+0.26	+0.65	+0.36	-0.06	+0.65	+1.02	+0.97
South East England	+0.49	+0.35	+0.85	+0.46	+0.84	-0.54	+0.40	+0.28
South West England	+0.72	-1.22	-0.35	+0.26	+0.48	-0.44	-0.11	-0.70
West Midlands	+0.10	+0.36	+0.45	+0.34	+0.84	+0.95	+1.06	+0.95
Yorkshire & the Humber	-0.92	-0.12	+0.45	+0.36	-1.95	+0.65	+0.67	+0.43

A1.8 Table A13 shows differences from the mean in standard deviations for Rural data.

Table A13. Differences from the mean for Rural data (σ)

	Standard broadband	Superfast broadband	2G mobile (premises)	3G mobile (premises)	DTT (3MUX)	DTT (6MUX)	DAB (BBC) (HH)	DAB (COM) (HH)
Northern Ireland	-2.42	+2.67	-1.74	-2.90	-0.65	-1.34	-1.04	N/A
Scotland	+1.13	-0.82	-1.62	-0.76	-0.50	-0.96	-0.89	-1.38
Wales	-0.50	-0.80	-1.36	-0.36	-1.28	-2.08	-1.77	-1.80
East Midlands	-0.66	-0.35	+0.79	+0.54	+1.69	+0.67	+1.01	0.74
East of England	-0.13	-0.50	+0.54	+0.48	+0.25	+0.53	+0.45	0.35
Greater London	+1.41	+1.30	+1.05	+0.58	+0.29	+1.31	+1.23	1.37
North East England	+0.14	-0.12	+0.16	+0.30	+0.68	+0.48	-1.18	-0.91
North West England	-0.13	-0.34	+0.54	+0.41	-0.65	-0.10	+0.28	0.20
South East England	+1.02	-0.04	+0.92	+0.58	-0.50	+0.50	+1.01	0.71
South West England	+0.31	-0.42	+0.16	+0.35	-1.28	-0.32	-0.09	-0.43
West Midlands	-0.02	-0.31	+0.54	+0.45	+1.69	+0.84	+0.87	0.79
Yorkshire & the Humber	-0.15	-0.26	+0.03	+0.33	+0.25	+0.47	+0.13	0.36

Regression analysis of the determinants of 3G mobile coverage

Data

A1.9 Our dataset was assembled from a number of sources. Detailed data were collected from MNOs on predicted outdoor 3G coverage in 2012. We used these data to construct a dataset of mobile phone signal strength across the UK in 200×200m pixels. To construct our measure of coverage, we matched these data to a database of postcodes. An MNO was classified as having good coverage if its 3G signal strength exceeded -100 dBm (CPICH97). The number of operators with good signal in the postcode was calculated by matching the nearest coverage pixel to the coordinates of the centre of the postcode in question.

A1.10 A database of population and demographic data at postcode level was constructed from census data by Europa Technologies. This dataset also included information on the rurality of the area based on UK Geographics' LOCALE classifications.

A1.11 Finally, topographic information was derived using Ordinance Survey Landform Panorama data. These were used to construct a database showing the average height of 200×200m pixels. This database was then used to obtain summary statistics that describe the topography of postcode sectors (for example, the median pixel height and variance of pixel heights in individual postcode sectors).

A1.12 There are in excess of 1.7m postcodes in the UK. The median postcode has a population of 31 and covers an area of 8,000m^2. The coverage of a typical mobile telephone cell varies, although a typical transmitter has a range of up to 10km. The majority of mobile cells are therefore likely to cover an area considerably larger than an individual postcode. As a result, we measured demand and cost drivers (i.e. population and demographic variables and the topographic information) using a larger geographic unit, the postcode sector. The median postcode sector has a population of 7,200 and covers an area of around 5.5km^2.

A1.13 Table A14 provides a list of the key variables used in our analysis.

Table A14. Descriptions of key variables

Variable name	Remarks
num_3G_ops	The number of operators with good coverage at the postcode's centre point. This variable can take the value 0, 1, 2, 3 or 4
ln_sect_pop1	The postcode sector's population measured in natural logarithms
sect_area_km2	The postcode sector's area measured in square kilometres
sect_percent_abc1	The percentage of the postcode sector's population that reside in a household classified in socioeconomic groups A, B or C1
sect_percent_0_24	The percentage of the postcode sector's population aged 24 or under
sect_percent_over60	The percentage of the postcode sector's population aged 60 or over
median_height	The median height above sea level, in metres, of the pixels in the postcode sector
std_de_height	The standard deviation of the heights of pixels in the postcode sector
urban_code	A categorical variable that identifies the postcode as Urban, Semi-urban or Rural
Region	A categorical variable that identifies the postcode's location as situated in an English region or Northern Ireland, Scotland or Wales

A1.14 Table A15 provides some summary statistics for the continuous variables we used in our analysis.

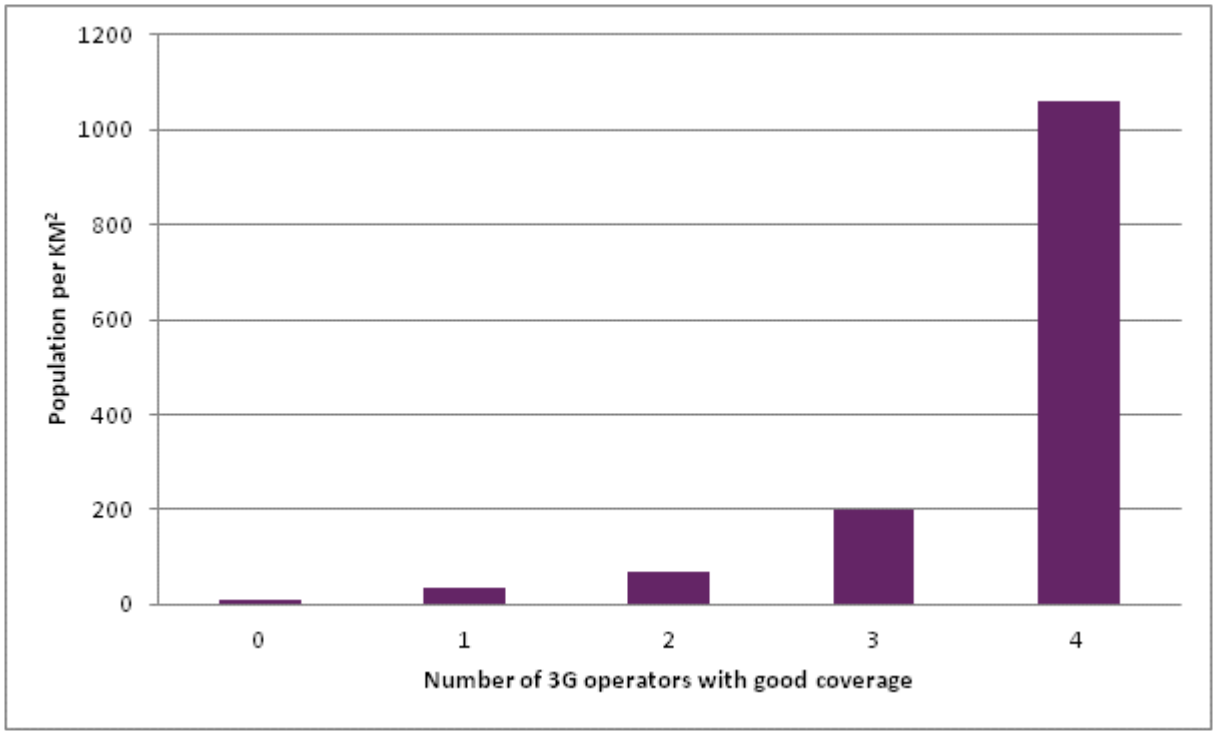
Table A15. Summary statistics

Variable name	Minimum	25th percentile	Median	Mean	75th percentile	Maximum
num_3G_ops	0	3	4	3.48	4	4
sect_population	0	4,986	7,207	7,363	9,501	23,024
sect_area_KM2	0.00	2.35	5.51	27.51	27.61	3,426.59
sect_percent_abc1	0.0%	42.3%	51.5%	51.7%	60.7%	100.0%
sect_percent_0_24	0.0%	27.5%	29.9%	30.7%	32.9%	100.0%
sect_percent_over60	0.0%	17.6%	21.1%	21.1%	24.3%	67.8%
median_height	-0.06	22.94	55.97	72.47	99.98	598.96
std_de_height	0.00	14.59	26.10	34.41	44.34	297.33

A1.15 As can be seen, in the majority of postcodes, all four MNOs have good coverage. 71% of the postcodes in the sample have a num_3G_ops value of 4, whereas 11% have a value of 3, 14% two and 3% only one. Areas in which no mobile operator has adequate coverage are referred to as not-spots; only 2% of postcodes are in this category.

A1.16 Figure A1 shows postcodes with good coverage are typically in more densely populated areas.

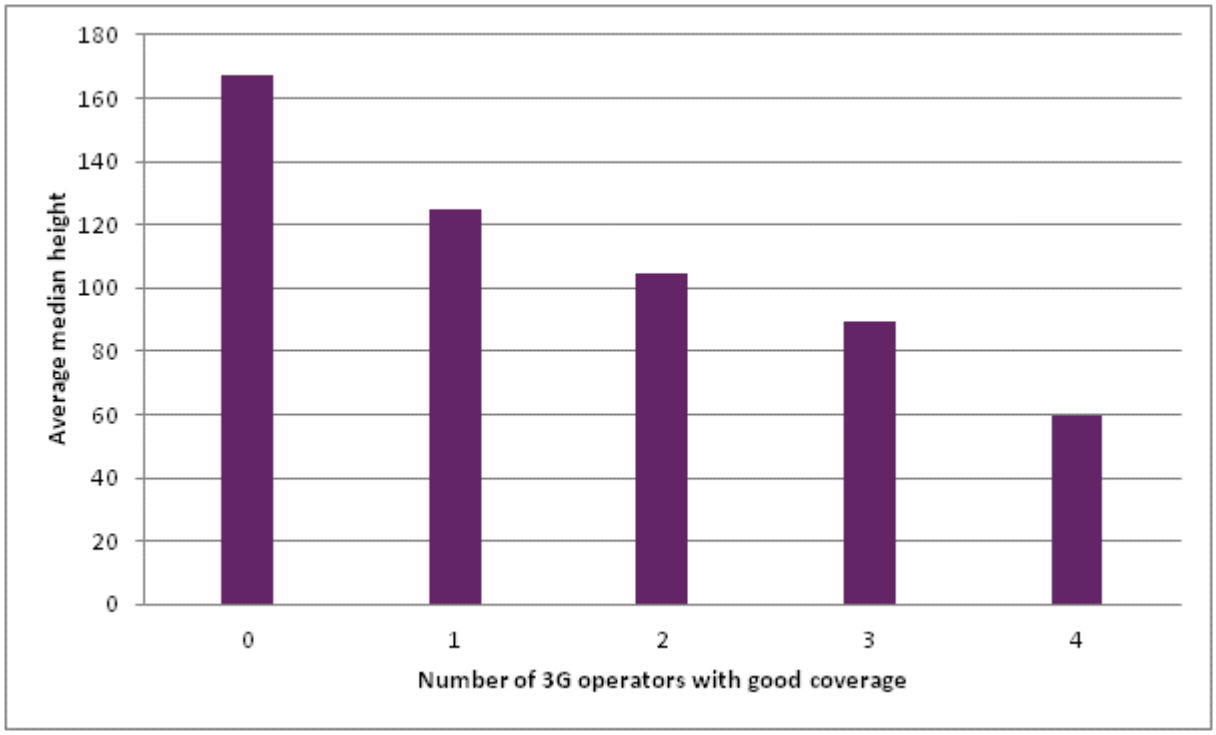
Figure A1. Weighted average population density by number of 3G MNOs



A1.17 In terms of topography, poor coverage would appear more likely in more mountainous areas of the UK. Figure A2 illustrates this by showing the average

height above sea level of postcodes by the number of operators with good coverage.

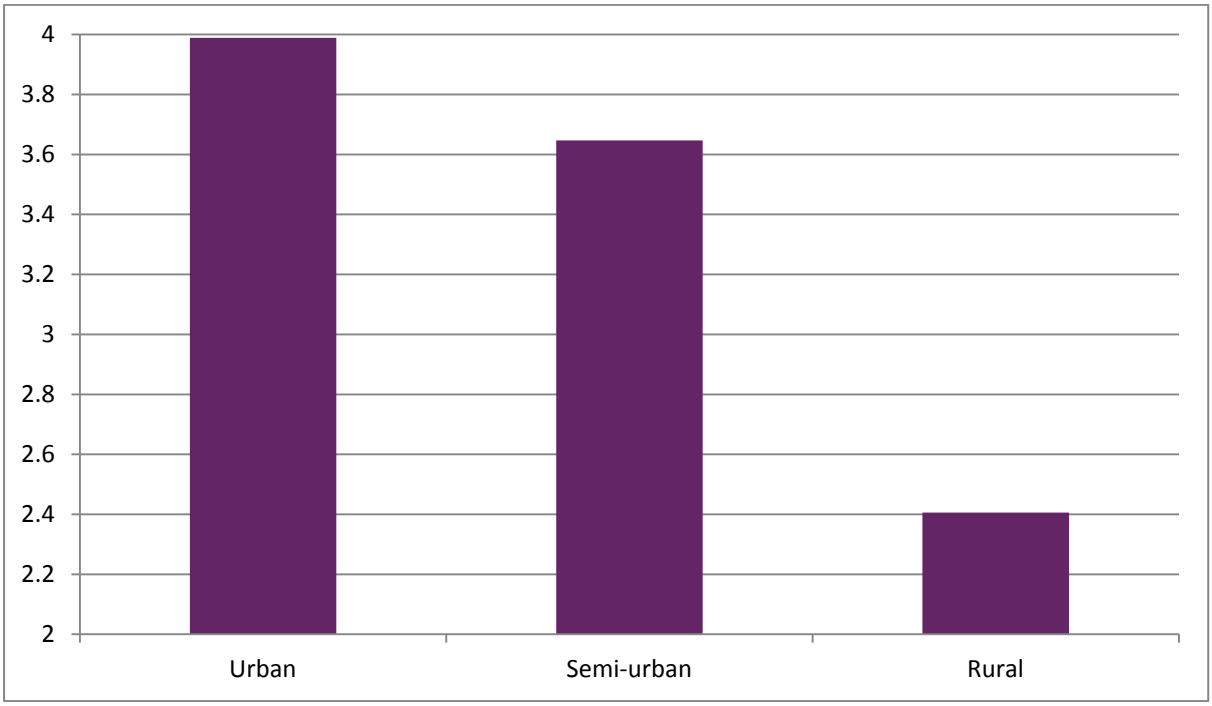
Figure A2. Average median height of postcode sectors by number of 3G MNOs



A1.18 As is readily apparent, areas with poor coverage tend to be located in areas that have a greater height above sea level.

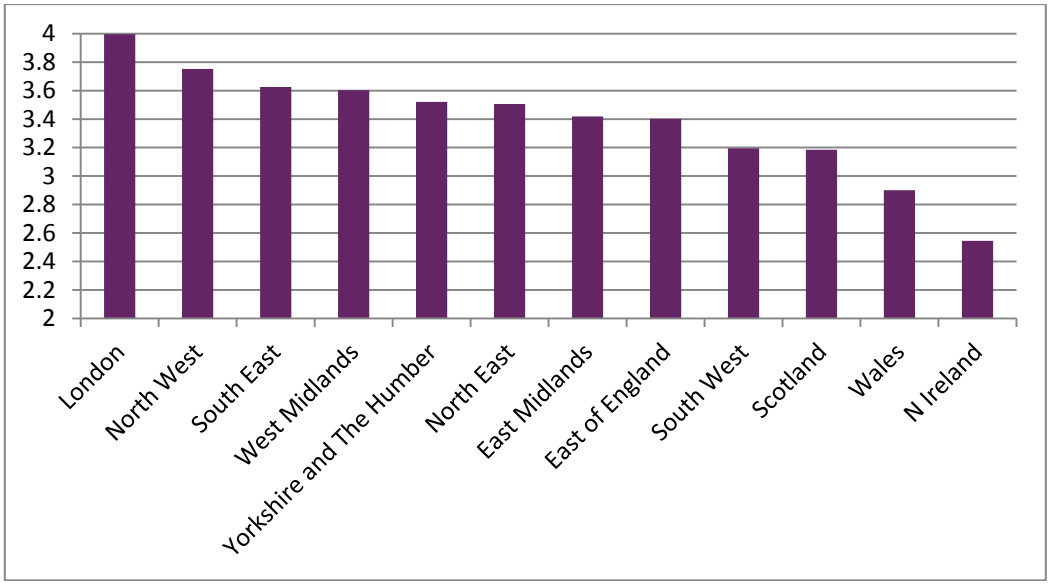
A1.19 Finally, rurality and a postcode's location appear to have an influence on the number of operators. Figure A3 shows the average number of operators with good coverage is higher in Urban postcodes and considerably lower in Rural postcodes.

Figure A3. Average number of 3G MNOs with good coverage by rurality



A1.20 Figure A4 shows the average number of 3G operators with good coverage by location.

Figure A4. Average number of 3G MNOs with good coverage by location

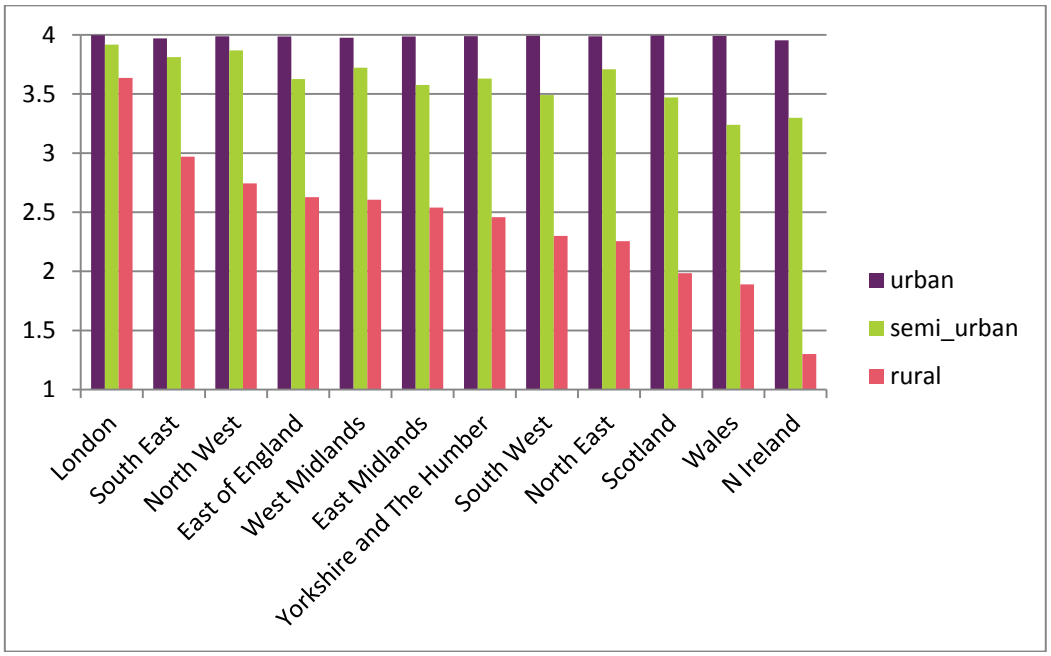


A1.21 Nearly all postcodes in London have good 3G coverage by all four MNOs. The South West of England, Scotland, Wales and Northern Ireland all exhibit lower averages, indicating 3G mobile coverage in these areas is less extensive.

A1.22 While there are large differences in coverage between locations in the UK, these are much less marked between Urban areas. Figure A5 shows the average number of 3G operators for each location split by rurality. Coverage in Urban areas in all

locations is very good. Urban postcodes perform very well regardless of their location. The clearest differences between locations are in Rural postcodes.

Figure A5. Average number of 3G MNOs with good coverage by location and rurality



Methodology

A1.23 To further our understanding of the factors driving the availability of 3G mobile services across the UK, we undertook multiple regression analysis. Simple averages typically contain a number of effects. For example, there are differences in the average number of 3G operators with good overage between locations, but there are also differences in terms of population density, population composition, topology and rurality. This makes it difficult to draw firm conclusions. Regression analysis has the advantage of enabling us to analyse the impact of each of the various factors affecting coverage while holding other factors constant.

A1.24 We had two primary aims in undertaking this analysis:

- to assess whether and to what extent possible explanatory factors (for example, the characteristics of the local population and the topography of the local terrain) have an effect on the likelihood of 3G mobile coverage; and

- to assess the extent to which regional differences in 3G mobile coverage (as illustrated in figure A5) can be explained by these factors.

A1.25 We used an ordered probit modelling technique to perform our analysis. This technique is designed to be used when the dependent variable is a categorical variable and the ordering of the categories carries some meaning. This is precisely the case with our dependent variable num_ops, which can take the values 0, 1, 2, 3 or 4 depending on the number of operators with good coverage and where a larger number of operators implies better coverage. A similar technique, the ordered logit model that uses slightly different assumptions, is also possible. We do not report the results here for reasons of brevity, but this alternative technique produced similar results.

A1.26 The variables we used in our analysis are summarised in tables A1 and A2. The model predicts the probability the postcode will have 0, 1, 2, 3 or 4 operators with good 3G coverage based on the explanatory variables listed above. These variables fall broadly into three categories:

- demand factors. Variables that describe the size of the local population as well as factors that describe the makeup of the local population in terms of age and affluence are likely to influence demand for 3G mobile services;
- cost factors. Local variations in the costs of providing 3G mobile services are likely to be driven in large part by the density of the local population and the characteristics of the local terrain (see section 5); and
- location-specific fixed effects. These variables capture unobserved variations in demand and costs specific to a particular location. For example, the indicator for Scotland will pick up any effects specific to Scotland but not accounted for elsewhere in the model, so it will not include population or topography but will pick up the net effect of other specific factors like Scottish planning laws.

A1.27 Finally, some care must be taken when assessing the statistical significance of our results because of the way in which we constructed some variables. We observe coverage at a postcode level, but the explanatory variables that measure local population and topography are measured at the level of the postcode sector. There are more than 1.6m postcodes in our dataset but only 9,488 unique postcode sectors. For this reason, we use clustered standard errors where clusters are defined by postcode sectors.

Results

A1.28 We ran a series of models, each with a slightly different set of explanatory variables. The models were constructed as shown in table A16.

Table A16. Description of regression-model specifications

Model	Description
Base	This model is included as a comparator. The only explanatory variables in this model are the location identifiers. As such, this exercise is very similar to the simple chart of averages in figure A4
1	This model includes the variables that describe the density and composition of the local population in addition to location
2	This model includes the variables that describe the local topography in addition to location
3	This model includes both the rurality code and the location categorical variables
4	This model includes the variables that describe the local population and topography but does not include the categorical variable urban_code
5	This model includes all the explanatory variables we believe have an influence on 3G mobile coverage

A1.29 The results of our analysis are provided in table A17.

Table A17: results of regression analyses

Model	Base	1	2	3	4	5
No. observations (postcodes)	1,684,413	1,676,362	1,684,413	1,679,962	1,676,362	1,671,950
Prob > chi^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.0767	0.2191	0.1168	0.2748	0.2307	0.3328
Dependent variable: num_3G_ops						
Explanatory variable	**Coefficient**					
ln_sect_pop1		0.475†			0.477†	0.358†
sect_area_km2		-0.007†			-0.006†	-0.004†
sect_percent_abc1		0.028			0.039	0.664†
sect_percent_0_24		4.560†			4.266†	1.446†
sect_percent_over60		-0.990†			-1.513†	-2.626†
median_height			-0.004†		-0.003†	-0.002†
std_dev_height			-0.004†		0.001	-0.001*
urban_code	**Coefficient**					
Semi-urban				1.448†		1.126†
Urban				2.974†		2.544†
Region	**Coefficient**					
East of England	-0.011	0.017	-0.176†	0.112†	-0.077†	-0.008
Greater London	2.306†	2.484†	2.159†	0.643†	2.306†	0.483†
Northern Ireland	-0.832†	-1.089†	-0.783†	-0.772†	-1.154†	-0.976†
North East England	0.155†	0.201†	0.222†	0.090	0.240†	0.235†
North West England	0.606†	0.674†	0.716†	0.545†	0.689†	0.663†
Scotland	-0.229†	0.221†	-0.017	-0.276†	0.234†	0.136†
South East England	0.315†	0.324†	0.251†	0.485†	0.284†	0.380†
South West England	-0.242†	-0.072	-0.207†	-0.143†	-0.076†	-0.009
Wales	-0.538†	-0.419†	-0.198†	-0.516†	-0.294†	-0.210†
West Midlands	0.294†	0.250†	0.501†	0.169†	0.354†	0.243†
Yorkshire & the Humber	0.157†	0.160†	0.284†	0.034	0.200†	0.133†

Notes: * Statistically significant at the 10% level. † Statistically significant at the 5% level.

A1.30 Table A17 displays the coefficients for each model estimated. The results of models of this type require careful interpretation. The model uses the data to fit a model that predicts a "latent variable." This is a variable that can be thought of, broadly, as a "score" giving the "favourableness" of the location. The higher this value, the more likely it is the location has a higher number of operators with good coverage. The model then fits a series of "cut-offs" that determine how that "score" translates to the probability of each category (0, 1, 2, 3 or 4 operators with good 3G coverage). The coefficients therefore give us an indication of the direction of the effect of each

explanatory variable, but for the magnitude of the effects, we must perform some further calculations.

A1.31 We have an extremely large number of observations (nearly 1.7m) within our data. As a consequence, it is perhaps unsurprising the models perform relatively well from a statistical perspective. The explanatory variables of interest are all statistically significant in each specification, and the qualitative results appear relatively robust across specifications.

- Population density: the variable ln_sect_pop1 describes the population in the postcode sector, and the variable sect_area_km2 describes the land area of the postcode sector. Together, these variables describe the population density of the location. These variables appear in models 1, 4 and 5. In all these models, the coefficient is positive for ln_sect_pop1 and negative for sect_area_km2. This indicates increased local population density has a positive effect on the likelihood a postcode will exhibit good 3G mobile coverage.

- Composition of population: the variables sect_percent_abc1, sect_percent_0_24 and sect_percent_over60 describe the affluence and age profile of the local population. These variables also appear in models 1, 4 and 5. Again, the qualitative results are consistent as, in all three models, a more affluent local population will have a positive influence on 3G coverage, as will a younger population, while an older population will have a negative effect on coverage. However, the magnitudes of the effects are less clear. It appears the affluence of the local population is larger in model 5 than in models 1 and 4. In models 1 and 4, it appears the youthfulness of the local population has the greater impact, but this is reversed in model 5, where the proportion of the population aged 60 or over has the greater effect. So, while the qualitative results appear robust, the magnitude of the effects of population composition appears sensitive to the model chosen and should be interpreted with some care.

- Topography: the variables median_height and std_dev_height measure the height of the postcode above sea level and the variability in the height in the postcode sector respectively. Increasing the height and variability of height appears to have a negative influence on coverage. With regards to height, the qualitative results are consistent, with the coefficients negative and statistically significant in models 2, 4 and 5. The picture is less clear with the variability in height, where the coefficient in model 4 is positive.

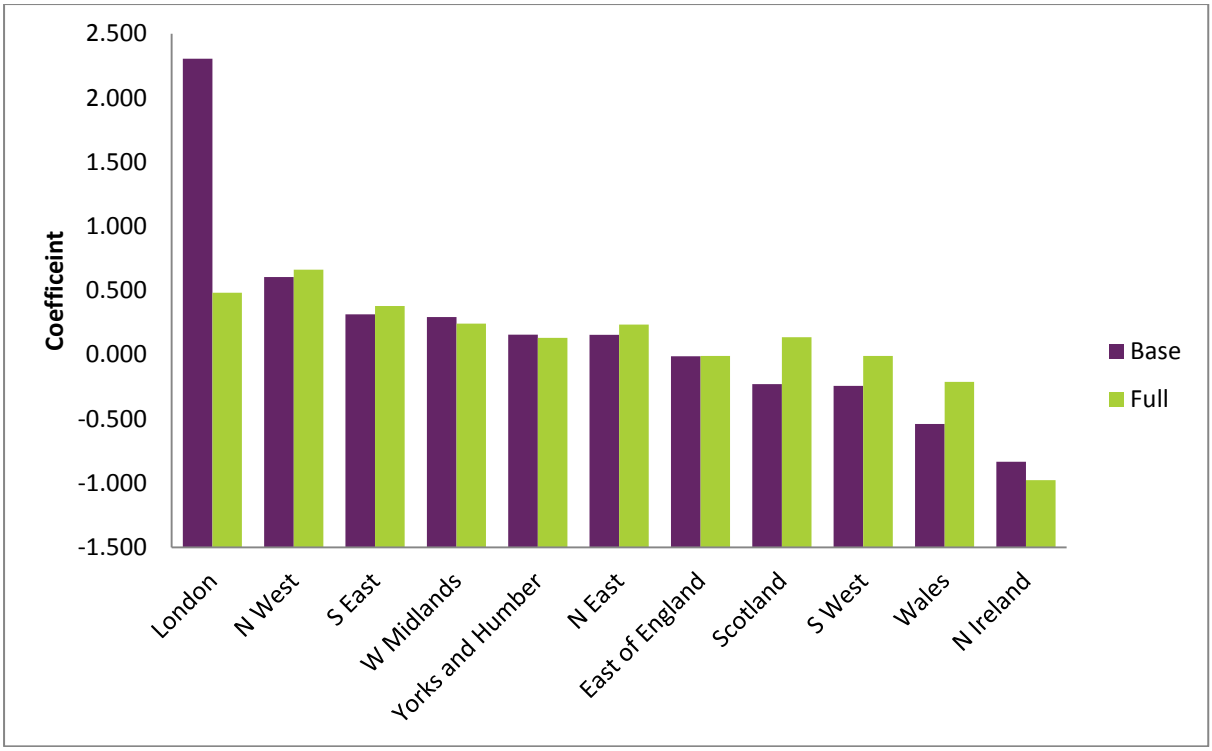
- Rurality: the variable urban_code identifies whether the postcode is situated in an Urban, Semi-urban or Rural location. The coefficients show the effect of being in the Urban or Semi-urban categories relative to the comparator category (Rural). The coefficients are of a similar magnitude and statistically significant in both models (3 and 5). The results indicate there will be a higher likelihood of good 3G mobile coverage in Semi-urban compared to Rural locations and higher still in Urban locations.

A1.32 The variable region is a categorical variable that identifies the location in which the postcode is situated. The coefficients for these variables show the effect of being in the particular location of interest relative to the comparator region (in this case, the East Midlands). The base model includes no other variables apart from the location identifier. As a result, this can be thought of as an exercise similar to plotting the simple chart of averages in figure A4. In this model, we did not control for differences between locations in terms of population density, population composition, topography or rurality. Models 1-5 include additional variables, with

model 5 (the "full" model) including all the explanatory factors we believe affect coverage.

A1.33 We see an interesting progression in the coefficients as we move from the base model to the full model. As more explanatory variables are added to the model, the values of the coefficients for the majority of locations converge. This is illustrated in figure A6, which compares the base model with the full model.

Figure A6. Comparison of effects between base model and full model relative to the East Midlands



A1.34 Once population density, the composition of the population, topography and rurality are taken into account, the differences between locations appear to reduce markedly. Greater London is densely populated and consists almost entirely of Urban postcodes. Once these factors are taken into account, its coefficient reduces markedly. The coefficients for Scotland, the South West of England and Wales improve markedly, indicating much of the poor coverage in these locations can be attributed to their low population density, challenging topography and high proportion of Rural postcodes. However, the coefficient for Northern Ireland remains persistently low, indicating there are factors other than population, topography and rurality that affect coverage here.[132]

A1.35 While our analysis appears to give consistent qualitative results, assessing the magnitude of the effects is more difficult, first because of the nature of the regression technique we have chosen and second because of the nature of the data.

[132] A test for the joint significance of the region coefficients reports they are jointly significant in both the base model and the full model. However, the test score falls markedly (from 2,063.62 in the base model to 582.83 in the full model), which indicates the reduced influence of the region indicators as more explanatory variables are added to the model.

A1.36 The coefficients returned by ordered probit technique show the effects of the explanatory variables on a latent variable, which in turn affects the predicted probabilities for each category of the dependent variable num_3G_ops. Some further calculations must be carried out before we can interpret the effects on the probability of a particular outcome (for example, the probability of good coverage by all four MNOs or of a not-spot). We show these calculations further below.

A1.37 Many of the explanatory variables in our data are correlated, which can make it difficult to pin down precisely the magnitude of the effects. This problem is called multicolinearity. Multicollinearity does not reduce the predictive power or reliability of the model as a whole, at least within the sample data themselves. It only affects calculations regarding individual explanatory variables. The correlation between explanatory variables in our sample is illustrated in table A18.

Table A18. Correlation between rurality and other explanatory variables

urban_code	Population	Area (km^2)	ABC1 (%)	0-24 (%)	60+ (%)	Median height (m)	Standard deviation of height (m)
rural	5,402	81.9	54.0	28.5	22.7	100.1	44.5
semi_urban	7,791	17.9	50.4	30.1	22.1	72.4	32.8
urban	8,116	3.0	52.2	33.3	18.3	52.3	29.5

A1.38 Table A18 shows Urban areas typically exhibit a larger, denser, younger population and are more commonly found in lower-lying areas with less-challenging topography. As a result, it can be difficult to disentangle the separate effects of these factors and rurality. This is readily apparent if we compare the results of models 4 and 5 in table A17. The coefficients for population, the land area of the postcode sector, the proportion of the population aged 24 or under and the median height are all larger in model 4 (which omits urban_code) than in model 5 (which includes all the explanatory variables). This indicates the magnitude of the effects for these explanatory variables may, in practice, be higher than is reported in model 5.

A1.39 In addition, some care must be taken when interpreting the coefficient for Greater London. Table A19 shows nearly all postcodes in Greater London are classified as Urban. As a result, there is very little independent variation to allow us to distinguish the differences between the effect of being in an Urban location and the specific effect of being located in Greater London.

Table A19. Urban, Semi-urban and Rural postcodes by location

Location	Urban	Semi-urban	Rural
Northern Ireland	15.7%	41.5%	42.9%
Scotland	22.1%	50.9%	27.0%
Wales	14.8%	51.7%	33.4%
East Midlands	20.3%	56.5%	23.2%
East of England	17.5%	53.7%	28.8%
Greater London	99.7%	0.1%	0.1%
North East England	17.0%	65.7%	17.2%
North West England	22.5%	64.8%	12.7%
South East England	14.6%	60.6%	24.9%
South West England	21.0%	45.3%	33.8%
West Midlands	41.0%	39.1%	20.0%
Yorkshire & the Humber	28.9%	53.0%	18.2%
All regions	29.8%	48.3%	21.9%

Marginal effects

A1.40 Our calculations of the marginal effects of individual explanatory variables are based on model 5 in table A17. As discussed above, it is likely our results suffer to some extent from multicolinearity, so these results must be interpreted with some care as the magnitude of the effects may be imprecisely estimated.

A1.41 Table A20 shows the effects of the continuous explanatory variables as estimated in model 5. These were constructed by estimating the probability a particular postcode will exhibit good 3G coverage by all four MNOs (in other words, a num_3G_ops value of 4) under a range of scenarios.

Table A20. Marginal effects of continuous explanatory variables in model 5

	Probability num_3G_ops = 4		
	Low value	High value	Difference
Population	79.9%	85.7%	5.9%
0-24	81.1%	83.2%	2.1%
60+	84.6%	80.1%	-4.5%
ABC1	80.7%	83.8%	3.1%
Height	85.2%	80.6%	-4.6%
Standard deviation of height	83.0%	82.0%	-1.0%

A1.42 In each scenario, we varied the explanatory variable within the interquartile range for that variable in our sample. The low value corresponds to the 25th percentile and the high value to the 75th percentile. This gives us a consistent basis on which to compare the magnitude of the effects of each variable. The values of all the other variables are held at their sample mean. This is sometimes referred to as the "margins at means" approach.

A1.43 To give an example, the 0-24 row of table A20 reports the effect of the youthfulness of the population on the probability of full 3G coverage. In our sample of postcodes,

the 25th percentile for the proportion of the population aged 24 or under is 27.5% and the 75th percentile is 32.9%. In the low-value scenario, the value of percent_0_24 is set at 27.5% and all the other explanatory variables are set to their sample means. This can be thought of as an "average" postcode with a below-average proportion of young population. This is straightforward for continuous variables such as population (the sample average population) and height (the sample average median height) but a little more difficult to envisage with categorical variables such as urban_code. In the sample as a whole, 22% of postcodes are classified as Rural, 49% as Semi-urban and 29% as Urban. The "average" postcode for the purpose of this exercise is therefore part Rural, part Semi-urban and part Urban. The same logic applies to location: 9% of postcodes in our sample are located in Scotland, so the average postcode is 9% Scottish. The table reports the probability a postcode will receive full coverage when the proportion of the population that is young is set at 27.5% (low) or 32.9% (high) respectively but all the other explanatory variables are set at their sample means. In this case, the probability of full coverage is 81.1% when the proportion of the population aged 24 or under is low, and this rises by 2.1 percentage points to 83.2% when the proportion of the population that is young is high.

A1.44 As table A20 shows, population has the greatest effect on the likelihood of there being four 3G operators with good coverage. A postcode at the 75th percentile for population has a 5.9 percentage-point higher probability of good coverage than a postcode at the 25th percentile for population. Table A21 shows the predicted probability of full coverage as the population of the postcode sector increases in increments of 1,000.

Table A21. Effect of population on predicted probability of four 3G MNOs with good coverage

Population	Probability num_3G_ops = 4	Difference (percentage points)
5,000	79.9%	
6,000	81.7%	1.8
7,000	83.1%	1.4
8,000	84.3%	1.2
9,000	85.3%	1.0
10,000	86.1%	0.9

A1.45 An additional 1,000 residents within the postcode sector results in a 0.9-1.8 percentage-points increase in the likelihood of full coverage.

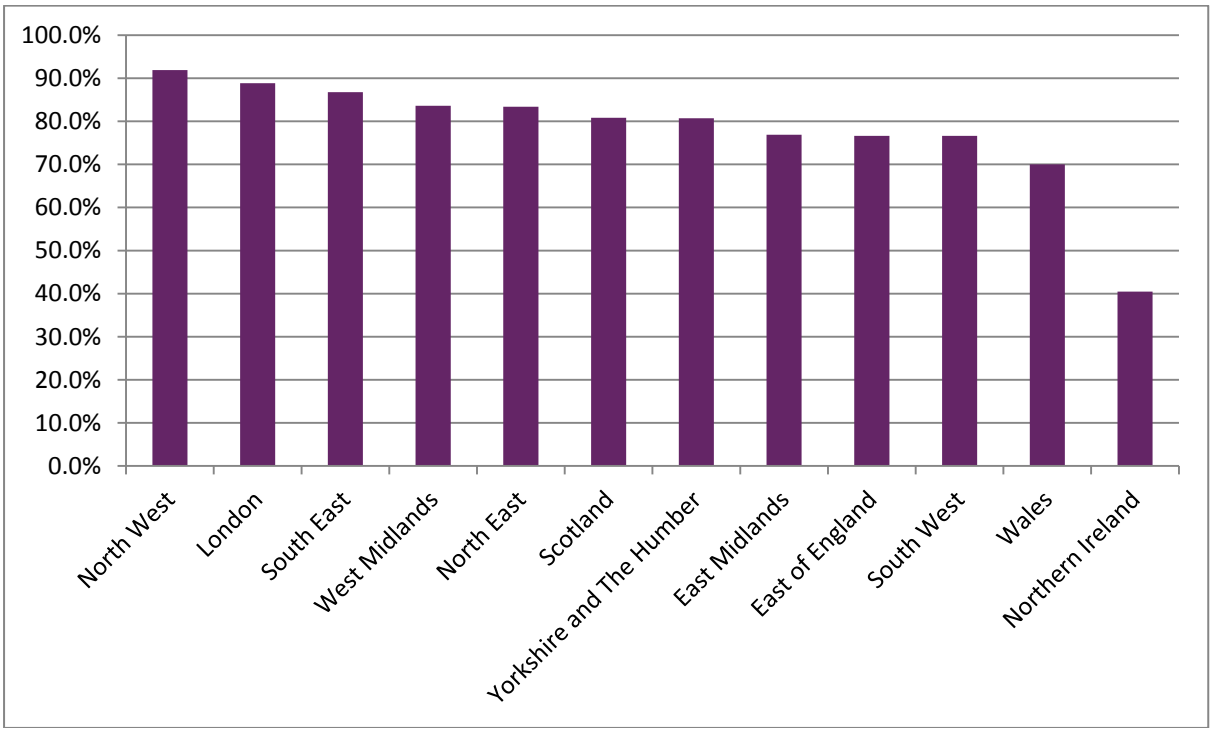
A1.46 Table A22 shows the effect of rurality on the probability of full coverage. The table shows a postcode classified as Urban but in all other respects "average" has a very high likelihood (more than 98%) of full coverage. The same postcode classified as Rural, however, would have only a 36% probability of full coverage. Model 5 therefore predicts rurality will have a powerful effect on the probability of good 3G mobile coverage (although, as discussed elsewhere, this may reflect the influence of some of the other explanatory variables).

Table A22. Effect of rurality on predicted probability of full coverage

urban_code	Probability num_3G_ops = 4
Urban	98.5%
Semi-urban	77.6%
Rural	35.6%

A1.47 The model also predicts a postcode's location can have a powerful effect on the probability of full coverage. Figure A7 shows the predicted probabilities of full coverage for an "average" postcode by location.

Figure A7. Effect of location on predicted probability of full coverage



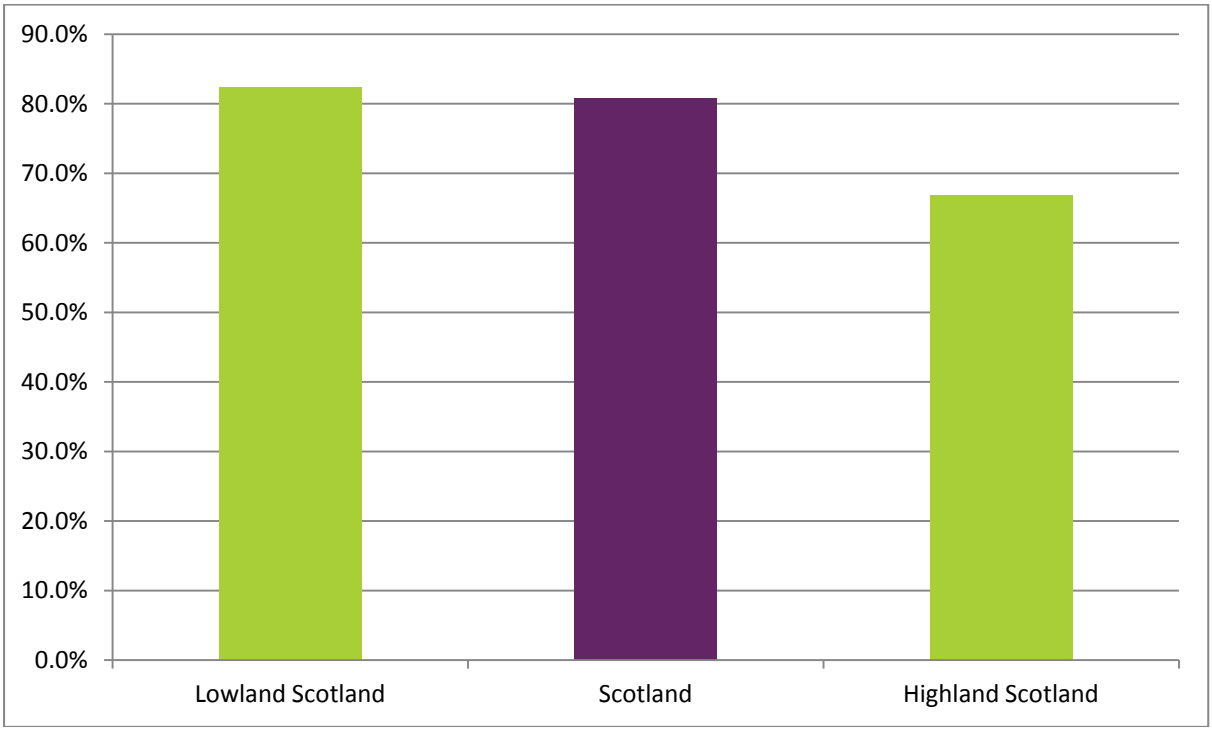
A1.48 All but one of the categories of the location variable exhibit predicted probabilities of 70% or more. The one exception is Northern Ireland, which exhibits a predicted probability of 40.5%.

Highlands and Islands

A1.49 It is often stated there are significant differences between the Highlands and Islands and other parts of Scotland because of their much lower population density and more challenging topography. The Highlands and Islands are also a part of the UK than can be described as predominantly remote (albeit by no means uniquely).

A1.50 We therefore undertook a further iteration of our model to disaggregate Scotland into "Highland" and "Lowland" areas. We classified postcodes within the local-authority areas of Argyll and Bute, Eilean Siar, Highland, Moray, the Orkney Islands and the Shetland Islands as "Highland" areas and the remaining postcodes within Scotland as "Lowland." We then repeated the analysis described as model 5 in tables A3 and A4 with a revised list of 13 locations (i.e. with Scotland divided into two separate categories). The results of this analysis are presented in figure A8.

Figure A8. Predicted probability of four 3G MNOs with good coverage by for an average postcode in "Highland" and "Lowland" Scotland



A1.51 Figure 8 shows there is a significantly lower probability of good coverage by all four 3G MNOs in "Highland" Scotland compared to the rest of the nation.[133] Indeed, in the ranking of locations in figure A7, "Highland" Scotland would come just below Wales. However, the coefficient for "Highland" Scotland is only significant at the 10% level, and the predicted probability of full coverage is still relatively high, especially when compared to Northern Ireland. This implies much of the poor 3G mobile coverage of the Highlands and Islands can be explained by the other factors in our model, namely population density and composition, topography and rurality.

[133] This difference is statistically significant at the 5% level. The 95% confidence interval for our estimate for "Highland" Scotland is 55.7-78.1% and 79.9-84.8% for "Lowland" Scotland.

Annex 2

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Annex 3

Glossary of abbreviations

σ	Standard deviation
2G	Second-generation mobile services
3G	Third-generation mobile services
4G	Fourth-generation mobile services
ADSL	Asymmetric Digital Subscriber Line
AM	Amplitude modulation
BCMR	Business Connectivity Market Review
BDUK	Broadband Delivery UK
CMR	Communications Market Report
CNL	Cybermoor Network Ltd.
DAB	Digital Audio Broadcasting
dBm	Decibels relative to milliwatts
DCMS	Department for Culture, Media and Sport
Defra	Department for Environment, Food & Rural Affairs
DETI	Department of Enterprise, Trade and Investment
DH	Department of Health
DSL	Digital Subscriber Line
DSO	Digital switchover
DTT	Digital terrestrial television
ERDF	European Regional Development Fund
EU	European Union
FM	Frequency modulation
FTTC	Fibre to the cabinet
FTTP	Fibre to the premises
GHz	Gigahertz
HD	High definition

HEVC High-efficiency video coding

ICT Information and communications technology

IP Internet protocol

IPTV Internet protocol television

ISP Internet service provider

Mbit/s Megabits per second

MCP Mobile communications provider

MHz Megahertz

MIMO Multiple Input Multiple Output

MIP Mobile Infrastructure Project

MNO Mobile network operator

MTR Mobile termination rate

NBS National Broadband Scheme

NGB Next Generation Broadband

NOL Norfolk Open Link

NUTS Nomenclature of Territorial Units for Statistics

OECD Organisation for Economic Cooperation and Development

ONS Office for National Statistics

PPP Public/private partnership

PSB Public-service broadcasting

RDPE Rural Development Programme for England

SD Standard definition

SMEs Small and medium-sized enterprises

USO Universal service obligation

VDSL Very high-bit-rate Digital Subscriber Line

VOD Video on demand

WBA Wholesale broadband access

WSD White-space device