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National Infrastructure Commission Wales

Digital Communications Infrastructure in Wales

Report and recommendations of the National Infrastructure Commission for Wales

2020

Contents

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Executive Summary

1. This report presents the findings of the National Infrastructure Commission for Wales' investigation into digital communications infrastructure in Wales. Our work was undertaken between mid-2019 and mid-2020 but disrupted by the COVID-19 pandemic after March 2020. The pandemic prevented us from engaging further with stakeholders as we would have wished and means that some predictions about future demands for digital communications in Wales (and the capacity of the industry to roll out the infrastructure to meet it) are more uncertain than would otherwise have been the case. The pandemic also underlined the critical role that is played by digital communications in modern societies in allowing people to continue to live their lives without regard to the physical distances between them.

2. The evidence in this report shows how households, and particularly businesses, have already obtained very significant economic and social benefits from adopting new digital communications technologies like superfast broadband or 4G. These benefits could be even greater for the next generation of technologies – fibre to the home and 5G – which are the focus of this report. Digital communications infrastructure is now a critical factor in determining where new, high growth businesses choose to locate and where young people decide to live. A key message is that these businesses and young people cannot afford to wait in the hope that a fibre connection will become available 10 years from now. They will move to somewhere where fast reliable broadband is already available in the meantime.

3. Although our remit is to advise the Welsh Government on strategy for the next 5-30 years, the rate of change in digital communications means that we have chosen to focus on the next 5-10 years. The evidence shows that nations that are leaders in digital communications in one technology cycle tend to remain the leaders for subsequent generations. The opposite is also the case. The recommendations in this report are designed to ensure that Wales will be better positioned to exploit the opportunities that are offered by continuous advances in digital communications technologies, both in the next 5-10 years and beyond.

4. The UK Government's policy for digital communications has undergone various twists and turns since 2017 but it has a clear focus today on extending fibre to the home to every household in the UK by 2025 and a set of policies and new legislation to support that aim. The Welsh Government currently does not have a similar set of policies or targets for digital communications infrastructure in Wales (as, for example, the Scottish Government does). We think it should, whilst recognising that digital communications policy is not a devolved matter and that many of the policy levers which might be used to influence the way in which digital infrastructure is deployed in Wales are held by the UK Government or by Ofcom, the UK telecommunications regulator.

5. We consider the role to be played by mobile communications in Wales. We think too much attention has been paid by policymakers to promoting fibre to the home technology in the UK and not enough on improving mobile broadband provision,

including using 4G and 5G connections to provide home broadband services instead of, or ahead of, fibre connections. The UK is behind most other countries in this regard, and only 3% of the total data traffic in the UK is carried over mobile networks today, much less than in most other countries. We think Wales can and should be doing more with its mobile infrastructure.

6. Mobile broadband technologies offer benefits which fixed broadband connections cannot offer, both in terms of availability whilst on the move and, importantly, the speed at which the infrastructure itself can be rolled out. 'Home' mobile broadband connections can be a good, low cost option for households in rural areas, either until fibre to the home turns up or on a permanent basis. The latest generation of mobile technology will also support a range of new applications for businesses and public authorities which promise significant economic and social benefits over the next 10-15 years. Importantly, the adoption and use of new mobile technologies tends to occur more quickly than with new fixed broadband technologies.

7. Whist our investigation was being conducted the UK Government concluded an agreement with the UK mobile operators to build a new Shared Rural Network. This is the first agreement of its kind in the UK and should significantly improve mobile coverage and choice of mobile provider for many households, both in the UK and in Wales. We welcome the UK Government's decision to adopt a more pro-active approach with the mobile industry, including the use of £500 million of public funds, rather than rely upon the market to deliver, as some of its predecessors have done.

8. Fixed and mobile broadband communications infrastructure are not separate and should be considered within the context of an overall digital communications infrastructure strategy for Wales. Mobile broadband networks will require fixed fibre connections to carry traffic from the mobile masts to the core networks of the operators. But we also think that the different rate at which fixed and mobile infrastructure can be deployed, particularly when the fixed infrastructure being deployed is fibre to the home, means that they should be thought of as playing a wider complementary role to each other.

9. This is particularly important in Wales, where a significant number of households (around 60,000) remain without access to fixed superfast broadband services and where many households and businesses who do have access to what is regarded as reasonable fixed broadband services today are likely to have to wait many years before further significant improvements in speed are available. During this time, many households and businesses in Wales will begin to find that today's broadband infrastructure no longer meets their needs.

10. One response to this, which appears to be favoured by the UK Government (and by the UK National Infrastructure Commission) is to accelerate the deployment of fibre to the home so that everybody can use fibre at home by 2025. We support the UK Government's desire to upgrade the UK's fixed digital infrastructure as quickly as possible and we think the Welsh Government should participate enthusiastically and ensure that a proper share of the £5 billion of funds which the UK Government has pledged are available in Wales. The design of

the programme needs to be flexible enough to meet Welsh needs, which we think differ from the rest of the UK.

11. We are concerned that Wales does not appear to be attracting investment from the new generation of smaller commercial fibre to the home operators which are emerging elsewhere in the United Kingdom. This kind of entry is attractive both because it would directly contribute to expanding fibre coverage in Wales and because it might increase pressure on Openreach and lead it to reallocate more of its resources to Wales. It might also introduce a welcome degree of competition into the next tenders for public subsidy of fibre to the home infrastructure in Wales.

12. A key recommendation is that the Welsh Government act quickly to replace the existing all Wales Digital Infrastructure Group with a high profile 'barrier busting' taskforce led by a senior civil servant, similar to that created by the UK Government, with clear objectives and deadlines within which to achieve them. One of the tasks of this group would be to ensure that local authorities and other organisations do more to facilitate the deployment of fibre to the home infrastructure by these operators. We also recommend that the Welsh Government review and simplify the existing broadband voucher schemes which are used to support the deployment and adoption of fibre broadband. The aim should be to improve the take up of vouchers in Wales and to guard against the risk that the existing voucher budget is allocated to an ever smaller number of households at an ever higher cost per household when it could be used for other, better value, purposes.

13. We share the view of others (including, recently, the CEO of BT) that the UK Government's target of nationwide availability of ultrafast digital infrastructure by 2025 is probably unachievable, given labour market and other constraints in the UK today. We think the £5 billion of public funds budgeted by the UK Government is unlikely to be sufficient to meet its targets and the total funding requirement could instead be as much as £10 billion. We are also concerned that the particular challenges of deploying fibre to the home infrastructure in Wales – with a large rural population and less competitive pressure on BT – mean that Welsh households and businesses will find themselves at the end of the (long) queue for fibre. This means Welsh households could be waiting many years – probably more than 10 in some cases – to obtain a better broadband connection than they have today. Some households and businesses will be so expensive to reach that they may never be served by fibre to the home technology, or only at an unaffordable cost.

14. This is why we think the Welsh Government needs an alternative strategy. This is intended to ensure that Welsh households and businesses can obtain access to significantly better broadband than they have today – at speeds of around 100 Mb/s – within the next 5 years rather than waiting for 10. We consider home broadband services delivered over 4G and then 5G mobile networks are best placed to perform this role. We consider that home broadband connections provided by these networks could be delivered much more quickly than fibre and at a fraction (perhaps a third) of the cost. They would not provide the gigabit speeds that are required for Virtual Reality gaming or 8k TV consumption

(the benefits of which we are uncertain about in any event), but they would still provide households and businesses in Wales with a substantial and necessary improvement in their broadband capability, at least until fibre to the home eventually arrives.

15. A strategy to extend and accelerate the provision of 4G and 5G mobile broadband services in Wales over the next 5 years has other attractions too. First, the provision of home broadband services over 4G and particularly 5G infrastructure would offer the mobile operators a source of revenue when the commercial prospects of many of the other applications using 5G remain uncertain today. This could help encourage the commercial deployment of 5G in Wales more generally, which promises significant additional benefits from IoT and other innovative applications. Second, as time passes, demand for other 5G services should emerge and the infrastructure which was initially used to support home broadband could then be re-used for other purposes. As and when fibre to the home is deployed within the relevant area, households would be expected (and could be required) to migrate to fibre, releasing the 4G or 5G capacity for other uses. Third, mobile infrastructure which is installed to support home broadband would also support mobile broadband provision across wider geographic areas, with benefits that arise from that. Fourth, the wider availability of 4G or 5G home broadband services should allow the Welsh Government to delay investments in fibre to the home in those parts of Wales where households and businesses were being adequately served with 4G or 5G home broadband. If the costs of deploying fibre fall over time and/or demand increases, then delay would mean the industry ends up serving more households on a commercial basis (BT's own estimates of the costs of deploying fibre commercially have fallen significantly in the past 5 years). A policy which promotes the use of 4G and 5G home broadband ought therefore to lead to a lower overall level of public expenditure whilst at the same time providing superior broadband availability in the short and medium term and a similar level of fibre coverage in the long term.

16. An alternative strategy for Wales might involve the Welsh Government copying the UK Government and investing very large sums of public funds – over and above whatever proportion of the £5 billion budget is allocated to Wales – in an effort to deliver fibre to every home in Wales by 2025. Even if a budget of £1.3 billion which we estimate would be required were available to do this, we do not think it would represent a good use of public money. Wales simply cannot afford to commit itself to a dogmatic policy which involves incurring ever greater costs to connect an ever smaller number of households to one infrastructure. We think far more can be achieved if a proportion of those funds were instead allocated to first maximizing the provision of 4G and 5G home broadband connections in Wales.

17. Action is urgently required if the strategy we recommend is to be implemented effectively. Instead of being a leader in the deployment of 4G or 5G technology today, Wales appears a less attractive place for telecommunications operators to invest than many other parts of the UK. It has been slow to reform its planning regime, which has an adverse impact on the cost and length of time taken to deploy new digital infrastructure. Guidance to Welsh local authorities on these

matters has not been revised since 2002. Another of our key recommendations is that the Welsh Government acts to ensure at least parity with the rest of the UK on telecoms planning matters. Other issues, such as the availability and cost to telecoms operators of using local authority and other public assets, also need to be addressed.

18. However, if Wales is to extract more from its 4G and 5G mobile communications infrastructure than the rest of the UK then it should be aiming not for parity but to have an even more favourable environment, particularly for mobile infrastructure. The challenge here is to ensure that any further actions which the Welsh Government take will yield tangible benefits for Welsh citizens rather than, for example, simply reducing costs for the mobile operators. We think the recent Single Rural Network agreement which the UK Government negotiated with the industry provides an example of what can be achieved when a more pro-active approach is taken, but that more can be done. This is why we recommend the Welsh Government explore with industry whether further changes to the planning regime and the provision of public funds could be used to secure additional 4G coverage and accelerate 5G availability in Wales, above and beyond that already committed to under the Single Rural Network agreement, including adopting a new 5G coverage target for Wales.

19. Responsibility for the implementation of many of our recommendations will rest with other public bodies, including local authorities (acting alone or through City Deals), Network Rail, Transport for Wales, the North and Mid Wales Trunk Road Agent and the South Wales Trunk Road Agent. We heard evidence that some local authorities in the United Kingdom are far more supportive of digital infrastructure than others. Wales will only improve its digital infrastructure if all organisations make it easy for operators deploying digital infrastructure, whether fixed or mobile, to deal with them. The best local authorities or regions approach digital investment in a strategic way, recognizing that the long term benefits of digital deployment for the community far exceed any short term revenues that might be earned by the authority itself in the form of rents.

20. Achieving this will require a greater degree of pro-active guidance and direction from the Welsh Government than we have seen in the past. That is why we recommend the creation of a 'barrier busting' taskforce, led by a senior Welsh Government official, with responsibility for leading the effective implementation of the changes we recommend in this report and identifying others that might be required.

21. Even if Wales succeeds in upgrading its digital infrastructure along the lines that we have proposed, there will still be a need to encourage the greater use of that infrastructure, particularly fixed broadband, by households and businesses in Wales. Today, fewer than half of Welsh households and businesses that could use superfast broadband actually do so, a lower proportion than the rest of the UK. Growth in data traffic in Wales during the COVID-19 pandemic was high – but still lower than that experienced in most other parts of the UK. Today's comparatively low levels of adoption and use of digital technologies mean that the Welsh economy stands to obtain even greater benefits from broadband infrastructure than other parts of the UK if we can increase usage of it.

22. There are many initiatives already in place in Wales and in the rest of the UK to encourage households and businesses to exploit the opportunities arising from new digital infrastructure. The UK Government has recently established a new Gigabit Take Up Advisory Group to provide a greater focus for these efforts across the UK. Before recommending more initiatives for Wales, we recommend that Audit Wales are asked to take stock and assess what is already underway. Those initiatives that work or can be adapted to the new technologies should be invested in and expanded. Those that do not should be discontinued.

23. A full list of our recommendations are contained in Chapter 8 at the end of this report. If adopted, we would expect a Welsh Government 'barrier busting' taskforce, working with local authorities and others, to move quickly to implement the recommendation intended to make Wales a more attractive place to invest in all forms of digital infrastructure and for the Welsh Government to start discussing ambitious targets for 4G and 5G 'home' mobile infrastructure with the mobile industry. This would include the offer of Welsh Government funds to support mobile infrastructure under a new, more flexible, 'Gigabit Cymru' programme, as well as serious consideration of planning rules that are more favourable towards mobile infrastructure than those seen elsewhere in the UK. The Welsh Government should not at this stage aim to spend more than £3500 to connect individual households to a fibre network and should simplify the use of vouchers for this purpose. However, the Welsh Government should consider investing heavily to improve the adoption of new digital technologies where the infrastructure is already available, but only after Audit Wales has reviewed the effectiveness of the programmes that already exist.

Chapter 1

Introduction

1. The National Infrastructure Commission for Wales was established in 2018 as a non-statutory body to advise and make recommendations to the Welsh Government about the infrastructure needs of Wales over the next 5-30 years[1]. Our remit includes digital communications, which we identified as being a priority for the Commission in our first annual report and in respect of which we issued a call for evidence in November 2019[2].

Our approach

2. This report presents the results of our investigation into digital communications in Wales and the recommendations which flow from it. We asked two questions of stakeholders in November 2019 and our work has largely been guided by our efforts to address them.

3. The first question related to the future provision of fixed broadband connections in Wales, asking whether:

"the UK Government's focus on extending more expensive fibre to the home to every household in the UK will best serve the interests of Welsh citizens, including those who still lack access to superfast broadband."

4. In posing this question, we were keen to explore whether technological solutions other than fibre to the home might better serve the needs of at least some Welsh households and businesses, at least until the provision of a fibre to the home or business connection became a realistic prospect. We should emphasise that throughout this report we refer to 'fibre to the home' or FTTH but in doing so we are at least as concerned about fibre connections for businesses and in Chapter 3 present evidence to show that many of the economic benefits from fibre infrastructure are generated by connections to businesses rather than households. In answering these questions, we needed to understand the current state of broadband provision in Wales, the prospects for the deployment of fibre to the home technologies, as well as what might be considered feasible alternatives to fibre. We also needed to consider what steps the Welsh Government, or other bodies, might take or were already taking to promote alternative solutions. Responsibility for most aspects of telecommunications policy in Wales remains a matter for the UK Government and for Ofcom, the UK telecommunications regulator. However some aspects, such as the planning regime (which can affect the cost and speed of deploying telecommunications equipment) and the operation of public subsidy programmes (such as 'Superfast Cymru') are delegated to or overseen by the Welsh Government.

1. Further details on the work of the Commission can be found at our website, https://gov.wales/national-infrastructure-commission-wales/terms-reference
2. https://gov.wales/sites/default/files/publications/2019-11/national-infrastructure-commission-for-wales-annual-report_0.pdf and https://gov.wales/sites/default/files/publications/2019-11/annex-2-call-for-evidence_0.pdf

5. The second line of investigation was intended to complement the first. We considered that mobile broadband infrastructure might be an alternative to fibre to the home broadband in some circumstances and wanted to understand what those circumstances might be. At the same time, we were conscious that mobile broadband infrastructure is itself also heavily dependent on fibre connections to convey traffic from the mobile mast to the core network. We felt that Government policy, at both UK and Welsh level, may have focussed too much on fixed broadband technologies in the past, leaving opportunities to improve or exploit the full potential of existing mobile infrastructure unrealised.

6. We therefore asked for views on our provisional view that:

"4G and 5G mobile broadband may be the lowest cost technology to provide superfast connections to some Welsh households; that mobile connectivity delivers significant additional economic and social benefits in rural communities; and that, therefore, a greater proportion of public funds should be allocated to mobile as opposed to fixed broadband infrastructure or other infrastructure objective."

7. In advancing this proposition, we were keen to explore both whether new mobile broadband technologies might be a better option than fibre to the home for some Welsh households but also whether additional public funding for mobile infrastructure might yield other benefits for Wales, particularly for those living and working in rural areas. Our focus on the allocation of public funds in Wales – away from the UK Government's focus on fibre to the home infrastructure and towards support for mobile communications infrastructure in Wales – reflects the fact that public subsidy programmes are one of the aspects of telecommunications policy over which the Welsh Government has a degree of decision making authority. We do, however, also make other recommendations in this report which are intended to improve the capacity of operators to extend and improve the mobile infrastructure that is deployed in Wales using private funds.

The contents of this report

8. Part 1 of this report considers the provision of fixed broadband connections in Wales. It starts, in Chapter 2, by explaining what fixed broadband services are and how they have developed in both the United Kingdom and in Wales over the past 20 years and how the telecommunications industry which supplies them operates. We also consider how Government policy has influenced the development of the fixed broadband services and infrastructure, both in the United Kingdom and Wales, and what the current objectives and ambitions for fixed broadband deployment are and the policies in place to support them. We hope this part of the report provides the reader with a useful overview of how we have arrived at the position we find ourselves in today[3].

9. Chapter 3 contains a review of evidence about the economic and other benefits which can be obtained from having good or better fixed broadband connections. Politicians in most countries today, irrespective of political affiliation, support greater investment, including with public funds, in fixed broadband technologies. However, the costs involved in making such investments can, as we show in this report, be very significant. Comparison of the relative costs and benefits associated with different technological options would seem desirable when deciding which technology to adopt, particularly if taxpayers' money is to be used to subsidise the infrastructure. We have found that there is less robust evidence on economic or other benefits actually obtained, particularly in relation to fibre to the home technology, than one might expect. There is no evidence that relates specifically to fibre to the home technology in Wales. This uncertainty is one of the things that led the United Kingdom's National Infrastructure Commission to conclude in their report that a policy to promote fibre to the home technology, which the UK Government has since adopted, represented a 'risk worth taking'[4].

10. We decided to consult with stakeholders in order to obtain their views on the issues we were considering (including both the fixed broadband questions we discuss in Part 1 of this report and the mobile broadband questions we discuss in Part 2). Prior to the COVID-19 pandemic we met in person with representatives from BT, Mobile UK (the mobile operator trade association), Ofcom, Openreach, and the Welsh Government. We received written submissions in response to our request for evidence from the Active Building Centre, BT, the Country Land and Business Association Cymru, the Design Council for Wales, the Federation of Small Businesses, the Growing Mid Wales Partnership, Mobile UK, the National Trust, and the Welsh Infrastructure Alliance. We are grateful to all of those who responded to our request and discuss their responses in Chapters 4 and 7 of this report.

3. The initial purpose of these parts of the report were to provide an internal briefing to Commissioners, most of whom do not have extensive experience in broadband issues (although some do). The material is reproduced in this report because it may also assist the reader and because it provides stakeholders with access to the information on which Commissioners subsequently adopted their recommendations.

4. See paragraph 41 below.

Impact of the COVID-19 pandemic on our work

11. The COVID-19 pandemic had a significant impact on the Commission's capacity to undertake its work in relation to this investigation from March 2020 onwards. Although the Commission has continued to meet by video on a monthly basis, some staff were redeployed to other duties by the Welsh Government at an early stage and some Commissioners have found themselves with other unforeseen demands on their time. In addition, we decided that further engagement with stakeholders would have been inappropriate, particularly in the initial period of the crisis, when digital communications providers needed to focus on maintaining their networks, protecting their own staff, and responding to an unprecedented increase in demand for their services arising from social distancing measures which confined many families to their houses for much of the day[5]. Recognising this, we were happy to consider submissions in response to our request for evidence after the initial deadline had passed.

12. We could have sought to engage further with stakeholders before publishing this report but concluded that it was better to proceed with publication now, even if this means that our work is not as complete or comprehensive as we would have liked. We are conscious that the COVID-19 pandemic has itself revealed the critical role played by digital communications infrastructure in Wales and its importance both today and in the future. We also know that both the United Kingdom and Welsh Governments are already developing economic recovery plans which are likely to include plans to promote investment in digital communications infrastructure, including a £5 billion UK Government subsidy programme for nationwide fibre to home deployment. We would expect the contents of this report to be highly relevant to these activities and so it is important that they are made available now.

13. At the same time, we are conscious that the long term consequences of the pandemic, both for demand for broadband infrastructure and for the capacity of the industry and other bodies to supply it, are not yet fully understood[6]. The uncertainties which already existed about the benefits and costs of particular technologies or policies have been further exacerbated by the COVID-19 pandemic. Since we do not know today when these uncertainties will recede, or when or if life will return to 'normal', we do not think there is much to be gained by delaying the publication of our report. We would, however, encourage those who wish to comment on our recommendations, or on other aspects of the report, to write to us. The Commission may decide to revisit these issues, or other aspects of digital communications, in the future.

5. Early data from Openreach suggested that its network in Wales saw an increase in traffic between February and April 2020 of almost 20%. This is a significant additional demand on the network, although lower than seen in most other regions of the country during the same period, see https://www.ispreview.co.uk/index.php/2020/04/COVID-19-19-impact-openreachs-network-traffic-by-uk-region.html

6. Some reports, published early in the pandemic, suggest that deployment of 5G infrastructure will be delayed. Other factors, such as the UK Government's recent decision to require UK mobile operators to remove Huawei equipment from their networks by 2027, will no doubt also have an impact. See https://www.strategyand.pwc.com/uk/en/reports/strategy-where-next-for-telecoms.pdf and https://www.gov.uk/government/news/huawei-to-be-removed-from-uk-5g-networks-by-2027

14. Part 2 of this report follows a similar structure to Part 1 but addresses the questions about mobile communications infrastructure which we chose to examine. In Chapter 5 we discuss the origins and development of mobile communications infrastructure and services in the United Kingdom, the features of the industry which supplies them, and the impact of Government policy in both a UK and Welsh context. We also consider the current policies and goals of both the UK and Welsh Governments in relation to mobile broadband services in general and 5G in particular.

15. In Chapter 6, we consider the evidence as to the economic and other benefits of mobile communications technologies. As with the fibre to the home technologies which we discuss in Chapter 3, we find that evidence of the benefits of 5G services is very limited, reflecting the fact that we are still at a relatively early stage of its development and deployment, both in the UK and globally. We also consider the evidence from earlier transitions from one generation of mobile technology to another (e.g. from 2G to 3G), from which some inferences about 5G might be drawn.

16. In Chapter 7 we present and discuss the views of stakeholders. The same issues arose with regard to the impact of the COVID-19 pandemic on our investigation into mobile communications as applied to our investigation of fixed communications.

17. Chapter 8 provides a complete list of our recommendations.

18. We would like to thank the staff of the Commission and all stakeholders who engaged with us for their help in preparing and publishing this report. Responsibility for its contents remains solely with the National Infrastructure Commission of Wales and its Commissioners.

Part 1 – Chapter 2

Fixed Broadband in the United Kingdom and Wales

19. Broadband services were first introduced into the UK (and elsewhere in Europe) in the early 2000s. Before this households had relied on 'narrowband' dial up services to access the internet and other digital services. Broadband offers two important benefits: it provides a more reliable 'always on' connection rather than requiring users to first establish a connection themselves, and it allows for the consumption of much higher volumes of data at much faster rates[7]. Broadband speeds are generally expressed in terms of bits (the volume of data) transmitted per second. A kilobit (kb) is 1000 bits, a megabit (Mb) is 1 million bits and a gigabit (GB) is 1 trillion bits. Narrowband internet services often ran at 144 kb/s. Today's fixed broadband services generally run at 20-30 Mb/s but some current and most future broadband connections will be capable of Gigabit speeds.

20. The introduction and subsequent development of broadband services has been enabled by advances in digital technologies. The vast majority of the costs of providing broadband connections relate to the 'last mile' connection between a central distribution point and the individual household or business premise. The data associated with these individual connections is then aggregated and carried over national and international 'core' or 'backbone' networks. These have been comprised of optical fibre and digital switching technologies for many years.

21. Until the early 2000s, telecoms operators like BT had relied upon their existing analogue copper telephony networks to support data services. Copper was used throughout the network and offered a connection to almost every household in the country. It represented a large proportion of the assets on BT's balance sheet and BT spent a significant proportion of its annual revenues and employed tens of thousands of technicians to repair and maintain this infrastructure. Any prospect of replacing it was thought to be prohibitively expensive and unnecessary. Instead of replacing the copper BT and others worked to create a new 'Digital Subscriber Line' (DSL) technology which allowed BT to deliver broadband services over the existing copper network by attaching digital equipment at both ends of the copper connection – a modem in the house and terminating equipment at the local BT exchange. This allowed BT to deliver broadband services, initially at relatively low speeds (typically 2-5 Mb/s but up to 8 Mb/s) and later at 15-20 Mb/s (up to 24 Mb/s) with subsequent generations of the DSL technology.

7. The combination of these features also allowed a third feature to emerge, namely the offer of usage-independent charges for broadband connections in which users paid a monthly subscription fee but no additional usage-related charges. Most fixed broadband connections in the UK today offer access to 'unlimited' volumes of data.

22. DSL technology had a number of benefits for BT and for consumers. First, the costs of reusing BT's copper network to provide broadband services were relatively modest, both for BT and for households who were required to purchase a modem. Costs of modems were the same irrespective of the location of the household. The cost of equipment installed by BT was shared amongst the households served and so depended on the number of households served by any particular local exchange. It was estimated to be around £50 per household passed on average[8]. Costs per household connected (and the total revenues earned by BT) then depended on the proportion of all households taking broadband services. Prices payable by households for broadband services are the same across the UK rather than varying by location or differences in cost[9].

23. Second, BT could upgrade its network rapidly since it only required the installation of new equipment in the local exchange and left the copper network itself undisturbed. BT was able to upgrade the vast majority of its exchanges by late 2005, making broadband services available to most households in the UK in the process. On the other hand, DSL technology had a number of shortcomings – it did not perform well if the distance between the household and the local exchange was very long or if the copper was in poor condition. Thus, although broadband services were often said by BT to be available in a particular area, the experience of individual households within that area could still vary from one household to the next. In 2010, there were still 2 million households in the UK unable to obtain a connection of at least 2 Mb/s[10], which was considered by the UK Government to be the minimum required at the time. In addition, in order to benefit from further improvements in DSL technology the household would generally have to replace their modem. Nonetheless, adoption of broadband connections was rapid in the UK and by 2010 71% of households subscribed to a broadband connection, compared to just 9% in 1998.

24. Demand for broadband services from UK households and businesses meant that BT had incentives to upgrade its network, but UK (and European) telecoms policy had for some years also attached significant weight to the role of competition in driving investment in new infrastructure. In 1991 the UK Government had allowed cable tv operators to provide local telephony services in competition to BT and the subsequent competition from cable networks has played an important role in those parts of the UK (representing around 65% of households) where cable infrastructure has been deployed. Developments in cable technologies, and the development of the DOCSIS (Digital Over Cable Service Interface) standard in particular, allowed cable operators to offer broadband services over their existing coaxial cable infrastructure (originally designed to deliver TV signals) at a significantly lower cost and at much higher speeds (100 Mb/s+) without replacing equipment, as BT needed to do. BT has therefore tended to prioritise the upgrade of its own DSL infrastructure in those areas where competition from cable, now operated by Virgin Media, arises.

8. http://www.broadbanduk.org/wp-content/uploads/2012/08/pipe_dreams_prospects_for_next_generation_broadband_final.pdf, p.21
9. Short term discounts, such as on connection fees, can vary by geography for BT, with these discounts generally targeted in areas where BT faces competition.
10. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/78096/10-1320-britains-superfast-broadband-future.pdf, p.4

25. In addition to competition from Virgin Media, the UK Government and regulator, Ofcom, sought to encourage competition in broadband services over the BT network itself. This involved allowing competing firms, such as TalkTalk or Sky, to rent the copper connection between the local exchange and the household and attach their own equipment at either end. This was known as 'unbundling' the BT network. The argument was that competition would then encourage firms, including BT, to upgrade their equipment more rapidly (in order to offer higher speeds to households) than BT might otherwise be inclined to do in the absence of such competition. The evidence of the impact of 'unbundling' on BT's investments in broadband is still disputed, in part because the other firms may face the same costs of 'stranding' existing assets as BT if they replace them with a newer technology. Competition in broadband means that BT has typically provided 40-50% of the DSL broadband connections in the UK, which is a lower share than some of its counterparts elsewhere in Europe. The rest are provided by Virgin Media or BT's other competitors.

26. Mobile technologies were also developing during this period. 3G technology (was the first generation of mobile wireless technology to be specifically designed to support broadband connections, albeit at significantly lower speeds of between 500 kb/s and 5 Mb/s and significantly higher costs per Mb of data consumed, relative to fixed networks at the time. 3G services launched in the UK in 2003, but widespread adoption occurred after the launch of the first touchscreen smartphone, the Apple iPhone, in 2007. The potential for 4G and 5G mobile technology to meet the future broadband needs of households and businesses in Wales is considered in Part 2 of this report.

27. Between 2010 and 2015, both BT and the UK Government were primarily focussed on the further upgrading of DSL technology to provide faster broadband services in the UK. This involved, in 2010, BT launching and then deploying the next generation of DSL technology (VDSL, or Very High Speed DSL) which supported speeds of at least 24 Mb/s and up to 50 Mb/s or around 10 times that generally available to existing users. This was labelled a 'superfast' technology, distinguishing it from slower, earlier broadband technologies. Obtaining higher speeds over existing copper wires is achieved by reducing the distance over which the data travels. This involves BT moving its own equipment from the local telephone exchanges into the street cabinets and replacing the copper connection between the cabinet and the exchange with fibre. This is why VDSL technology is sometimes referred to as 'Fibre to the Cabinet' or FTTC. The replacement of the copper means that VDSL involves significant additional costs beyond those which BT had already incurred to provide broadband services using existing DSL technology – estimates at the time suggested an average cost (before the modem is purchased) of £190 per UK household[11], or around 4 times the cost of the previous DSL technology. However, the requirement to install equipment closer to households also accentuates the variation in cost per household between areas with different housing densities. Costs for VDSL technology in remote rural areas are of the order of £350 per household or more.

11. https://www.hie.co.uk/media/3288/connectivity_review_exec_summary_sept_2009.pdf, p.8

28. The roll out of VDSL was also slower, reflecting the additional work required from BT. Some of the challenges with DSL also applied to VDSL, so that households with very long copper connections to the nearest cabinet would still experience speeds that were much lower than those available to those nearer the same cabinet (and some households could not be served with VDSL at all). This explains why there has been some controversy about the way in which broadband services are advertised in the UK, since there can be a large discrepancy between the theoretical speed offered by the technology and the actual speed experienced by a particular household[12].

UK Government policy on VDSL or superfast broadband

29. In 2010 the Coalition Government published a strategy for the UK to achieve 'the best broadband network in Europe'. This was the first national broadband strategy produced in the UK[13] and had two elements – to ensure 'universal' access to broadband services at speeds of at least 2 Mb/s by 2015 and to extend the reach of new 'superfast broadband' technologies capable of higher speeds (24 Mb/s+) to 90% of households by mid-2015. This deadline was subsequently extended to the end of 2016 after delays in obtaining approvals from the European Commission (see below). To support this, the Government allocated £530 million to fund the deployment of superfast broadband in those areas which BT had said it could not serve on a commercial basis, or which it would not reach in the foreseeable future (being the next 3 years). This represented about a third of all households in the UK. Additional funds were contributed by local authorities and the European Regional Development Fund, raising the total public sector contribution to £1.2 billion.

30. This fund was administered by a new body within the Department for Culture, Media and Sport (DCMS), Broadband Delivery UK (BDUK), which oversaw the allocation of funds and the running of public procurement exercises by local authorities (who were invited to bid for central Government funds provided they agreed to match them). The extension of superfast broadband was, in the process, expected to largely address those households unable to access broadband at speeds of 2 Mb/s. The procurement process itself was the result of negotiations between the UK Government and the European Commission to obtain EC approval of the scheme under the European State Aid rules. BDUK ran a tender process to identify 'approved suppliers'. It was originally expected that both BT and a consortium led by Fujitsu would qualify, but Fujitsu withdrew, leaving BT as the only supplier with whom the Government then negotiated a framework agreement. Local authorities were then invited to identify areas which would qualify for public funding (being areas which BT or others would not otherwise serve on a commercial basis) and enter into contracts with BT, or negotiate with other suppliers if they could. 44 contracts were entered into in Phase 1, for 33 of which BT was the only bidder. The other 11 involved some competitive bidding but BT won them all.

12. https://www.asa.org.uk/news/new-standard-on-broadband-speed-claims-in-ads-comes-into-force-today.html

13. In 2009, the Brown Government had published a broader 'digital strategy' which included a commitment that every household in the UK would be able to obtain broadband at speeds of at least 2 Mb/s by 2012 (at a cost to the public of £200m) and establishing a Next Generation Digital Fund by levying a tax of 50p/month on every existing copper telephone connection. Neither was implemented.

31. The Phase 1 BDUK scheme attracted criticism from the National Audit Office and Public Accounts Committee, much of which focussed on concerns that BT had inflated its cost estimates (which local authorities were then unable to benchmark given the lack of competitive options)[14] and underestimated the demand for superfast broadband services. MPs were also concerned that the 90% coverage target left some areas unserved. There were examples where BT had upgraded the network in one half of a village but not the other[15]. Nonetheless, the Government announced the 90% target had been achieved by March 2016 (somewhat behind the original date but ahead of the revised target) and total expenditure was actually £127 million lower than expected (some of which was then reinvested to further extend coverage)[16]. In addition, take up of superfast broadband connections once the networks were deployed was higher than BT had projected in its original business plans so that a further £490 million was 'clawed back' by local authorities and also used to further extend coverage. Compared to some other large public procurement projects, the BDUK Phase 1 programme appears to have been well managed. The Culture Media and Sport Select Committee concluded in 2016 that "The progress made since 2010 in providing superfast broadband access has on balance demonstrated that the Government was right to go with the BDUK scheme which principally involved BT and deployment of its fibre-to-the-cabinet solution".[17] The Government's own assessment, undertaken in 2018, broadly agreed[18].

32. In 2013 the Coalition Government announced a Phase 2 BDUK scheme, allocating a further £250 million of funds to extend superfast coverage from 90% to 95% of households by the end of 2017 under the same arrangements as for Phase 1. These were expected to be matched by a further £250 million of funds, primarily from local authorities. Many of these tenders were also won by BT, but some were awarded to other operators, primarily Gigaclear, who had begun to deploy 'ultrafast broadband' networks which relied upon fibre to the home or FTTH technology rather than VDSL.

33. In 2015 the Coalition Government also announced that it would introduce a 'universal broadband scheme' which would ensure that every household in the UK could obtain access to a connection of at least 10 Mb/s. This was in part prompted by the realisation that BT's near-universal deployment of DSL technology did not translate into universal availability of broadband services at reasonable speeds for the approx. 2% (500k) of UK households which were located at the end of very long copper connections and in part by the realisation that its earlier commitments to universal access of 2 Mb/s no longer met expectations of what represented an acceptable broadband speed in the UK, which had risen in the meantime. This has involved establishing a set of arrangements under which all broadband users in the UK contribute towards an industry fund which will be used by BT to meet their costs of fulfilling the obligation. Households benefiting from this scheme will make

14. See reports of the National Audit Office at http://www.nao.org.uk/wp-content/uploads/2013/07/10177-001-Rural-Broadband_HC-535.pdf and http://www.nao.org.uk/wp-content/uploads/2015/01/The-Superfast-Rural-Broadband-Programme-update.pdf, subsequently endorsed by the Public Accounts Committee Reports.
15. https://publications.parliament.uk/pa/cm201617/cmselect/cmcumeds/147/147.pdf, p.11-12
16. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734855/Superfast_Integrated_Report.pdf, p.20
17. https://publications.parliament.uk/pa/cm201617/cmselect/cmcumeds/147/147.pdf, para 29
18. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734855/Superfast_Integrated_Report.pdf

no contribution themselves (beyond the normal charges) provided the cost to BT of serving the household is no more than £3400. Households will be expected to meet costs any above this threshold. BT began implementing this scheme in 2020.

Comparative performance of the United Kingdom in fixed broadband provision

34. The Government (and BT's) focus on extending broadband in the UK using VDSL technology differed from policies adopted in some other European countries, notably France and Spain (but also parts of former Eastern Europe, Japan, Korea, Australia and New Zealand). In these countries, much greater emphasis was placed on replacing the copper network altogether with FTTH technology. This was for a number of reasons. In some cases the existing copper network was ill-suited to DSL technology. In Spain for example, the main operator, Telefonica, had installed its cabinets in underground chambers rather than in street cabinets, as BT had done. Installing DSL equipment in these chambers and maintaining it at the required temperature under Spanish conditions was very difficult. In other countries the length of the copper connection between the cabinet and the household was much longer on average than in the UK, which meant that the speeds that could be obtained from DSL technology were also much lower.

35. The costs of installing alternative technologies such as FTTH were also significantly lower in some other countries than in the UK. For example, both Spain and Portugal had well maintained and comparatively new but empty duct systems through which new fibre connections could easily and quickly be pulled. In contrast, the UK duct system has been poorly maintained, is often unmapped, and is already full of copper bundles. Installing new fibre under these conditions is more difficult. In Eastern Europe, planning regulations have allowed the installation of fibre lines on poles or off buildings rather than requiring them to be installed underground. This has a very significant impact on costs. Moreover, some European countries have a much greater density of flats and apartments than UK cities, which means that many more households can be served for every kilometre of fibre that is installed. Added to this FTTH was regarded by some Governments as being the 'gold standard' in broadband technology since it could support much higher speeds – of at least 1 Gb/s – than DSL. These Governments considered that the higher costs and slower rate of deployment of FTTH, compared to DSL, were more than offset by the greater benefits that households would obtain once they finally had access to FTTH services. In their view, investments in inferior DSL technology were ill-advised when they would need to be replaced by superior FTTH technology within 10-15 years.

36. These countries initially made slow progress in the provision of faster broadband services, relative to the UK, because FTTH was much more costly and slower to deploy. At the time, the average cost of FTTH in the UK was estimated at around £900 per household passed, compared to around £190 for VDSL, although FTTH costs were often lower in those other European countries where it was being adopted for the reasons given above. In 2015, the UK had superfast VDSL (and cable) coverage for 79% of households, whereas France had

FTTH coverage for only 14% of its households (and 15% for VDSL) and Spain FTTH coverage for 45% of its households (and 11% for VDSL)[19]. In other words, many more UK households had access to broadband speeds above 24 Mb/s in 2015 than in other countries who were waiting for FTTH connections, but on the other hand only 1% of UK households had access to the gigabit speeds enabled by FTTH.

37. The position has altered as time has passed. The rate of increase in VDSL coverage has slowed in the UK as BT was left with the most difficult to serve final 10% of households. At the same time FTTH coverage accelerated in other European countries where large gains in coverage were still relatively easy to make. By late 2018, around 45% of Spanish households were connected to FTTH networks (and over 95% could do so) and over 20% of French households were connected. The comparative lack of focus on FTTH in the UK prior to 2018 meant that only 2% of UK households were connected to FTTH[20].

The UK National Infrastructure Commission's fixed broadband report

38. The UK NIC had previously published a report on 5G mobile infrastructure (which we discuss in Chapter 5), but its first recommendations on fixed broadband were offered when it made universal FTTH a central recommendation in its first National Infrastructure Assessment in July 2018[21].

39. The UK NIC's recommendations were based on a number of assumptions, most of which were subsequently adopted by the UK Government:

a. FTTH was the next logical evolution of technology after VDSL, the deployment of which had largely been completed by 2017, when 98% of UK households were expected to have access to superfast connections.

b. Since FTTH technology involved the complete replacement and decommissioning of BT's existing copper network in the UK (or the building a completely new network by other firms), it would take 10-20 years to complete a nationwide deployment of FTTH. This would be much longer than the transition to VDSL or G.Fast (see below). The NIC considered that even if the need for FTTH was not demonstrated today, it was necessary to begin deployment now in order to anticipate future demand and avoid being left behind other countries who had already started deploying FTTH much earlier than the UK.

19. https://www.ofcom.org.uk/__data/assets/pdf_file/0020/31268/icmr_2015.pdf, p.208
20. https://www.ftthcouncil.eu/documents/FTTH%20Council%20Europe%20-%20Panorama%20at%20September%202018.pdf, p.18
21. https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf

c. Aside from higher speeds, FTTH technology would produce other benefits. It was more consistent and more reliable than VDSL technology (where, as noted earlier, performance could vary depending on the characteristics of each individual copper connection) and involved lower operating costs to maintain (saving £5bn over 30 years). FTTH networks also consume significantly less energy than copper networks.

d. The NIC expected existing firms like BT to deploy FTTH to up to 14 million households by 2025 on a commercial basis. It recommended that steps be taken to reduce the costs of deploying FTTH in the UK and that plans be made to decommission the copper network from 2025. It also proposed that public funds be made available to support FTTH deployment in rural areas (where commercial deployment was not viable) from 2020 onwards.

e. The NIC estimated that the costs of deploying FTTH would be £33 billion, which was £11 billion more than the cost of what it called 'incremental upgrades' of the existing copper network (in practice, a transition from VDSL to G.Fast).

40. It is important to understand the assumptions behind the UK NIC's recommendation to target universal FTTH deployment by 2033[22]. The UK NIC relied upon demand forecasts produced by its advisers, Frontier Economics[23]. Frontier were asked to forecast demand over a 30 year period, significantly longer than the forecast period attempted in many other studies. They approached this task by identifying a large number of applications and considering how they might develop under a variety of different network technology assumptions. Under some assumptions, such as '100% FTTH', demand would be fully met. Under others, such as the scenario in which BT upgrades 90% of households to the next generation of copper broadband technology G.Fast[24], the use of some applications would be inhibited. Frontier then produced two forecasts – a 'moderate evolution' scenario which assumes that demand for broadband continues to grow as it has in the past, and an 'ambitious innovation' scenario in which there is step change in demand as new applications and innovations which rely on ultrafast connections are widely adopted in the UK. The report finds:

a. The benefits of moving to FTTH rather than continuing to upgrade to G.Fast are either small or negative under the 'moderate evolution' scenario. In fact, the discounted benefits from G.Fast are greater because they are realised earlier than the (slower to build) FTTH.[25] For this reason, FTTH delivers economic benefits of £-0.8 billion (i.e. negative benefits) over the 30 year period to 2050 (relative to G.Fast).

22. https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf

23. https://www.nic.org.uk/wp-content/uploads/Benefits-analysis.pdf

24. Households with very long copper lines may never be suitable for G.Fast and are assumed to instead be served with a new DSL technology which BT has developed (LRVDSL) which is intended to provide higher speeds of up to 100 Mb/s to such households. G.Fast involves installing equipment on poles or at other locations very near to the property, further reducing the length of the copper connection (and thereby increasing the speed that can be obtained).

25. Op cit p.11 and p.60. G.Fast takes 6 years to roll out, FTTH 10 years.

b. The benefits of moving to FTTH are much greater than continuing to upgrade to G.Fast under the 'ambitious innovation' demand scenario. This is primarily because under this scenario there is widespread adoption of 8k TVs, virtual and augmented reality applications, smart home remote monitoring, healthcare (remote diagnosis with very high resolution imaging) and more teleworking. Some of these applications can be delivered to a lesser degree with G.Fast or VDSL, but many are assumed to require FTTH to work properly. In this case, FTTH delivers positive benefits of £15.7billion.

c. Frontier undertake a very detailed 'bottom up' demand forecast, both for each application and for different types of household, some of whom will use the applications and have more devices than others. The demand arising from some applications such as telehealth or online education do not vary greatly between the scenarios and/or do not contribute significantly to the total demand of the household. In contrast, two applications, Virtual Reality applications (online gaming) and 8k TV consumption account for the vast majority of the bandwidth required. These are the activities for which Frontier think FTTH is required, and which would be constrained by G.Fast under the 'ambitious innovation' scenario.

41. The UK NIC report itself recognises the possibility that the 'ambitious innovation' required to justify the economic case for FTTH 'may not materialise'. It concludes, however, that 'the investment in full fibre is a risk worth taking'[26]. It would appear to do this on the basis that the Frontier 'ambitious innovation' scenario proves wrong then the UK will have foregone only about £800 million of economic benefits by deploying FTTH instead of G.Fast technology, whereas if the 'ambitious innovation' scenario, or some approximation of it, proves correct then the potential economic prize for the UK is over £15 billion. Another way to arrive at the same conclusion is to compare the additional costs of deploying FTTH relative to G.Fast, which the NIC estimates to be £11 billion[27], with the additional economic benefits which might be achieved under the 'ambitious innovation' scenario, which the NIC estimates to be £15 billion.

42. A further point arises from the cost studies that were undertaken by the NIC's advisers and which needs to be considered in light of the uncertainties about the economic benefits of FTTH and the UK NIC's conclusion that FTTH is a 'risk worth taking'. It has been argued, including by BT in the past, that the best path to FTTH was to continue to deploy fibre ever closer to the home until, finally, the last few metres of copper were replaced by fibre. On this view, VDSL, and then G.Fast, would be intermediary technologies in the journey towards FTTH.

26. https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf, p.22

27. https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf, p21. We note that Frontier Economics, in their study for the UK Government's Future Telecoms Infrastructure Review (discussed below) also estimate the cost of universal FTTH to be £33 billion. These figures are the same because they both rely on costing work commissioned by the NIC, see https://www.nic.org.uk/wp-content/uploads/Cost-analysis.pdf.

The decision as to whether to invest in FTTH (and incur the additional £11 billion of expenditure referred to above) could then be deferred until the demand for and economic benefits of FTTH were more certain than they are today. Economists refer to this as retaining an 'option value'.

43. The UK NIC did not, however, accept this approach, in part because they noted that deploying FTTH to every household in the UK would take between 10 and 20 years even if a decision to start were made today. This means that any further delay would risk depriving some households of access to FTTH technology until well into the 2030s. The NIC's advisers provide some further evidence on this point by estimating the additional costs which a more incremental approach would involve. The additional costs arise from several sources: a delay in moving to FTTH but eventually doing so does not avoid the capital expenditure that eventually has to be incurred but means that some of the operating cost savings of the more reliable FTTH network are only realised later, whilst some of the costs of G.Fast network equipment which would be deployed in the meantime would have to be written off. The advisers calculate that delaying the decision to deploy FTTH by 8 or 15 years (e.g. until the future requirements of UK households become clearer) would add £5 or £7 billion of additional costs to the total project (relative to the £33 billion costs if FTTH roll out commences immediately).

44. It is important to note that these conclusions depend on the assumption that FTTH is deployed to every household over a period of 13 years and that no more G.Fast or other technology is deployed in the meantime. This would mean that, in practice, some households would be required to rely on their current VDSL connection until after 2030 without any improvement in their broadband service from today's levels (which for many households is 50 Mb/s or less). If BT was required to install G.Fast (or some other technology) to improve the service available to at least some of these households in the meantime, then the additional costs of £5-7 billion would be lower. It seems reasonable to suppose that some, perhaps most, UK households will not be prepared to wait for over 10 years before their existing VDSL service of 50 Mb/s or less was upgraded. Most UK households upgraded from basic DSL to VDSL within a period of around 5 years and, given growth in demand for data, it seems unlikely that they will be prepared to wait for 10 years or more before experiencing further improvements.

45. The UK NIC proposes that FTTH deployment on a commercial and competitive basis should be encouraged wherever possible but recognises that a substantial number of households will remain unviable on a commercial basis. It proposes a programme similar to the BDUK superfast programme to extend FTTH to these properties, noting:

"Unlike the 'Broadband Delivery UK' programme, government should focus initially on the areas least likely to receive full fibre broadband commercially, and which are also most likely to experience unreliable broadband through long distances of copper cables. Communities within these areas should be eligible to get their full fibre sooner if they volunteer to help build their network at community level, as for example Broadband for the Rural North have done. However, a reasonable cost threshold will be necessary: the most expensive premises can cost above £45,000. This threshold should be high enough for the programme to cover the vast majority of premises."

The shift to FTTH

46. UK Government policy on broadband has switched from a focus on VDSL and towards a focus on FTTH in recent years. In the 2017 election the Conservative manifesto proposed a target of having FTTH available for 10 million households by 2027, subsequently revised to 15 million FTTH premises by 2023 and all households by 2033, and then, under the current Johnson Government, to 'gigabit connections' to all households by 2025.

47. The primary reason for this shift appears to have been concerns that the UK's broadband infrastructure would begin to fall behind (i.e. would be slower than) those of other countries, such as Spain and France, who had already been deploying FTTH at scale for some years by then. Another important consideration for politicians was that the performance of BT's DSL technologies depended on the length of the copper connection to individual households and businesses, with the result that performance often varied significantly between households and businesses who were otherwise served by the 'same network'. Many constituents complained of receiving broadband speeds which were lower than advertised, or than obtained by their neighbours. An FTTH network – which is not reliant on a copper connection – can deliver the same, consistent, performance to every household that is connected to the network.

48. In the 2016 Autumn Statement, the Chancellor had already announced the creation of a £740 million National Productivity Investment Fund to support 'ultrafast' FTTH and 5G technology deployment. In 2017, the Government allocated a further £400 million to a Digital Infrastructure Investment Fund to 'catalyse the market for alternative full fibre providers'[28]. The reference to 'alternative full fibre providers' related to the emergence, during this period, of a number of new firms with plans to deploy FTTH technology in the UK. Any firm without an existing infrastructure to upgrade (as BT and Virgin Media had) would choose FTTH technology rather than copper-based technologies when building a new network, since the costs of installing either were essentially the same if starting from scratch whilst FTTH networks have much higher performance and are cheaper to operate.

49. Thus, Gigaclear, a firm based in Oxfordshire, had begun deploying FTTH infrastructure in rural areas (where BT had yet to deploy VDSL) in 2011 and had passed around 40k premises in England by 2017. Cityfibre had announced plans to deploy FTTH technology in cities, initially undertaking trials in conjunction with Talk Talk and Sky in York and later concluding a partnership with Vodafone with a target of 5 million households in 50 towns and cities by 2025.

50. It was also during this period that BT substantially completed its deployment of VDSL technology by fulfilling its various contracts with BDUK. It had begun trialling the next generation of copper-based technology, G.Fast. As with the earlier transition from basic DSL to VDSL, moving to G.Fast would involve the replacement of more of the existing copper with fibre connections and the installation of electronic equipment closer still to the individual property – often on a pole or in a cabinet close by (i.e. within 500 metres). G.Fast technology was expected to deliver speeds of over 100 Mb/s, and up to 1 Gb/s, again depending on the length of the copper connection.

51. BT announced it was launching G.Fast pilots in January 2017. It had initially announced its intention to deploy G.Fast to serve households in most of the UK, representing around 15 million premises, by 2025. This would be in addition to 2 million households to be served by FTTH technology. Subsequently, BT adopted a target to serve 10 million premises with G.Fast by the end of 2020. At the end of 2018, BT had deployed G.Fast to serve a little over 2 million households and serves 2.8 million today[29]. In June 2020, BT announced that further deployments of G.Fast will not occur until after April 2021 at the earliest[30]. Given BT's and the UK Government's focus on FTTH technology, it seems unlikely that significant further investments will be made in G.Fast by BT. However, it is unclear

whether or when those households that are already served by G.Fast networks will be upgraded to FTTH. We do not know how many G.Fast households are in Wales, but expect it to be small (we do know pilots were undertaken by BT in some areas of Cardiff[31]).

52. Following the 2017 election, the May Government published the results of its Future Telecoms Infrastructure Review (FTIR) in the same month as the UK NIC's National Infrastructure Assessment was published[32]. The review was intended to identify the actions necessary to realise the Government's FTTH ambitions. It remains the most recent substantive policy document on FTTH to be published by the UK Government.

53. The FTIR broadly adopts the recommendations of the UK NIC. That is, the Government proposes that competition between rival firms should be expected to drive the roll out of FTTH to around 80% of UK households provided the Government takes appropriate steps to encourage and facilitate such competition. This is based on modelling by its advisers (again Frontier Economics). The Government expected that 10% of households will be served on a commercial basis by a single provider and that the remaining 10% of households will prove unviable to serve under any conditions and will therefore require public subsidy. The FTIR estimated that £3-5 billion of public subsidy would be required to ensure that the last 10% of households were provided with FTTH.

54. The projection of 90% commercial coverage assumes that the Government implements a range of measures to promote competition which we list below – and that those measures prove effective. If they do not, Frontier estimated that 60% of UK households would be served with FTTH on a commercial basis by 2033, leaving 40% of the UK to be supported with public subsidy[33]. The measures which the UK Government have now taken or are taking to promote competition and hence the commercial deployment of FTTH include:

a. A series of measures to reduce the costs of deploying new FTTH infrastructure, such as simplification of planning and permitting rules when undertaking streetworks, addressing the need to obtain consents from private landlords to install new connections and obligations on developers to install FTTH in new building developments (some of which have been implemented through changes to the 2017 Digital Economy Act and others of which were included in the proposed Telecoms Infrastructure (Leasehold Property) Bill which is currently awaiting a third reading in the House of Lords[34] or will be implemented by planned amendments to building regulations[35]).

31. https://gov.wales/sites/default/files/statistics-and-research/2019-10/evaluation-next-generation-broadband-wales-programme-2015-18.pdf, para 3.25
32. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf
33. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727890/FTIR_Annex_A_-_FE_Report.pdf, p.7
34. https://services.parliament.uk/bills/2019-21/telecommunicationsinfrastructureleaseholdproperty.html
35. https://www.gov.uk/government/news/new-build-homes-to-come-gigabit-speed-ready

b. Application of the policy, already adopted by Ofcom as part of the findings of its own 'Strategic Review' which reported in February 2016[36], to allow new firms to use BT's existing ducts and poles to deploy their own FTTH infrastructure, thereby removing the cost and difficulty of digging trenches themselves (this work remains ongoing today).

c. 'A stable and long term regulatory framework', which is administered by Ofcom but which the Government reiterated in their first 'strategic steer' to Ofcom, a measure which was enabled by the Digital Economy Act 2017[37].

d. A 'switchover process' for the decommissioning of the existing copper network once FTTH has been deployed that would support demand for FTTH services. These are matters on which BT and Ofcom have since been consulting with the rest of the telecoms industry. It is rumoured that BT is currently proposing to fully decommission its copper network by 2027, subject to certain conditions (including some of the measures listed above) being met by the Government and other industry participants[38].

55. Boris Johnson was critical of the May Government's FTTH plans during the Conservative leadership contest and proposed to accelerate deployment to achieve universal FTTH coverage by 2025, a promise he reiterated at the Conservative Conference in September 2019. His position was widely criticised as being impractical and unachievable[39]. It has since become apparent that this target has been abandoned by the Johnson Government[40], although a clear statement of current UK Government's policy is not easy to find. The then Culture Secretary, Nicky Morgan, suggested that the Johnson Government remained committed to achieving 'universal gigabit capability' by 2025 – the significance being that 'gigabit capability' could be obtained by a combination of FTTH, DOCSIS and 5G technologies rather than the relying wholly on FTTH[41]. More recently, in July 2020, Matt Warman, the Minister for Digital Infrastructure, said that deployment would 'go as fast as we possibly can…but it is also right to say that it [100% by 2025] is an immensely challenging target'[42]. We interpret this to mean that the UK Government's current target is the widespread deployment of gigabit-capable infrastructure by 2025, most of which it expects to be FTTH, but without the expectation that every household or business would be served by then and no further target as to when the remainder of the build would be completed by.

36. https://www.ofcom.org.uk/__data/assets/pdf_file/0016/50416/dcr-statement.pdf
37. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779226/SSP_Consultation_-_Publication_Version__2_.pdf
38. https://www.ispreview.co.uk/index.php/2019/09/bt-to-propose-full-fibre-move-and-copper-switch-off-by-2027.html
39. https://www.independent.co.uk/news/uk/home-news/boris-johnson-broadband-full-fibre-rollout-target-telecoms-a9037631.html
40. https://www.bbc.co.uk/news/technology-50042720
41. https://www.ispreview.co.uk/index.php/2019/10/culture-secretary-confirms-2025-uk-gigabit-broadband-for-all-aim.html
42. https://www.ispreview.co.uk/index.php/2020/07/uk-gov-appears-to-soften-2025-gigabit-broadband-target.html

Public funding of FTTH

56. In September 2019 the then Chancellor announced that the Johnson Government would allocate £5bn to support its target of universal FTTH by 2025[43]. The Chancellor appeared to think that moving the target from 2033 to 2025 would mean that a further 10% of households would not be served on a commercial basis, so that coverage of 20% of households would need to be subsidised. However, it remains unclear whether or not the £5bn estimate of the Chancellor reflects a revised view of the costs of FTTH (relative to the view in July 2018 that £5bn of subsidy might be required for the last 10%).

57. Since VDSL technology can be deployed at a substantially lower cost per household than FTTH technology, we might expect the commercial opportunity for FTTH (assuming the transition from VDSL to FTTH is not accompanied by a significant increase in revenues) to be more limited than VDSL. VDSL coverage of around 65% was achieved in the UK on a commercial basis (but as we explain below, the figure was much lower in Wales). The Government's FTIR assumption that the FTTH could extend, on a commercial basis, to more households than VDSL would, therefore, appear to be ambitious. If the measures to extend FTTH commercially fail to achieve their intended outcomes, then the Government's expectation that universal FTTH would require £5 billion of public subsidy would likely need to be substantially revised.

58. The NIC's advisers have estimated the capital expenditure required to achieve varying levels of FTTH coverage across the UK[44]. Achieving 100% requires around £22 billion of capital, which contributes to the £33 billion figure of total costs (the rest are operating costs) referred to above. However, achieving FTTH coverage of the first 50% of the UK population requires expenditure of only around £5 billion. £17 billion is then required to extend coverage to the remaining 50% of UK households.

59. If FTTH coverage on a commercial basis were to be only 60% (as the Government's own advisers suggested would be the case in the absence of the Government's additional measures) then the capital required to serve the remaining 40% would be of the order of £15 billion. If the 'aid intensity' were to be around 60% (as it was for the BDUK VDSL programme), then the public funding contribution to serve the remaining 40% would be £9 billion. If the FTTH coverage were to extend to 90% on a commercial basis, as the FTIR suggests, then the public funding requirement would be around £6 billion. Thus, a reasonable range for the public funding requirement for universal FTTH in the UK, based on the UK NIC's and UK Government's own figure, would appear to be between £6 and £9 billion. These figures are, of course, subject to a high degree of uncertainty, particularly in relation to the underlying costs of deploying FTTH and in relation to the share of costs or aid intensity which might apply in relation to FTTH. We assume an upper bound of £10 billion in this report.

43. https://www.bbc.co.uk/news/technology-49881168
44. https://www.nic.org.uk/wp-content/uploads/Cost-analysis.pdf, p.11

Current UK Government actions to support FTTH

60. The UK Government and Ofcom have already been proceeding on a number of fronts to promote an accelerated deployment of FTTH in the UK. BT's target of passing 3 million households with FTTP (having passed around 3 million by June 2020) by March 2021 was increased to 4 million households in May 2019 and stands today at 4.5 million by March 2021. BT's aim of reaching 10 million households by 2025 was also increased to 15 million (still only half of Boris Johnson's target of universal coverage of 30 million households by 2025) and in May 2020 BT said, in its most recent projections, that it expected to pass 20 million households by the 'mid to late 2020s' provided certain conditions are met[45]. It also predicted average costs per household for FTTH (across the 20 million households it proposed to cover) as £300-400.

61. As this report was being finalised, the CEO of BT was reported to have referred to unpublished research that had been undertaken for BT and which predicted that, at current rates of deployment, FTTH coverage would reach 70% of UK households and businesses by 2025 and that full national coverage would not be achieved until 2033[46]. BT advised the UK Government that with significant additional action, full coverage might be possible by 2027.

62. Investment in FTTH by alternative providers, including firms such as Gigaclear, Cityfibre, Hyperoptic and Virgin Media are also continuing at some pace, and new entrants such as You Fibre, Zzoomm, Toob, Voneus and Community Fibre are also emerging. Many of these firms have announced relatively modest deployment plans (of the order of 1 million households passed with FTTH technology) and most of them are currently seeking funding from equity investors before they attempt to raise the debt required to fund the majority of their roll out. Most are seeking to deploy FTTH in specific local areas, normally avoiding competition with each other. Most are based in England and none appears to have plans for Wales (although we are aware of one operator, Beacons Telecom based in Crickhowell, which is currently undertaking a small scale FTTH deployment in Gilwern in Powys)[47]. The aggregate coverage provided by these operators, if they were to implement the plans they have announced as at August 2020, would represent around 43 million households (of which Virgin Media represents around 16 million and the other FTTH operators the remaining 27 million), or equivalent to 1.5 networks per household. In practice, it is likely that a significant proportion of this investment will involve the duplication of networks, as providers compete to serve the same households in the same areas, and that at least some of the firms will fail to achieve their targets.

45. https://www.bt.com/bt-plc/assets/documents/investors/financial-reporting-and-news/quarterly-results/2019-2020/q420-slides.pdf
46. These estimates were confirmed by BT in a blogpost at https://newsroom.bt.com/the-road-to-full-fibre/
47. https://beaconstelecom.com/

63. The UK Government has also directed BDUK to reallocate Phase 2 funds away from support for superfast VDSL broadband and towards FTTH instead. The Government announced a separate £200 million Local Full Fibre Network Challenge Fund, which is intended to support FTTH initiatives by local communities (often working in conjunction with established FTTH providers, including BT). These funds were allocated in three phases, with the last announced in March 2019[48]. The funds allocated are small (awards have been made to over 20 applicants), ranging from £1 million to £15 million. For example, the North Wales Economic Ambition Board successfully bid for £7 million to connect public institutions such as libraries, GP surgeries and schools to FTTH in Denbighshire, Wrexham, Conwy, Flintshire, Anglesey and Gwynedd[49]. The Gigabit Voucher Scheme has also allocated £67 million to support UK households and SMEs connecting to FTTH networks with grants of up to £3500[50].

64. The UK Government's flagship programme for FTTH is currently the Rural Gigabit Connectivity Programme which was announced in May 2019[51]. £200 million has been allocated to this fund. The aim is to deliver FTTH to public institutions or 'hubs' such as schools and libraries, in the expectation that this will also stimulate commercial investments to extend FTTH to households and businesses in the surrounding area (including with the assistance of the Gigabit Vouchers referred to above). The Government aims to connect 300 rural schools by March 2021.

65. In the December 2019 Queens Speech the Johnson Government announced three measures that were intended to facilitate the realisation of its fixed broadband plans. The Government aimed to address the challenges of installing fibre to home connections when requests from operators seeking access from a landlord receive no response. It also sought to address concerns that large number of new build developments were still being built without a gigabit-capable connection. The government intends to implement these measures by means of the Telecoms Infrastructure (Leasehold Property) Bill 2019-21 and amendments to building regulations.

66. The Telecoms Infrastructure (Leasehold Property) Bill 2019-21, which has cross-party support and is currently awaiting a third reading in the House of Lords, will create a cheaper and faster process for telecoms companies to obtain interim code rights (or access rights) from a court for a period of up to 18 months. This will mean that they can install broadband connections where the landlord has failed to respond to previous requests for access.

48. https://www.ispreview.co.uk/index.php/2019/03/government-lists-9-winning-uk-bidders-for-wave-3-full-fibre-fund.html
49. https://www.ispreview.co.uk/index.php/2019/06/north-wales-sets-out-gigabit-full-fibre-plan-to-connect-public-sites.html
50. https://researchbriefings.parliament.uk/ResearchBriefing/Summary/CBP-8392
51. https://www.gov.uk/government/publications/rgc-programme-key-information

67. Amendments to building regulations in England will:

a. Guarantee that all new build homes have the infrastructure to support gigabit-capable connections; and

b. Require developers to work with broadband companies to install gigabit-capable connections in virtually all new build homes, up to a cost cap of £2000[52].

68. We understand the Welsh Government plans to consult on similar amendments to building regulations in Wales.

69. The £5 billion FTTH subsidy programme announced by the Johnson Government, will be administered by the renamed BDUK unit, now known as 'Building Digital UK'[53]. Details of the programme began to emerge during our investigation, although the precise allocation of funds remains unknown at this point. In July 2020, it was reported that the plans included:

a. A series of 'demand side' interventions to promote fibre connections to public institutions and sites (presumably in addition to the Rural Gigabit Connectivity Programme referred to above, although this is still unclear).

b. An extension of the existing Rural Gigabit Voucher Scheme (referred to above) beyond its current projected expiry of March 2021. It seems likely that this could involve larger vouchers and more funding in total. In July, the UK Government launched a pilot of a new website for the 'Broadband Upgrade Fund' to allow households in certain counties to register their interest in upgrading to FTTH or other gigabit networks (and for individuals to volunteer to be local co-ordinators). Households who currently have access to broadband at speeds of less than 100 Mb/s (so they may already have superfast broadband) are eligible to apply for vouchers to upgrade to FTTH. The vouchers have the same value (£1500 for households, £3500 for businesses) as those under the Rural Gigabit Voucher Scheme. For Wales, Carmarthenshire, Ceredigion and Pembrokeshire have been included in the pilot[54].

c. The allocation of grants, under terms similar to the previous BDUK superfast subsidy programme, to support commercial investments in FTTH infrastructure in areas which would not otherwise be viable to serve commercially. This is expected to consume the majority of the £5 billion budget. Initial indications are that the programme would involve the tendering of many more much smaller lots (of around 3,300 premises) in order to attract interest from at least some of the new smaller FTTH operators we referred to earlier (who may lack the resources to commit to larger contracts)[55].

52. Reflecting a pledge the Government made on 17 March 2020, when it committed to introducing legislation to make sure that developers prioritise on the installation of high-quality digital infrastructure from the outset in new build homes. See https://www.gov.uk/government/news/new-build-homes-to-come-gigabit-speed-ready

53. https://www.ispreview.co.uk/index.php/2019/10/bduk-possible-build-scenario-for-uk-full-fibre-broadband-rollout.html

54. https://broadband-upgrade-fund.campaign.gov.uk/about

55. https://www.ispreview.co.uk/index.php/2020/07/progress-on-bduk-plan-for-5bn-uk-gigabit-broadband-rollout.html

It also appears that public funds will be available for infrastructure which is 'capable' of gigabit speeds even if it cannot deliver them at the time it is deployed, provided the infrastructure being deployed can deliver at least 500 Mb/s. Crucially, in 'limited cases' it may be possible to obtain public funds under the new UK Government scheme when deploying infrastructure which is capable of 'ultrafast' speeds (these have yet to be defined but could be 100 Mb/s or 300 Mb/s[56]). This would appear to allow home broadband services delivered using 5G (and perhaps 4G) technologies to qualify for public subsidy. Officials are reported to be planning to award contracts for large FTTH projects from late 2021, which suggests that actual deployment under these contracts is not likely to commence until late 2021 or early 2022. This would appear to be further evidence to doubt the prospects of achieving of the 2025 target of nationwide deployment: it is likely to take several years to award all of the contracts (particularly if lots were to be very small and many tenders were to be competitive), in which case deployment in some areas will only be starting (rather than finishing) in 2024 or 2025.

70. As at January 2020, the latest date for which we have figures, Ofcom reported that 12% of UK households could now connect to an FTTH network, representing 3.5 million properties and an increase of over 500,000 over the previous four months[57]. In August 2020, the UK Government announced that around 25% of UK households could access 'gigabit' connections. Other modelling (by Thinkbroadband) suggests 14% of households can access FTTH networks today (August 2020), with the remainder being served by Virgin Media which has recently upgraded its DOCSIS cable infrastructure to enable gigabit speeds[58].

71. The UK Government has also announced that 45,000 Gigabit Broadband Vouchers had been issued, representing a value of £90 million, to support 29,000 new connections[59]. At the same time, the UK Government announced the creation of a new Gigabit Take Up Advisory Group to consider further actions to promote the adoption of gigabit connections by households and businesses that are already able to obtain them. Current take up rates for gigabit services appear to be at around 30% in the UK.

56. 100 Mb/s is the standard definition used by the European Commission and most others, but Ofcom appears to adopt 300 Mb/s. Brexit may have implications here, since the new UK scheme will not require approval under the European Commission State Aid regime (which has previously imposed conditions on the performance characteristics of infrastructure that can receive public subsidy). This may give the UK Government greater flexibility, although negotiations between the European Union and United Kingdom for an exit agreement also appear to involve the creation of a new UK State Aid regime, with which the gigabit public subsidy programme would then presumably need to comply.

57. https://www.ofcom.org.uk/__data/assets/pdf_file/0028/195256/connected-nations-spring-update-2020.pdf

58. https://labs.thinkbroadband.com/local/

59. https://www.gov.uk/government/news/gigabit-broadband-rollout-milestone-reached. It is unclear how the £90 million spent relates to the £67 million of funding that was originally earmarked by the Government for this purpose, but it may include funds allocated to previous voucher schemes.

72. In July 2020, the UK Government also announced that it had participated in a consortium (with Bharti Airtel) to acquire OneWeb, the owner of a fleet of low earth orbit global satellites[60], purchasing a 'significant equity stake' for $500 million. Similar systems to deliver 'fibre like' broadband connections are being developed by firms such as Starlink[61]. The UK Government's objectives in acquiring an interest in this business remain unclear to us and we do not consider it likely to be relevant to our investigation or recommendations.

Superfast broadband in Wales

73. Wales has faced many of the same challenges in relation to the deployment of broadband infrastructure as the rest of the UK. BT remains the dominant provider of fixed broadband services throughout Wales, with Virgin Media providing alternative superfast and ultrafast broadband services in the densely populated Cardiff and Newport areas. More recently, Virgin Media has been extending its network in Wales (Wrexham) as part of its 'Project Lightening' programme, which was planned to pass another 4 million households across the whole of the UK by the end of 2019 and had passed 1.8 million in the summer of 2019[62]. The combination of the lack of competition and the relatively high costs of serving rural households in Wales initially meant that Welsh superfast broadband availability lagged far behind the rest of the UK as BT deployed VDSL on a commercial basis. In 2011, for example, only 31% of Welsh households had access to superfast broadband, compared to an average of 58% across the UK as a whole[63]. In 2011, the Welsh Government determined that only around 35-40% of Welsh households would be likely to access superfast broadband services on networks built on commercial terms, compared to around two thirds of households who could be served on a commercial basis in the UK as a whole. We were told by the Welsh Government that the actual proportion served by superfast on a commercial basis had been 48%, still significantly below the UK average.

74. Despite this, Welsh Government targets for broadband coverage have tended to be more ambitious than those adopted by the UK Government. For example, in 2010 the Welsh Government suggested that all households should have access to superfast broadband, which it defined as being speeds of at least 30 Mb/s rather than the 24 Mb/s threshold used by the UK Government[64], and capable of 100 Mb/s, by 2020 and all businesses by 2016[65]. In 2012, as part of the UK's broader BDUK programme, the Welsh Government concluded an agreement with BT for the provision of superfast broadband services to 95% of the households in the 'intervention area' which had been identified as being unlikely to otherwise be served

60. https://www.gov.uk/government/news/uk-government-to-acquire-cutting-edge-satellite-network
61. https://www.starlink.com/
62. https://www.ispreview.co.uk/index.php/2019/08/virgin-media-hit-5-266-million-uk-broadband-users-as-network-grows.html
63. https://www.ofcom.org.uk/__data/assets/pdf_file/0022/53158/fixed_broadband_june_2011.pdf, p.6
64. 30 Mb/s was the threshold for 'next generation access' adopted by the European Commission. The UK Government adopted a lower threshold, 24 Mb/s, which was achievable using DSL technology at the time.
65. https://gov.wales/sites/default/files/publications/2019-07/delivering-a-digital-wales.pdf, p.28

on a commercial basis. This represented 690,000 premises[66], was branded the 'Superfast Cymru' programme and was one of the largest of its kind in the UK (principally because the Welsh Government let a single contract for the whole of Wales, rather than delegating the procurement process to local authorities, as was done in England). All of these households were expected to be able to obtain speeds of at least 24 Mb/s, but 40% were expected to be able to obtain speeds of at least 100 Mb/s.

75. In addition, BT committed to make 'FTTH on demand' available in Wales on a commercial basis. 'FTTH on demand' has been available in the UK to businesses (and households who are prepared to pay thousands of pounds for a FTTH connection) since 2013. BT Openreach has made various changes to its pricing model since then, but costs remain very high. Businesses (but not households) in Wales have been able to apply for a voucher (grant funding) from the Welsh Government to fund a connection of at least 100 Mb/s to the value up to £10,000. As of October 2018, 1700 Welsh businesses had obtained funds totalling £1.2 million under this and another scheme (Access Broadband Cymru) which encouraged households to upgrade from very low speed broadband connection to those that were at least twice as fast (with households receiving £800 if the new connection was at least 30 Mb/s and £400 if at least 10 Mb/s)[67].

The Access Broadband Cymru scheme remains in place[68] but the 'broadband on demand' scheme was superseded by the UK and Welsh Government's Gigabit Voucher Scheme in March 2019. In this case the Welsh Government offered funds to provide an additional £300 per household and £3000 per business, over and above the £500 and £2500 respectively provided by the UK Government[69]. The map on the UK Government website suggests that some vouchers have been allocated in north and south but very few in mid-Wales[70]. It is unclear whether the additional subsidy offered by the Welsh Government has done anything to contribute to higher FTTH adoption in Wales than in the rest of the UK (but the comparatively low level of community broadband projects in Wales, which we discuss below, would suggest it may not). As noted above, a number of Welsh counties are also currently participating in the pilot of the Broadband Upgrade Fund.

76. Consistent with the UK Government's wider targets, Phase 1 of the Superfast Cymru programme was intended to deliver superfast broadband coverage to 95% of Welsh households by 2015, subsequently revised to 2016 (as it was for the rest of the UK). BT also agreed to employ 100 apprentices as part of the programme. A number of features of the Superfast Cymru phase 1 programme should be noted:

66. https://www.audit.wales/system/files/publications/Broadband_2015_English.pdf
67. https://www.ispreview.co.uk/index.php/2018/10/progress-update-on-the-broadband-voucher-schemes-in-wales.html
68. https://gov.wales/go-superfast/boost-your-broadband#:~:text=This%20scheme%20provides%20grants%20to,homes%20and%20businesses%20in%20Wales.&text=The%20amount%20of%20funding%20you,800%20for%2030Mbps%20and%20above
69. https://gov.wales/gigabit-broadband-voucher-scheme-boost-wales
70. https://gigabitvoucher.culture.gov.uk/home/about-the-scheme/

a. The programme had to be large because the proportion of households in Wales requiring public subsidy to obtain access to superfast broadband services was significantly higher than in the rest of the UK, where a higher proportion were expected to be able to be served on a commercial basis.

b. The requirement that at least 40% of households obtain speeds of more than 100 Mb/s, which was unlikely to be achieved using VDSL technology, was relatively unusual at the time and may at least partly explain why the programme supported a higher proportion of FTTH deployment by BT in Wales than the rest of the UK (where BDUK programmes were predominantly VDSL)[71]. In 2017, 3% of Welsh households had access to FTTH connections, the same as in the UK as a whole. However, 9% of rural households in Wales had access to FTTH, compared to only 5% in the UK[72]. This may in part reflect the impact of the targets, but may also reflect the challenges of deploying VDSL technology in some parts of rural Wales where the length of the copper lines mean that VDSL technology cannot achieve the speeds (of at least 24 Mb/s) required by the contract. This noted, the gap between Wales and the rest of the UK is narrowing (as new investments in FTTH have tended to focus on England). As at January 2020 (the latest figures), 13% of Welsh properties can obtain FTTH services, compared to 12% in the UK and 11% in England[73]. Estimates for July 2020, suggest that 15% of Welsh households had access to FTTH, the same proportion as the UK as a whole[74]. If recent trends continue, Welsh FTTH coverage is likely to progressively fall behind that of England or the UK average (although is likely to remain higher than that in Scotland).

c. As a result of these factors, the public share of the funding of the Superfast Cymru phase 1 programme, known as the 'aid intensity', was higher than in BDUK superfast broadband programmes elsewhere in the UK[75]. Of a total capital funding requirement of £231 million, BT contributed only £26 million. The Welsh Government contributed £58 million, as did the UK Government via BDUK. The balance, of £90 million, was provided by the European Regional Development Fund[76]. The aid intensity for Superfast Cymru was therefore a little under 90%, which compares to aid intensity for other Phase 1 projects in the UK as a whole of between 60% and 85%. A higher proportion of the cost of broadband infrastructure deployed in Wales has been and is being funded by taxpayers than in the rest of the UK.

71. SQW suggest that the Welsh Government initially hoped that BT would use FTTH rather than VDSL for most of the deployment, but it became clear during the procurement phase that this was 'unaffordable', http://www.sqw.co.uk/files/8814/7560/5709/160928-next-generation-broadband-wales-programme-en.pdf, p.26-7.
72. https://www.ofcom.org.uk/__data/assets/pdf_file/0023/108842/wales-connected-nations-2017.pdf, p.15
73. https://www.ofcom.org.uk/__data/assets/pdf_file/0028/195256/connected-nations-spring-update-2020.pdf
74. https://labs.thinkbroadband.com/local/
75. The Welsh Government advise us that once the additional 40k households referred to para 76(d) are taken into account, aid intensity is similar to that of other procurements elsewhere in the UK.
76. https://www.audit.wales/system/files/publications/Broadband_2015_English.pdf, p.11

d. As with the other BDUK phase 1 schemes, the programme broadly achieved its objectives and the gap in coverage between Wales and the rest of the UK had largely – although not entirely – been eliminated by 2017. At this point 89% of Welsh households could access superfast broadband, compared to 91% across the UK as a whole[77]. By the end of 2018, the Welsh Government announced that the Phase 1 scheme had extended superfast coverage to 730,000 premises and that 95% of households could now obtain superfast services[78]. No statement was made about the target to offer connections to all businesses. (Ofcom currently reports Wales as having 93% superfast broadband coverage (as at January 2020)). The increase from the original 690,000 target was agreed in 2014 following identification of another 40,000 households that would not be served commercially, and the deadline for delivery extended from 2016 to June 2017 to reflect this.

e. The Welsh Government had a target that 50% of Welsh households should be using superfast broadband services by 2024[79] and some resources were devoted by BT (£1.7 million, mainly for a website and 3 staff) promoting take up as the network was built. Take up (at least amongst households) significantly exceeded expectations at 49% by December 2018[80], and appears to have been amongst the highest of all Phase 1 projects in the UK. However, research also showed that over 30% of businesses and 40% households not connected to the network after 6 months were not aware that they could do so[81].

Current Welsh Government broadband policy

77. The Welsh Government does not appear to have made any public statement about its plans for Wales following the publication of the UK Government's Future Telecoms Infrastructure Review of 2018[82]. There is not, therefore, currently a specific target for FTTH coverage in Wales, other than that implied by the UK Government's targets for the UK as a whole.

78. The Welsh Government has sought bids for Superfast Cymru 2 funds[83] to further extend superfast broadband beyond the 93% of the population who could obtain it according to the latest Ofcom data. It identified three areas or Lots on which it sought bids. The programme had originally allocated £62 million of public funds, £2m from BDUK, £33 million from the European Union, £27 million from the Welsh Government[84]. However, only £26 million of the £62 million was initially allocated to projects to serve 26,000 households at the end of the bidding process by March 2021[85]. We understand that 8,300 households had been passed with FTTH by May 2020.

77. https://www.ofcom.org.uk/__data/assets/pdf_file/0023/108842/wales-connected-nations-2017.pdf, p.10
78. https://gov.wales/written-statement-superfast-cymru-0
79. It is unclear where this target, announced in 2015, derives from. The European Union has adopted a target of 50% of households using broadband services of at least 100 Mb/s (not 24 Mb/s as provided by Superfast Cymru) by 2020. There is no European or UK target for 2023.
80. Op cit, p.21
81. http://www.sqw.co.uk/files/8814/7560/5709/160928-next-generation-broadband-wales-programme-en.pdf, p.28
82. The Welsh Government website simply refers to efforts to pass a further 26,000 homes, which is a reference to the Phase 2 Superfast Cymru programme.
83. We refer to this programme as 'Superfast Cymru 2' or 'phase 2' (as it is commonly known), although Welsh Government advise us it forms part of the BDUK phase 3 programme.
84. https://www.ispreview.co.uk/index.php/2018/10/welsh-government-award-13m-fibre-broadband-contract-to-bt.html. and as advised by the Welsh Government.
85. https://www.ispreview.co.uk/index.php/2019/05/welsh-gov-admit-subsidised-rural-fttp-broadband-coming-to-an-end.html

79. The original aim of the Welsh Government was for the phase 2 programme to provide superfast broadband of at least 30 Mb/s and preferably FTTH for 100 MB/s+ to at least 88,000 households. We were told by Welsh Government and Openreach (see Chapter 4) that funds remained unallocated because Openreach was unable to commit to building to more households before the March 2021 deadline, but that the funds would nonetheless be used to deliver additional FTTH infrastructure after that date. Since then, the Welsh Government has announced in July 2020 that the Phase 2 programme has extended to include a further 13,000 households, bringing the total to 39,000 households, at an additional cost of £30 million[86]. This suggests that the additional costs per household have risen dramatically, from £1000 to over £2,300. It is reasonable to assume that any allocation of the unspent funds to support FTTH deployment would involve even higher levels of subsidy per household passed. This compares to the £300-400 average cost per household projected by BT for its commercial deployment of FTTH over the next 5-10 years.

80. In June 2020, the Welsh Government announced that its latest review had found that 79,000 premises were still not expected to obtain access to superfast broadband under either commercial plans or the Phase 2 programme[87]. Other sources suggest that at least 52,000 premises are currently (as at August 2020) unable to access superfast broadband in Wales[88]. To address this issue, the Welsh Government has recently (in June 2020) increased its additional contribution to the Rural Gigabit Broadband Voucher Scheme still further, adding £1,500 and £3,500 to the UK Government's vouchers, effectively doubling the grant to £3,000 per household and £7,000 per business respectively[89]. The scheme is targeted at 50,000 households, of which a significant proportion are likely to be unable to obtain superfast broadband services today. Whether even these levels of subsidy will be sufficient to induce operators to deliver FTTH infrastructure to these households (assuming the householders obtain the vouchers required) remains unclear. Giventhe other evidence presented above, it seems likely that the costs of connecting these households could substantially exceed even the £3000 which is now available.

81. It should be noted that in Scotland the Government's Phase 2 'Reaching 100%' (R100) superfast broadband programme appears to have encountered similar challenges to those in Wales. This programme, with a budget of £600 million, was intended to extend superfast VDSL broadband of at least 30 Mb/s to the last 5% of Scottish households by the end of 2021. Contracts are not now expected to be signed until the end of 2020[90] and completed by 2023/4. The Scottish Government had intended the R100 programme to extend coverage to around 180k households, in three Lots. Two of the

86. https://www.ispreview.co.uk/index.php/2020/07/wales-extends-bt-fttp-broadband-rollout-to-39000-premises.html
87. https://www.ispreview.co.uk/index.php/2020/06/79000-premises-in-wales-remain-without-superfast-broadband.html
88. https://labs.thinkbroadband.com/local/
89. https://www.gov.uk/government/news/uk-and-welsh-governments-team-up-on-big-broadband-boost-for-rural-wales
90. https://www.ispreview.co.uk/index.php/2019/06/scotlands-r100-broadband-contract-delayed-until-end-of-2019.html

three were uncontested and have been awarded to BT[91]. Whereas the Welsh Phase 2 awards envisage all households being served with FTTH, the Scottish Government is said to be seeking FTTH connections at only 25% of the households in the third Lot (for Northern Scotland and the Highlands), which is being contested in court by Gigaclear and has yet to awarded. Although details have yet to be published, it seems likely that the Scottish Phase 2 programme will fall some way short of the 180k households originally targeted.

82. The Scottish Government had, since 2012, also established a 'Community Broadband Scotland' scheme which provides support to local communities who are seeking to develop and fund their own community broadband schemes in areas which are nether served by BT on a commercial basis nor fell within the Phase 1 scheme (i.e. were within the last 5% of households without any form of superfast broadband). Around £6.5 million was spent by the Government to deliver broadband to fewer than 2000 premises. Audit Scotland concluded that this programme had failed, and the Scottish Government discontinued it, instead inviting existing schemes to be incorporated into the R100 plan discussed above[92].

83. Both the UK and Welsh Governments have also sought to promote various community broadband schemes in which local communities contribute to the funding of the infrastructure[93] and the UK NIC report, quoted earlier, also suggested that communities who volunteered to contribute should receive preferential access to public funds. The highest profile community enterprise (cited as an example by the UK NIC) is B4RN or Broadband for the Rural North, which uses local volunteers to operate an FTTH network passing around 10k households in rural Lancashire and Yorkshire[94], supported by a combination of crowdfunding and Gigabit Broadband Vouchers. Similar schemes, often involving less than a hundred householders, operate in some other rural areas.

84. BT runs a 'Community Partnership Scheme' which allows households to co-fund infrastructure alongside BT. BT reports that 850 such agreements have been concluded and that 100k households and businesses have been, or will be, able to obtain access to superfast or FTTH broadband as a result, with economic benefits for 60,000 premises of £340 million over 15 years[95]. 90% of Community Partnerships to date have involved VDSL technology. A significant proportion of the benefits (£1700 per household) have been attributed to the increase in house valuation as superfast broadband became available. A study undertaken by consultants for BT identified benefits in terms of business productivity, access to new markets and innovation,

91. https://www.ispreview.co.uk/index.php/2019/10/scotland-pick-bt-for-part-of-600m-superfast-broadband-rollout.html
92. https://www.audit-scotland.gov.uk/uploads/docs/report/2018/nr_180920_broadband.pdf, p.9-10
93. https://www.gov.uk/government/publications/community-led-broadband-schemes/introduction-to-community-led-schemes
94. https://www.thinkbroadband.com/news/8352-updates-to-b4rn-full-fibre-footprint
95. https://www.openreach.com/news-and-opinion/articles/openreach-community-fibre-programme-brings-p340m-worth-of-benefi

the creation of new businesses in rural areas, and homeworking (where they assume that 20% more households work from home with superfast broadband and that they are 20% more productive when they do so)[96].

85. It is not clear how many community broadband schemes have been undertaken in Wales to date. The Welsh Government cites Michaelston y Fedw, which developed an FTTH network to serve 200 households during 2018. This claims to be the first community FTTH network in Wales and is certainly one of very few[97]. It is not clear what proportion, if any, of the 100k households in BT Community Partnerships are located in Wales but Openreach told us it had 8,000 households in the pipeline for 2020[98]. The Welsh Government has set aside £10 million of capital for what it describes as the 'Local Broadband Fund' which appears intended to support more community based initiatives in Wales (presumably leveraging the Gigabit Broadband Voucher scheme). We understand implementation was delayed by the COVID-19 pandemic but that the first set of applications were sought in July 2020 and are currently being assessed (further applications will be sought every 6 months until 2023).

86. A number of points emerge from this:

a. At first sight, Wales starts from a stronger position in relation to FTTH than VDSL, where we noted that coverage had been significantly behind the rest of the UK prior to the Superfast Cymru programme. In contrast, the latest data from Ofcom shows that a slightly higher proportion of Welsh properties could obtain FTTH (13%) than in the UK as a whole (12%).

b. On the other hand, the gap between Welsh FTTH provision and the rest of the UK (and England in particular) has been diminishing over time and is likely to reverse in the coming years. The Welsh advantage in FTTH in the past is attributable to the specific features of the Phase 1 Superfast Cymru programme, which is now to be superseded by a new £5 billion funding programme in the UK. At the same time, progress in England has been driven in part by Openreach (which also has a significant presence in Wales), Virgin Media (which has a much more limited presence in Wales than in the UK as a whole) and a group of new FTTH operators (none of whom currently appear to have plans for Wales). Unless the Welsh Government takes further action, we can expect Wales to move from the top of the FTTH league to towards the bottom in the next period (behind Northern Ireland but likely still ahead of Scotland).

96. https://www.openreach.com/content/dam/openreach/openreach-dam-files/images/fibre-broadband/community-fibre-partnership/how-to-apply-for-a-cfp/Impact%20of%20high%20speed%20bb%20for%20communities.pdf

97. https://www.myfi.wales/home. We are aware of other very small schemes in Crai and Llangattock, each involving fixed wireless access broadband technology and each involving fewer than 100 households. In July 2020, Pembrokeshire County Council also announced the award of £2 million (alongside £4m from the Local Full Fibre Networks Programme and £810,000 from Welsh Government) for an FTTH project to be implemented by Broadway Partners, https://www.ispreview.co.uk/index.php/2020/07/broadway-partners-picked-for-2-pembrokeshire-broadband-pilots.html

98. Meeting with Openreach, 5 March 2020.

c. In addition, only 93% of Welsh households can now access superfast broadband services (of at least 30 Mb/s) and around 3% still cannot access broadband at speeds of 10 Mb/s (and so will fall within the remit of the broadband USO from 2020[99]). The comparable figures for England are 95% and 2% and for Scotland 93% and 3%. The remaining Phase 2 Superfast Cymru programme will provide FTTH coverage for only 39,000 households. This will leave 50,000-80,000 Welsh households unable to access even reasonable broadband services (assuming that the Gigabit Voucher scheme is not capable of addressing this issue, as we do not believe it is in current form). Some of these households may be addressed through expenditure of the £105 million of funds that remain unspent or which have been clawed back from Openreach, although that would be at a likely cost well in excess of £3000 per household.

d. Public funding of FTTH deployment in Wales may be approaching its limits, at least for the next 5 years whilst operators focus on more profitable opportunities or until costs come down further. The same may be true in Scotland. The UK Government anticipates that 80% of premises will be served with FTTH on a commercial basis over the next 5 years. There is some competition between BT and alternative providers of FTTH networks developing elsewhere in the UK, but none of any significance in Wales. Competition is therefore limited to that between BT and Virgin Media, predominantly in South Wales.

e. The UK Government expected competition between BT and other providers to extend to around 70% of the country as a result of the measures it adopted in the FTIR but the impact these measures would have on the commercial activities of firms is uncertain at this stage. If they are less effective than the UK Government anticipates, then 60% rather than 80% of the UK might be served with FTTH on the commercial basis (70% with competition between operators and 10% by a single operator on a commercial basis), and perhaps less than this. History suggests that the lack of competition in Wales would mean that commercial roll out of FTTH would be significantly less than the rest of the UK[100]. We noted earlier that projections suggested that Wales would achieve VDSL superfast broadband coverage of 35-40% on a commercial basis and that it in fact achieved 48%. Commercial FTTH coverage could exceed this if the UK Government's measures prove effective but could be less than this (perhaps 45%) if they are not.

f. At the same time, it is not clear on the basis of the latest Phase 2 experience, what, if any, level of public subsidy would be necessary to induce BT or any other operator to serve the remaining 55%+ of households in Wales with FTTH. Even if BT were willing to deploy FTTH infrastructure to the 55% of households which it would not serve commercially, it is unclear whether the Welsh Government could commit funds to support FTTH deployment on this scale. The best evidence we have to date as regards costs is the latest Phase 2 funding

99. https://www.ofcom.org.uk/__data/assets/pdf_file/0028/195256/connected-nations-spring-update-2020.pdf. Curiously, the Ofcom figure of 4% for January 2020 is an increase from 3% in previous quarters. We suspect this is a measurement error rather than any change in the underlying position.

100. In late September, as this report was being finalised, BT advised us that they will be publishing research by Analysys Mason in November 2020 which suggests that 64% of Welsh households could be served on a commercial basis (compared to 75% in the UK as a whole). We consider these figures to be comparatively optimistic. BT made reference to this work in a blog at https://newsroom.bt.com/the-road-to-full-fibre/

announcement, the vast majority of which is applied to FTTH deployment. In that case, 13,000 homes will be passed at a cost to public funds of £2,300 per household (BT's contribution to the cost, and hence the 'aid intensity', does not appear to have been disclosed). It seems reasonable to assume that households within the intervention area which BT declined to include in the contract would require an even higher level of public subsidy (current Rural Gigabit Voucher levels in Wales, of £3000 per household they offer gives some indication of the likely level required). If we were to assume that the subsidy per FTTH household passed might average £2,000 across the 50% of Welsh households who might remain unserved on a commercial basis[101], then the public subsidy required to deploy FTTH to every household and business in Wales will be of the order of £1.3 billion. This compares with the £231 million of public funds applied to Phase 1 of the Superfast Cymru programme, of which the Welsh Government contributed less than £60 million, and £62 million in Phase 2, of which the Welsh Government contributed £27 million.

g. The Welsh Government's consideration of these issues should also be informed by the position in the rest of the UK. The current UK Government committed £200 million to its Rural Gigabit Connectivity Scheme and £67 million to Gigabit vouchers, of which Wales receives a small proportion. The UK Government allocated £67 million of its £530 million BDUK Phase 1 budget to Superfast Cymru, or about 13% of the total. On that basis, Wales might expect to receive around £30 million from current UK Government FTTH funding initiatives and £500-600 million from the £5 billion programme. As explained above, we think that would represent only about half of the funds required to deliver fibre to every home in the country.

101. Although Ofcom's figure of almost £3800 for FTTH households under the USO scheme (para 37) suggests that £2000 per FTTH household could be conservative.

Chapter 3

Evidence on the economic benefits of fixed broadband

87. Many studies have been produced to measure or predict the economic and other benefits arising from the provision of fixed broadband infrastructure. These benefits arise primarily from the adoption and use of broadband connections, rather than from the deployment of the infrastructure itself[102]. An econometric study for Ofcom of broadband adoption in OECD countries between 2002 and 2016 concluded that if broadband adoption increases from 10% to 20%, then GDP grows by 1.4%. If it increases from 20% to 30%, the impact on GDP is 0.82%, and the cumulative impact of the growth in broadband adoption over the entire 14 year period was estimated to be 4.34%[103]. Similar studies have been undertaken and similar conclusions drawn by the International Telecommunications Union, the OECD, World Bank and others[104].

88. There is therefore good evidence that broadband adoption has positive impacts in terms of productivity, economic output, wellbeing and the environment. At the same time, it is also recognised that the extent to which productivity gains are realised from digital technologies also depend on factors other than the availability of a broadband connection, including the capacity of firms to re-engineer their business processes and strategies in order to take full advantage of the opportunities afforded by digitisation[105]. In addition, some of the evidence suggests that gains from broadband in some communities may be at the expense of other communities (e.g. as businesses or employees relocate from one to the other), rather than representing a benefit to the nation as a whole.

89. The UK Government commissioned a report from SQW, a consulting firm, in 2013 to estimate the economic and other impacts of broadband for the UK[106], which at that time remained focussed on extending VDSL technology. SQW estimated that the roll out and take up of superfast broadband (and the universal availability of basic broadband of at least 2 Mb/s) would contribute to 0.07% growth in real annual GVA over the period from 2008 to 2024, of which 0.03% would be attributed to the BDUK programme (and the remainder to the commercial deployment of VDSL and cable upgrades). It also estimated that it would create 56,000 jobs. This produced a benefit to cost ratio on the BDUK programme of 20:1 over the 10 year period. As we explain below, later studies have suggested more modest, although still significant, benefit to cost ratios.

102. There will also be short term benefits in terms of employment to deploy the infrastructure, as with the apprentice scheme in the Superfast Cymru programme discussed below.

103. https://www.ofcom.org.uk/__data/assets/pdf_file/0025/113299/economic-broadband-oecd-countries.pdf, p.8

104. https://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf; https://www.oecd.org/sti/40781696.pdf; http://pubdocs.worldbank.org/en/391452529895999/WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf

105. https://businesswales.gov.wales/superfastbusinesswales/?_ga=2.76404053.1190147845.1572534495-912051584.1557734525

106. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/257006/UK_Broadband_Impact_Study_-_Impact_Report_-_Nov_2013_-_Final.pdf

90. The vast majority of the economic benefits were expected to come from increased productivity of firms using superfast broadband, with a further small contribution from increased employment (chiefly the greater participation of carers and disabled persons in the economy), increases in teleworker productivity (but as a result of more working hours rather than higher productivity per hour[107]), savings in travel costs and some benefits from retaining businesses which would otherwise be displaced to other areas with better broadband. The report also identifies significant environmental benefits arising from reductions in commuting and business travel, and energy savings as locally hosted servers are replaced with cloud services. These savings were estimated to represent 0.3% of the UK's annual carbon emissions. It is important to note that SQW limit themselves to modelling benefits which are capable of being quantified and for which there is robust evidence, such as time saved by teleworking. Other benefits, such as greater educational participation, are either unsupported by clear evidence or difficult to quantify robustly. This does not mean that such benefits may not arise. Research for BT, for example, has found that the 'social' value of being connected to a broadband network for new user is £1064 p.a. (and £3,568 p.a. for a professional user)[108].

91. In all these studies a key question is how much of the benefit is attributed to having any form of broadband, and how much to particular speeds. SQW drew on research for the Bank of England which had found that a doubling of broadband speed (e.g. from 20 Mb/s to 40 Mb/s) will yield a 0.3% increase in productivity over the subsequent 3 year period[109]. But they also noted "as superfast broadband has only been introduced relatively recently, evidence of the relationship between broadband speed and productivity has yet to be fully addressed in the academic literature"[110].

92. The UK Government commissioned a report in 2018 by IPSOS Mori to assess the actual economic impact of the BDUK superfast broadband programme which had been running in the meantime[111]. This found that superfast adoption had increased business turnover by around 1.2%, employment by 0.8% and productivity by 0.38% over the period of the programme (to mid-2016). These results were obtained by comparing economic performance in postcodes included in the BDUK programme against those with otherwise similar characteristics but excluded from it. The report noted that a significant proportion of the turnover (65%) and employment (86% of total) benefits might be attributed to firms relocating from one area (which lacked access to broadband) to another, rather than representing an increase in total output

107. The study assumes that 60% of the travel time saved is devoted to work at home, and rest to additional leisure, op cit, p.17
108. https://www.justeconomics.co.uk/uploads/reports/Just-Economics-BT-Valuing-Digital-Inclusion.pdf
109. Op cit, Annex D-2
110. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/257006/UK_Broadband_Impact_Study_-_Impact_Report_-_Nov_2013_-_Final.pdf, p.14-15
111. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734855/Superfast_Integrated_Report.pdf

for the country as a whole[112]. It found that the largest economic benefits arose in the education and health sectors, where turnover per employee increased by over 3.5%[113]. 'Health' excludes the NHS but includes GPs and dentist practices. No other sector achieved turnover gains of more than 1%.

93. The IPSOS Mori report concluded that the economic and public benefits arising from the programme up to 2016 for the UK as a whole were £1.7 billion, compared to public costs of £850 million, a benefit to cost ratio of almost 2:1. It did not find significant differences in economic impact between the regions. The ratio is much lower than the SQW ratio of 20:1 which it forecast in 2013, partly because the former relates only to benefits derived from public expenditure up to mid-2016 whereas the 2013 estimate projects benefits (and costs) forward to 2024.

94. In terms of the impact of superfast broadband for households, the report noted:

"Qualitative research with 36 households on upgraded and non-upgraded postcodes provided some insight into the factors that may be driving this result. Internet use was similar across both groups of households interviewed, with few appearing to use the internet for purposes that required high bandwidths. Households in upgraded areas that had not opted to move to higher speeds tended to report that their current internet speeds were sufficient for their needs, while those that had upgraded were typically motivated by factors other than a direct need for faster download speeds, such as a feeling of wanting "the best"[114]

95. This was reflected in the estimates of the economic benefits which businesses and households derived from superfast broadband. Businesses derived £12.28 from every £1 spent on superfast coverage whereas households derived only £1.18.

96. We therefore have a reasonable body of evidence to show that adoption of superfast broadband services, enabled by VDSL technology have produced significant economic and social benefits to households and businesses in the UK, but with the vast majority of the economic benefits relating to productivity gains at business locations. These benefits will be greater the more extensive the availability of superfast networks and the higher the rate of adoption by those businesses and households who can access them.

97. As noted earlier, some of the assumptions adopted in these and other studies may be challenged by changes arising from the COVID-19 pandemic. We are not aware of any studies which have sought to quantify the economic benefits of broadband since March 2020.

112. In addition to standard economic measures, the report estimated an increase in subjective wellbeing which it valued at £222 per household p.a.
113. Op cit p.38
114. Op cit, p.8

The case for 'universal broadband'

98. Even if broadband offers benefits to individual households, a separate case needs to be made for making broadband universally available to every household in a country. This is because, as will be apparent from earlier chapters of this report, whilst benefits increase the more extensive the broadband network, variations in the costs of connecting households and businesses mean that the benefit to cost equation becomes ever more challenging as more and more higher cost to serve households and businesses are included. These variations on the cost side of the equation also become significantly more acute as the technology employed shifts from DSL to VDSL and then to FTTH.

99. The UK NIC report, which we discussed in Chapter 2, makes the case for universal broadband (using FTTH technology) on several grounds:

a. Its research suggests there is widespread popular support for universal availability. This is likely to reflect, at least in part, experience of copper-based networks in the UK which have been provided by BT and its state-owned predecessor on a near universal basis. The public may expect 'utility' services such as telecoms, water and energy to be universally available, notwithstanding the fact that these services are now delivered by firms in the private rather than public sector.

b. There is a regional policy case for universal FTTH on the grounds that some areas might otherwise be excluded from participating fully in the UK economy, and households may also be socially and culturally excluded. We have already noted that there is good evidence to suggest that the deployment of faster broadband in some areas may attract businesses to move away from other areas. There is therefore a concern that without universal availability, faster broadband in some areas might contribute to economic and social exclusion and exacerbate depopulation in other areas. The funding provided by the European Regional Development Fund for the BDUK superfast broadband programme is motivated, at least in part, by such regional policy considerations.

c. Some have argued that households and businesses in rural areas may derive greater economic and social benefits from faster broadband connectivity than their counterparts in urban areas, and that these benefits may offset the higher costs of serving rural households. However, there is limited evidence on this (and none relating to Wales that we are aware of), in part because prices of broadband connections in the UK tend to be set on a national basis and data on the take up of broadband services by area is difficult to obtain.

d. The UK NIC also makes a separate point, which is that the delivery of public services in rural areas may benefit more, in terms of cost savings, from broadband access than public services in urban areas where travel times and other costs of delivery may be lower. Some have also argued that universal broadband availability is required if many public services are to move fully online, since otherwise there is a risk of exclusion[115]. Without universal access, it is argued, public services will be unable to decommission existing delivery models or realise the cost savings that are otherwise enabled if everything is fully digitised.

115. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/228844/7650.pdf, para 77

100. The case for universal availability of some form of broadband also needs to be distinguished from the case for FTTH. Many of the savings in public service delivery, for example, might be realised with universal access to VDSL or equivalent connections, rather than requiring FTTH. When, in 2015, Prime Minister Cameron announced his intention to introduce a 'universal broadband service obligation' that would ensure that every household in the UK had access to an affordable broadband connection of at least 10 Mb/s[116] he justified this proposal on the same grounds – popular expectations of broadband as a utility, economic and social inclusion and support for public service delivery – as we have listed above[117]. The threshold of 10 Mb/s was recommended by Ofcom, advising the Government, on the grounds that it was the minimum required for a decent service and that it could be delivered by a number of different technologies[118]. Ofcom recognised that minimum requirements would be likely to increase over time and that the threshold should therefore be kept under review.

101. A few points can be drawn from this:

a. The current and proposed universal service arrangements in the UK support the availability of broadband connections at speeds far below anything that requires FTTH. Current UK Government policy still appears to take the view that significant variations in the broadband speeds available to households in the UK can persist, at least until 2025, provided all households obtain connections of at least 10 Mb/s.

b. Even when universal broadband obligations apply, households which cost more than £3400 to connect will be required to meet the additional costs themselves.

c. There is some tension between the case for universal broadband made by the Government in relation to the USO and the case made by the UK NIC for universal FTTH (which we consider further below). If 10 Mb/s is sufficient to address concerns about social and economic inclusion in 2020, as the (Cameron) Government has said, then it is not clear why universal access to FTTH would be required 5 (or 8) years later. Speeds greater than 10 Mb/s may be required by then, but it is not clear that 'gigabit' speeds (of 1 Gb/s or more) – which require FTTH – would be.

d. An important distinction between the USO arrangements and proposals for universal FTTH is that the former will be funded by the industry itself, through levies on existing broadband customers, whilst the latter would have to be subsidised by the taxpayer. It is not clear, however, why differences in funding arrangements should support different objectives[119].

116. Subject to the cost per connection being no more than £3400, above which the householder is required to make a separate contribution.

117. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/510148/Broadband_Universal_Service_Obligation.pdf, p.11-12

118. https://www.ofcom.org.uk/__data/assets/pdf_file/0016/50416/dcr-statement.pdf, p.27-8

119. In both cases, the rationale for public intervention is that there are wider social and economic benefits for society is broadband is available to all, such that all existing broadband users or taxpayers to contribute to the costs of extending access to those members of society who do not currently have it. This is a classic 'externality' justification for Government intervention. There is evidence that such externalities do exist, and that existing users of broadband may benefit from having other households connected, not least in order to communicate with them. What is not clear is why these externality benefits should be so much larger if households are connected by FTTH, relative to being connected by VDSL or some other technology such as 4G or 5G home broadband.

102. We conclude that there is relatively little robust evidence about the benefit of broadband universality, either in relation to superfast broadband or FTTH. The case for ensuring that all households have access to basic or superfast broadband connections of a minimum speed would seem to be a more straightforward one to make, since there is robust evidence of significant economic and social benefits arising from a superfast broadband connection and no evidence to suggest that rural households would benefit less than their urban counterparts (although no evidence that they benefit more either). These benefits then need to be set against the relatively modest costs of extending superfast broadband services to all households in the UK. Ofcom has estimated that if the 10 Mb/s broadband USO were introduced in the 'early 2020s' (as is now the case) then around 500,000 households would still lack access to a service of at least 10 Mb/s and that the cost of serving them would be around £1 billion (of which less than £1 million would be attributable to households in Wales)[120]. The vast majority of these UK households could be served by VDSL technology, and the remaining 10% where the copper connection was too long would be served with FTTH. Ofcom estimate that the average cost per household of the VDSL connections would be £870-1000, whilst the average cost per household of the FTTH connections would be £3,790.

103. Given the almost 4 times higher cost of FTTH, the case for universal access to FTTH technology would appear to be much more challenging unless households were to gain very large benefits from the additional speeds it enables. We consider below the evidence that might suggest additional benefits that might be obtained from an FTTH connection relative to a superfast VDSL connection.

Evidence on benefits of FTTH

104. The very limited number of FTTH connections in the UK means that evidence of their benefits is necessarily limited today. Some evidence on benefits of ultrafast networks such as FTTH were contained the Government's 2018 study of the BDUK programme by IPSOS Mori[121]. In Appendix C, entitled 'Supplementary research on large increases in download speed', the researchers considered the impact of large (>100 Mb/s) changes in broadband speed such as might result from a household moving from VDSL to FTTH technology. This has occurred in a small number of cities served by alternative FTTH providers such as Cityfibre, Hyperoptic or Virgin Media's FTTH project, or by Kingston Telecom in Hull. Postcodes experiencing such large increases in speed represent less than 4% of all UK postcodes.

120. https://www.ofcom.org.uk/__data/assets/pdf_file/0015/105342/Technical-advice-on-a-broadband-USO-Updated-cost-estimates.pdf, p.5

121. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734857/BDUK_SF_EVAL_ANNEX_B_ECONOMIC_IMPACTS.pdf

105. The report finds that increases in speed of more than 500 Mb/s led to increases in turnover of 5.8%, whereas increases of 100-200 Mb/s led to turnover increasing only 1.2%[122]. IPSOS Mori also found evidence that FTTH may attract entry by new firms into an area (followed by the exit by some existing firms as competition from more productive entrants increases). They also note that the sample sizes are small and that some of the differences observed could be attributable to other factors.

106. This study is important because it is based on actual outcomes rather than assumptions or inferences about how households or businesses might be expected to behave given what we already know about the transition from basic to superfast broadband. It is also based on UK data rather than evidence from FTTH adoption elsewhere in the world, which may differ from the UK or from Wales. However, the small number of FTTH connections that existed in the UK in the period (2012 to 2016) mean that any results may not be representative of the wider population. One of the few other studies of a similar kind considers evidence from FTTH deployment in the United States. It found that FTTH adoption by at least 50% of premises (likely much higher than that obtained in the postcodes featuring in the UK study just discussed) produced an increase in GDP per capita of 1.1%[123], relative to areas in which FTTH was not available.

107. Most other studies on the benefits of FTTH tend to rely on projections rather than observed outcomes. A common approach is to first project demand for data services into the future and conclude that it cannot be met by existing VDSL technologies. This is the approach adopted by Frontier Economics for the UK NIC (discussed earlier) and by WIK, a consulting firm, in a study for Ofcom. WIK forecast that around 40% of UK households would require speeds of 1 GB/s or more (which can only be obtained from FTTH or DOCSIS technologies) by 2025[124] and that a further 42% would require speeds of between 300 Mb/s and 1 Gb/s.

108. WIK also identify a number of studies from other countries, including Sweden and the US, which suggest that FTTH deployment has delivered economic or social benefits. The Swedish healthcare study cited by WIK illustrates the challenge of distinguishing between the benefits of broadband and benefits that are specifically attributable to FTTH technology. The Swedish study considers the economic benefits of providing broadband connections to elderly households so as to enable video conferencing, other messaging services and the monitoring of patients in their homes via video links[125]. However, it would appear that all of these services could readily be supported by superfast VDSL broadband connections, rather than requiring FTTH.

122. Op cit p.63
123. https://pdfs.semanticscholar.org/965e/9b363836a09006229693758d984228714d3f.pdf
124. https://www.ofcom.org.uk/__data/assets/pdf_file/0016/111481/WIK-Consult-report-The-Benefits-of-Ultrafast-Broadband-Deployment.pdf, p.51
125. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1041.9141&rep=rep1&type=pdf

In contrast, another study cited by WIK finds that home workers using FTTH work for an average of 12.8 days per month, compared to 10 days for DSL users[126]. Whether FTTH connections induce users to work more from home, or those working from home more tend to take up FTTH connections is, again, unclear. Another study for NESTA shows that there are many other demand projections which suggest that existing VDSL or G.Fast technology would be more than capable of meeting the majority of UK household requirements until at least 2025[127].

109. Recent studies have been undertaken by Oxera (for the Broadband Stakeholders Group)[128] and CBRE (for Openreach)[129]. The Oxera study summarises the existing literature on the economic benefits of both FTTH and 5G, highlighting the complementary relationship between the technologies as the widespread deployment of 5G will depend upon the wide availability of fibre backhaul connections from mobile cells. Oxera have developed a model which is intended to allow local authorities to assess the benefits for local businesses (both existing and new), employees, consumers and local authorities themselves, thereby encouraging the authorities to take actions to facilitate the deployment of new digital infrastructure within their area.

110. Oxera, echoing the findings of other studies which have already been referred to, suggest that the magnitude of the benefits achieved in any particular local authority area will depend, amongst other things, on the level of existing broadband provision (which will be partly a function of population density as VDSL degrades with the length of the copper connection), the size of businesses (smaller businesses tend to achieve greater gains in terms of employment), the composition of businesses, the digital skills of the unemployed (which may be partly a function of the length of time they have been unemployed), and the broadband provision in surrounding areas (since businesses may migrate from one area to another). The Oxera model presents generic results but it could be used by Local Authorities in Wales (or by the Welsh Government) to estimate the potential economic gains from FTTH and 5G deployment by area within Wales. These estimates would, of course, depend critically upon the assumptions adopted, most of which are derived from experience of superfast broadband and previous generations of mobile technologies.

111. The CBRE report for Openreach, published in October 2019, adopts similar assumptions to estimate the benefits of FTTH deployment across the UK that is completed by 2025 or 2033[130]. If completed in 2025, CBRE estimate UK economy productivity gains by 2025 of £1,700 per worker (or £59 billion) and the inclusion of 475k new workers into the workplace.

126. Op cit, p.54
127. https://media.nesta.org.uk/documents/exploring_the_costs_and_benefits_of_ftth_in_the_uk_v7.pdf, p.10
128. https://www.oxera.com/wp-content/uploads/2019/09/Impact-of-full-fibre-and-5G-Publication-12.9.19_complete.pdf
129. https://www.openreach.com/content/dam/openreach/openreach-dam-files/images/hidden-pages/full-fibre-impact/Full%20fibre%20broadband%20-%20A%20Cebre%20report%20for%20Openreach.pdf
130. https://www.openreach.com/content/dam/openreach/openreach-dam-files/images/hidden-pages/full-fibre-impact/Full%20fibre%20broadband%20-%20A%20Cebre%20report%20for%20Openreach.pdf

These gains grow to between £70 billion and £130 billion by 2038. If deployment is instead completed in 2033, GVA per worker in 2025 is only £345 (£11 billion in total) and between £70 billion and £100 billion by 2038.

112. The CBRE report breaks its estimates down by region. Under the 2025 rollout scenario, Welsh productivity gains amount to £2 billion (of the £59 billion for the UK as a whole), but only £1300 per worker compared to the UK average of £1,700. This is the lowest in the UK. Understanding why, on this view, Wales stands to gain least (in GVA terms) from FTTH will be important, particularly in light of the factors which Oxera identify in their report and the findings of SQW, referred to above, which actually suggest that Wales achieved higher economic benefits from the superfast broadband programme than the rest of the UK.

113. At the same time, CBRE find that FTTH could improve employment rates in Wales by around 1.6% (adding around 27,000 workers), amongst the highest proportionate gain in the UK. FTTH is, in other words, expected to have a comparatively greater impact on employment in Wales than on productivity.

114. The CBRE model also considers the impact on population distribution, since FTTH-enabled homeworking (and better connectivity in SMEs) is expected to allow some consumers and workers to relocate from urban to rural areas. Around 18k workers are expected to relocate to Wales between 2019 and 2033 irrespective of FTTH (as other technologies enable homeworking and for other reasons), but this figure would almost double (to 32k) with FTTH deployed by 2025.

115. In April 2020, Assembly, an economic research firm commissioned by Huawei, estimated the impact of national gigabit broadband coverage involving widespread deployment of FTTH but with 20% of the country served by 5G home broadband services[131]. This is the first study we have seen to consider a scenario in which 5G home broadband plays such a significant role in the provision of fixed broadband infrastructure, as we recommend. The Assembly report estimates that if national rollout were to be completed by 2025, the UK as a whole would benefit from an additional £51 billion of GVA, rising to £69 billion by 2030 (similar results to the CBRE report).

131. https://www-file.huawei.com/-/media/corporate/local-site/uk/pdf/gigabit-britain.pdf

Evidence of economic benefits of fixed broadband in Wales

116. In accordance with the terms of the European State Aid rules, the Welsh Government has commissioned several reports to assess the performance of the Superfast Cymru programme (the Welsh Audit Office also produced a report in 2015). In 2016, the authors of the report, SQW, concluded that the overall programme had been 'well managed' and had delivered significant economic benefits to households and businesses in Wales[132].

117. SQW estimated that the present value of public funds was £205 million, compared to present benefits of £1.35 billion (to 2015), yielding a benefit to cost ratio of 6.7:1[133]. This compares with the 2:1 ratio to which we referred earlier in this paper and which SQW found for the BDUK Superfast Programme as a whole in the period to mid-2016. It would appear, therefore, that Wales obtained significantly greater economic benefits from the Superfast Cymru programme than did the rest of the UK from the equivalent BDUK programmes. It is not clear why this should be and we note that it contrasts with the CBRE estimates for FTTH, where the benefits obtained by Welsh households and businesses are estimated to be lower than the rest of the UK.

118. It may be relevant that the Welsh superfast programme addressed a higher proportion of all households and businesses in the country (over 50%) than did the UK programme (around 35%). It may also be that businesses who could be served on a commercial basis in England derive larger economic benefits from superfast broadband than businesses in areas which require subsidy. Alternatively, differences in costs may account for the differences in the ratios. Welsh households in the Superfast Cymru programme may have been less costly, on average, to serve than those UK households in the BDUK programmes, even if the benefits each obtained from superfast broadband were similar. Finally, the UK results relate to the period to mid-2016 and those in Wales to 2015, whereas a proper comparative assessment would require consideration of the present value of both costs and benefits over their lifetime, both past and future. We also note the explanations offered by Openreach for these differences in Chapter 4.

119. A further report, considering benefits for the period after 2015 (and until 2018), was undertaken for the Welsh Government by Miller Research and published in October 2019[134]. This report considers the impact of four discrete funding programmes, collectively representing £30 million of European funds (which were then matched by the Welsh Government and BDUK).

132. Similar conclusions were drawn about the BDUK programme in the rest of the UK, see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/734855/Superfast_Integrated_Report.pdf

133. http://www.sqw.co.uk/files/8814/7560/5709/160928-next-generation-broadband-wales-programme-en.pdf, p.7

134. https://gov.wales/evaluation-next-generation-broadband-wales-programme-2015-2018

As with the SQW report, it concludes that the programme was well managed and broadly achieved its objectives. Two of the four European funding programmes (and the majority of the funds) being assessed related to superfast broadband deployment (i.e. at least 30 Mb/s) whereas the other two related to ultrafast broadband deployment (i.e. at least 100 Mb/s).

120. Take up of broadband during this period of the programme remained high, at around 50% of homes passed. This was higher than adoption in other parts of Wales served by operators on a strictly commercial basis (the average for the nation as a whole was 38%), and higher than that generally achieved by comparable subsidy programmes elsewhere in the United Kingdom.

121. The report estimates that the present value of public funds was £49 million, compared to present benefits of £635 million (in 2015 prices), yielding a benefit to cost ratio of almost 13:1. This compares with the 6.7:1 ratio calculated by SQW for the period to 2015. Unfortunately, for our purposes, the report does not decompose the economic benefits into those associated with the superfast element of the programme (i.e. the VDSL deployments) and those that might be associated with the FTTH element. Nor is it clear from the report how the productivity assumptions differed, or indeed whether they did, between the different programmes and technologies.

122. The only other study of which we are aware is research undertaken by Cardiff University in 2018, again based on surveys of SMEs[135]. This found:

a. Around 40% of SMEs surveyed attributed growth in turnover to adoption of either basic or superfast broadband, with a smaller proportion claiming positive employment effects.

b. The assessment of the economic benefits by SMEs appears to diminish over time (between 2017 and 2018), although it is not clear whether this is because SMEs are reappraising their valuation of the benefits, or the benefits themselves are diminishing over time.

c. Extrapolating from these results suggested that SME turnover in Wales could be £166 million p.a. higher as a result of the adoption of broadband and superfast broadband (equivalent to about £60 million p.a of GVA) and that employment might increase by 1,600. Around £90 million of the £166 million of turnover was attributable to superfast rather than basic broadband adoption, but the report provides no indication of whether those SMEs adopting superfast broadband had previously used broadband, nor whether the economic benefit identified could be attributable to the difference in speed between the two. It is reasonable to suppose that at least some of the economic benefit could be attributed to the increase in speed, but impossible to determine how much.

135. https://www.cardiff.ac.uk/__data/assets/pdf_file/0011/1496198/eir-2018-full-report.pdf

Chapter 4

Stakeholder views and conclusions on FTTH

Stakeholder views

123. In this chapter we first summarize the evidence we received from stakeholders in response to our Call for (written) Evidence and in the in-person meetings that we were able to have prior to the introduction of social distancing in March 2020.

124. Although most responses to our consultation recognized the particular challenges which exist in Wales in relation to the deployment of FTTH broadband infrastructure, many also noted that existing digital infrastructure in Wales remains significantly underutilized, more so than in the rest of the UK. The WIA reminded us that the Welsh Government may be able to play a greater and more direct role in encouraging adoption and use of existing digital technology in Wales than in the supply of new infrastructure, where responsibility for policy remains largely in the hands of the UK Government and Ofcom.

125. The Commission agrees that the Welsh Government needs to focus on measures to promote the better exploitation of existing digital infrastructure assets in Wales. This is an area of policy where are large number of diffuse initiatives are already underway, some initiated by the public sector and some by the industry itself. The effectiveness and impact of many of these activities is, however, uncertain and there is a lack of robust evidence or auditing of their impact[136].

There is a danger that new projects will be taken up without existing projects first being critically reviewed. Some of these should probably be stopped. We did not receive specific recommendations or proposals from stakeholders as to which of the existing activities worked well or should be scaled up. As part of our recommendations we propose that a systematic appraisal of the effectiveness of existing measures being taken to promote the adoption of digital communications technologies in Wales should be undertaken by Audit Wales, with input from the Welsh Government's new Chief Digital Officer. We also recommend that the operation and effectiveness of the existing voucher schemes in Wales should be reviewed.

126. No stakeholder considered Wales to be a leader in terms of creating conditions which would encourage investment in new digital infrastructure. The greatest concerns arose in relation to mobile infrastructure, where Welsh planning regulations clearly place the country at a significant disadvantage today. However, the WIA and BT also suggested that local authorities could be more supportive of FTTH deployment by providing access to their own assets, including ducts, on standardized terms and at low charges. Openreach said that small housing developers should be directed to install FTTH in all new developments, which ought to occur once the Welsh Government implements changes to building regulations in Wales as proposed by the UK Government in England.

136. This is not specific to such programmes in Wales. For a review of 'demand side' policies for broadband more generally see https://cerre.eu/publications/demand-side-policies-accelerate-transition-ultrafast-broadband/

127. Although proposed by some stakeholders, we did not receive convincing evidence that business rates relief will accelerate the deployment of FTTH infrastructure (or mobile masts) in Wales. We would encourage those operators who advocate such a policy to develop better evidence in support of such claims, or to offer additional commitments which would ensure that such relief would yield tangible benefits for Welsh households and businesses (rather than cost savings for the operators themselves).

128. As explained in Chapter 2, the public funding arrangements for the next phase of FTTH deployment are still being developed by the UK Government and officials at DCMS. We share BT's concerns about the initial proposals to allocate very small lots which may not be appropriate in the absence of smaller FTTH operators to compete for them in Wales. We expect that engagement with the industry will allow the UK Government to refine the process and recommend the Welsh Government remain engaged. We note BT and Openreach's view that the commercial viability of FTTH is likely to improve over time (as costs of deployment fall or demand increases and so revenues are brought forward for later investments). In Chapter 2 we noted how BT's own estimates of the cost of FTTH had fallen significantly over time – from £900 per household in 2015 to £300-400 today[137]. We consider this to be a good reason for Wales not to seek to accelerate FTTH (assuming the public funds to do so were available) but to maximise the use of 4G and 5G home broadband services as an 'interim' solution and to reallocate significant public funds for this purpose. This would allow operators to delay the deployment of FTTH in some areas but then deploy on a commercial basis, leading to a lower overall call on public funds.

129. In the following paragraphs we summarize the evidence received from each stakeholder.

Active Building Centre

130. The Active Building Centre, based at the University of Swansea, was created as part of the Government's Industrial Strategy and contributes to work intended to halve energy use in new buildings by 2030.

131. They told us that it was not necessarily the case that every home needed a gigabit connection, which we took to refer to fibre to the home technology. The technologies which supported active buildings would not require such speeds or capacity and they considered that 'current bandwidth' (although it was not clear what they meant by this) would be sufficient. They recognized that demand for capacity arising from other applications could lead to congestion, which might then adversely impact the applications supporting active buildings. This is consistent with our understanding.

137. We recognise this may not be a like for like comparison, since the 2020 figure relates to the average cost of serving 20 million households whilst the 2015 figure may relate to serving a larger number of households. Nonetheless, we think it indicative of a change of view over time.

BT

132. BT told us its superfast broadband service was available to 93% of premises in Wales, but that Wales had better access to FTTH than the rest of the UK (with 12% of premises having access compared to 10% in the UK as a whole, and 17% of rural premises, again compared to 10%) – see Chapter 2 for latest figures. It is currently connecting 26,000 FTTH households a week and has budgeted to reach 4 million households by 2021.

133. BT recognized 'the need to go further' and ensure that 'the hardest to reach parts of the country are not last in the queue'. They cited low population density and a high proportion of national parks as factors which presented challenges when it came to the deployment of infrastructure in Wales. They highlighted the UK Government's view that FTTH provision to 20% of UK households may not be commercially viable by 2025 but said that they did not know what proportion of these households were in Wales. In our meeting with them, BT agreed with our view that commercial deployment of FTTH to 80% of households by 2025 remained very challenging, and that the public funding requirement to achieve the UK Government's objective of national coverage by 2025 might be more than the £5 billion that had been announced and that delivery would depend on how the subsidy programme was managed. However, BT also said (as did Openreach) that more households might become commercially viable after 2025, even if they were not viable before then.

134. Openreach (see below) told us that around 20% of the 608,000 households eligible under the UK Government's USO scheme (see Chapter 2) would be served by FTTH[138], with the remainder being served using 4G home broadband.

135. BT noted that take up of fast or superfast broadband services in Wales, when they were available, was lower than in the UK as a whole. 93% of Welsh households have access to superfast broadband but only 38% are using it. BT said it was taking various actions to ensure more customers take superfast broadband but that further effort was required from the Government, industry and others to drive take up of broadband where it was already available. BT referred to Denmark as a potential model and noted that it makes it mandatory for citizens to access public services online (however it was not clear to us whether BT considered that Wales should adopt this approach). BT also suggested that digital technologies should be adopted for healthcare delivery in Wales, including for remote diagnostics, although it did not present any specific or detailed proposals of actions which the Welsh Government might take, or which we might recommend, to stimulate demand for broadband in Wales.

138. They subsequently noted that this figures also depends on the proportion that can be served for less than £3400, above which households themselves are asked to make a contribution.

136. BT also said that the Welsh Government should focus on:

"a) Adapting the existing UK Government Digital Infrastructure Toolkit for government assets, published last year, to include property belonging to Welsh Government Departments, agencies and other public bodies.

b) Ensuring that clear guidance is issued to public bodies, in particular local authorities, on the valuation of telecoms agreements under the new Electronic Communications Code and the benefits of mobile connectivity.

c) Standardising documentation that could be used across all public assets to clarify areas of misalignment, such as providing a valuation methodology to be adopted for all assets. This is a matter which is currently leading to deadlock in some negotiations."

137. We also met in person with representatives of both BT and Openreach prior to the restrictions imposed by the COVID-19 pandemic[139]. Openreach told us that when deploying new infrastructure it seeks to obtain a 'geographic balance' and so may invest in areas promising a lower financial return before areas offering a higher financial return, although all proposed areas would need to be profitable. Openreach told us business rates relief on fibre network investments (for a period of 20 years) was their first priority. Openreach explained that the reason BT had not bid to serve more households in the latest Superfast Cymru tenders (which we discuss in Chapter 2) was that the funds had to be spent by March 2021 and BT bid for what it could do within that timeframe. They expected the remaining funds to be used to extend FTTH coverage after that date, with the priority being those areas where existing Superfast coverage was lower than average.

138. Openreach suggested that the evidence of higher economic benefits from fixed broadband in Wales relative to the rest of the UK might be associated with SME start up activity in rural areas (which would otherwise occur in other areas in the absence of superfast fixed broadband availability). They had seen similar phenomena elsewhere in the UK. They referred us to the CBRE study, which we discuss in Chapter 3.

139. Openreach said they often had difficulties with smaller housing developers, who still did not see the need to install FTTH into new developments.

140. Openreach told us that the Gigabit Voucher scheme worked better when it was administered by the UK Government on a national basis. The main challenge, in their experience, was getting local communities to agree on the scope of the network. Many villages consist of a 'core' of houses alongside a number of peripheral properties that are significantly more expensive to serve and whose inclusion therefore increases the average cost, to which all households may be asked to contribute. They noted that 4G home broadband might be part of the solution to overcoming these challenges and scaling up the use of Vouchers.

139. Richard Feasey met with Kim Mears of Openreach on 20 March 2020 and Richard Feasey, Emma Thomas and Adrian Davies met with Nick Speed and Richard Wainer of BT on 9 March 2020.

141. Openreach supported the use of public funds, but wished to ensure that entire communities were built at the same time, rather than Openreach deploying FTTH to the profitable 'core' households in a village at one point in time and then returning at a later date to 'fill in' the unprofitable households with assistance from public funds.

142. Openreach were concerned that some local authorities were deploying their own digital infrastructure, or their own duct infrastructure (which they then intended to lease to operators such as Openreach). They referred us to a recent agreement between the Welsh Government and Net Support UK, a Cardiff based business (who also run Spectrum Internet) to install ducts and fibre along trunk roads and the M4[140]. In their view, local authorities and public bodies should not seek to profit directly from the provision of infrastructure to operators.

Country Land and Business Association

143. The Cymru CLA represents nearly 3000 rural businesses, including many farms, in Wales.

144. The CLA highlighted the low level of adoption of broadband technology, including by businesses, in those areas where it was already available and noted that further actions were required to improve both digital skills and awareness of the benefits of broadband.

145. The CLA noted that the Government's targets of national FTTH or gigabit connectivity by 2025 would require significant additional labour to be recruited and that the capacity to do so might be inhibited by current intentions to restrict migrant labour into the UK. We share this view. They indicated that 8,000-10,000 additional civil engineers would be required in Wales alone to meet the 2025 target. It is not clear to us where this figure has been obtained from.

Design Commission for Wales

146. The Design Commission said we should not focus only on household requirements for broadband and should recognize that businesses often require 'symmetric' capacity with high upload as well as download speeds.

Federation of Small Businesses

147. The FSB represents around 10,000 small business members in Wales.

148. The FSB submission provided data from a recent FSB report on the broadband requirements of small businesses across the UK, with 33% saying their current service was insufficient for their needs and 39% in rural areas saying they received less than 10 Mb/s, of which 49% said they paid over £40/month. When comparing these findings against evidence of the availability and cost of superfast broadband connections in the UK today (discussed in Chapter 2), they would appear to indicate that a substantial number of small businesses are not aware of the

140. https://businessnewswales.com/innovative-welsh-fibre-infrastructure-first-of-its-kind-in-the-uk/.

broadband services that are already available to them, or have not chosen to adopt them for one reason or another. This is interesting in light of FSB evidence that suggests 52% of small businesses intend to upgrade to FTTH if and when it becomes available and 34% to upgrade to 5G. These figures would suggest a far greater willingness to upgrade to new, but as yet unavailable, technologies than willingness to upgrade to technologies which, for many small businesses, ought already to be available.

149. The FSB also presented evidence to show that inadequate broadband provision results in small businesses failing to communicate with customers, struggling to grow, or losing sales.

150. The FSB told us that the needs of business needed to feature more significantly in our thinking. In terms of specific proposals, the FSB said:

"Welsh Government should continue to fund market interventions similar in scale and ambition to Superfast Cymru to ensure Wales is at the forefront of digital connectivity."

151. We understand this to mean that public funding of broadband in Wales should remain at a similar level to that undertaken since 2012, during which time we estimate around £300 million has been spent or committed (or around £40m p.a.). These funds have been provided by the Welsh Government, the European Commission and BDUK. We explained in Chapter 2 why we think the funding requirement for FTTH in Wales will be much greater than this.

Growing Mid-Wales Partnership

152. The Growing Mid-Wales Partnership is a regional partnership comprising of representative bodies from across the private, public and voluntary sector in Mid Wales.

153. They told us that only 81% of premises in mid-Wales have access to superfast broadband connections, compared to 95% in Wales as a whole. Around 15% of premises access a broadband connection of 10 Mb/s or less, compared to 3.4% in Wales as a whole.

154. They told us:

"In the Vision for Growing Mid Wales Document, one of the priorities for the region is a programme of measures to extend the coverage of Superfast and Ultrafast Broadband in the region focusing on fibre to the premises, with no order limitations. We also intend to carry out feasibility work on extending Welsh Government publicly owned "Fibre Speed" network to Mid Wales".

Welsh Infrastructure Alliance

155. The WIA told us that the COVID-19 pandemic had demonstrated the importance of digital infrastructure to people's lives. They noted that although responsibility for policy relating to the physical infrastructure itself was not devolved, the Welsh Government could play an important role in other aspects, such as 'funding, economics, enablement, data and skills' in order to unlock the full potential of that infrastructure.

156. The WIA considered there was no substitute for a fibre connection and that policymakers should seek to maximise the leverage on public investment from matched private funds. They said there was significant interest from private investors in digital infrastructure assets. Barriers and costs to deploying fibre in ducts should be minimized and a standardized process for local authorities, who should also provide access to ducts which they themselves own, should be adopted.

Welsh Government

157. We met in person with representatives of the Welsh Government before social distancing measures were imposed[141].

158. They told us that commercial deployment of superfast broadband had reached 48% by 2010 and that the Superfast Cymru programme had then been devised to extend this to 95% with the assistance of public funds.

159. They told us that the Welsh Government remained committed to 100% superfast broadband coverage in Wales. The Superfast Cymru programme succeeded in getting Wales to 95% superfast coverage and a new procurement is delivering an additional 26,000 premises with FTTH for £26m (now increased to 39,000 premises with FTTH for c.£56m) using EU, UK Government and domestic funding. The total forecast clawback funding is estimated to amount to between £60m and £80m by 2023. The Welsh Government recognize that some premises will be relatively expensive and likely to exceed £5,000. The Welsh Government remains "technology agnostic", whereas the UK Government policy is to deliver only gigabit capable solutions.

160. The UK Government had not yet clarified how many Welsh premises would be included in their estimates that 20% of households could not be served with FTTH on a commercial basis or where they are in Wales. However, the Welsh Government thought that a share of up to £1 billion of the £5 billion which the UK Government had announced would likely be needed to support provision to these households across Wales.

161. The Welsh Government intended to launch 'community broadband projects', seeking applications from April (we understand these plans were subsequently delayed by the COVID-19 pandemic but that applications were invited in July 2020). Communities who bid for funds would not necessarily need to deploy or own the infrastructure themselves. In addition, the Welsh Government will 'top up' the UK Government's new Rural Gigabit Connectivity Vouchers (as they had previously done with Gigabit Vouchers), but only in respect of households not already served by superfast broadband networks (see Chapter 2 for more details).

162. We were told that the Welsh Government was not minded to grant business rate relief to large telecommunications operators, but that it was looking at requiring developers to install FTTH into all new developments.

141. Richard Feasey, Emma Thomas and Adrian Davies met with Richard Sewell, Deputy Director ICT Infrastructure and Adam Butcher on 9 March 2020.

163. The Welsh Government had not implemented the Digital Asset Database that was promised in Mobile Action Plan. However, a working group to share best practice with Estates Wales has now been established. There remained some tensions between local authorities' desire to get best price for access to assets and the need to improve the digital infrastructure and realise the benefits of doing so.

164. The Welsh Government speculated that the potential cost to the UK Government of ensuring full fibre connectivity to all premises in Wales would likely be in the order of £1 billion.

Our conclusions on FTTH

165. We have found that realising the economic and social benefits of superfast broadband in Wales over the past 8 years has required significantly higher levels of public subsidy than in the rest of the UK. This has reflected the weaker commercial incentives for operators to invest in Wales, including a lack of competition to BT in most of the country and the greater proportion of difficult and costly to serve households. It has also been a result of the Welsh Government's ambitions in the Superfast Cymru programme, which have aimed to obtain higher speeds than the equivalent programmes in England or Scotland.

166. Although the public costs of superfast broadband have been higher in Wales than in the rest of the UK, there is some evidence to suggest that the economic benefits have been higher still in Wales, so that the benefit to cost ratio for superfast broadband in Wales is higher than the equivalent ratio for the rest of the UK. Compared to other forms of infrastructure investment, superfast broadband has so far represented a good investment for the Welsh Government, with economic benefits being estimated at between 6 and 13 times the total cost of the Phase 1 Superfast Cymru programme of £230 million. On the other hand, the costs of connecting the remaining 50-80,000 households and businesses in Wales that remain unserved appear has been rising dramatically, with the latest Phase 2 Superfast Cymru award implying a subsidy cost per household of £2300 and the Welsh Government now awarding vouchers to a value of £3000 per household. This is ten times the average cost which BT predicts for its commercial FTTH roll out across the UK and more than double the cost of earlier Phase 2 awards. At these levels, the benefit to cost ratios for public expenditure are likely to be much lower or even negative. Moreover, costs are only likely to escalate still further, with some households likely to cost tens of thousands of pounds to serve with fibre. The total cost to the taxpayer of delivering fibre to every household and business in Wales could be of the order of £1.3 billion, or more than four times the expenditure required for superfast broadband.

167. The roll out of superfast broadband infrastructure in Wales under Phase 1 of the Superfast Cymru programme has been very successful, even more so than in the rest of the UK. It has been largely on time and below budget and has produced significant economic and social benefits for the Welsh population, with apparently high levels of take up. That said, around 3% of Welsh households will continue to suffer from no or very slow broadband unless and until the UK Government's Universal Broadband

Obligation addresses their needs[142].
The Phase 2 programme is likely to fall short of its initial ambition to 88,000 households by March 2021, although both Openreach and the Welsh Government told us that any unallocated funds would be absorbed and deliver additional connections after that date (likely at a very high cost per household).

168. Although some important insights may be drawn from the experience of superfast broadband deployment in Wales and in the rest of the UK over the past 10 years, our understanding of the additional economic and social benefits that might be obtained in moving from superfast VDSL technology to ultrafast FTTH broadband technology over the next 10-15 years remains limited. The UK NIC recommended a universal FTTH target for the UK on the basis that it is a 'risk worth taking'. It accepted that there was significant uncertainty as to whether many UK households will actually need the bandwidth and speeds which FTTH provides but argued that any delay would mean that the UK will be too late if and when it later becomes clear that the demand does exist. In coming to this view, the UK NIC appeared to assume that households will be prepared to wait for FTTH without further improvements in their broadband in the meantime. Whilst this may be an acceptable assumption for those parts of the UK where broadband provision is already very good, we do not consider that this can be the right strategy or approach for Wales. Moreover, one study, from CBRE, suggests the benefits in Wales from FTTH could be lower than for the rest of the UK (and we do not in any event consider reliance on Virtual Reality gaming or 8k TV consumption, on which the UK Government's assessment appears to rest, to represent the most compelling rationale for requiring FTTH at the expense of other, lower cost and faster to deploy, technologies).

169. The Welsh Government does not appear to have an FTTH or 'gigabit' target, so Wales is currently included by default within the UK Government's target of 100% coverage by 2025. UK Government policy on broadband has changed significantly since the 2017 election, but this does not appear to have prompted a significant review of policy or targets in Wales.

170. The UK Government's 2025 FTTH ambitions rely heavily on the assumption that 80% of the UK can be served on a commercial basis. BT is currently planning to serve around 50% (15 million) of UK households with FTTH by 2025 and 20 million by 2030. There is uncertainty about the assumptions for commercial roll out for the UK as a whole and even more reason to think that Wales will not achieve commercial FTTH coverage to anything like that extent. Wales achieved coverage of cheaper, easier to deploy VDSL technology of less than 50% of households on a commercial basis by 2010. Measures being taken by the UK Government to promote competition and reduce the costs for FTTH might increase this for FTTH (although only if also implemented by the Welsh Government), but the higher costs of FTTH or lower demand might also reduce it. Either way, the scope for commercial deployment of FTTH in Wales is likely to be significantly lower than for the rest of the UK (although we still think the Welsh Government should do more to attract investment from the newer FTTH operators that are beginning to emerge elsewhere in the UK).

142. A few may take advantage of the Welsh Government schemes referred to at paragraphs 80 and 85.

171. The UK Government has suggested that to extend FTTH coverage to the 20% of UK households who it does not expect to be served commercially will cost £5 billion. Evidence from the Government's own advisers suggests this is likely to be an understatement, and that a public expenditure of up to £10 billion would seem to be a more plausible estimate. The Welsh Government indicated to us that it thought £1 billion of funds would be required for Wales to achieve universal FTTH coverage. We present our own estimates, which produce a figure of £1.3 billion. The terms of any eventual financial settlement for Wales in relation to the UK Government's £5 billion fibre fund remain unknown at this stage.

172. An important issue for any FTTH policy, including that proposed by the UK Government and UK NIC, is what households are expected to do in the 10-15 years it could take for FTTH to reach some of them. BT has already halted its G.Fast activity to avoid making investments which it may then subsequently have to write off when FTTH is eventually deployed. This means that many UK households will have to continue to rely upon superfast VDSL connections of little more than 24 Mb/s until after 2025 and some for long after that.

173. When considering the case for FTTH in Wales, the Welsh Government starts with some strengths. The challenges in deploying VDSL to remote households with very long copper connections has meant that a slightly higher proportion of households in Wales – 13% – can already obtain an FTTH connection than is the case in the rest of the UK. Most of these have been funded by the Superfast Cymru programme, although some may also have been encouraged by the Welsh Government's contributions to the Gigabit Broadband Voucher Scheme. However, the FTTH gap between Wales and the rest of the UK has been narrowing in recent years and we expect it to reverse in the coming quarters as Openreach prioritises build in other regions where it faces more competition and because Wales lacks the benefit of additional investments being made by new, smaller FTTH operators in other parts of the UK.

174. At the same time, community FTTH schemes have yet to achieve significant scale in Wales. The Welsh Government told us in March that they intended to invite applications from communities under a new programme, but we understand has been deferred by the COVID-19 pandemic and the funds available are in any event only £10 million. We think community schemes could become more important if UK Government FTTH policy were, in future, to place greater emphasis upon financial contributions from local communities (alongside public and private funds) in order to meet any funding gap in its plans. We also think community schemes serve an important function in stimulating demand for and interest in new fixed broadband technologies, something which a number of stakeholders highlighted as remaining a challenge, particularly in Wales where only 38% of households and businesses that could connect to superfast infrastructure currently do so.

175. Assuming commercial activities by BT and others will deliver FTTH to around 50% of Welsh households over the next 10 years, the question remains whether and how the Welsh Government should intervene to extend coverage beyond that. We think there are a number of actions which the Welsh Government should take.

176. First, the successor programme to Superfast Cymru (yet to be named so far as we are aware, but presumably to be called something like Gigabit Cymru) will require a new delivery model. The UK Government is currently developing its own model (involving bidding on lots of 3000 households, reflecting interest from smaller local FTTH providers that have emerged in England but to a much lesser extent in Wales[143]) but this remains a work in progress and is unlikely to be suitable to the needs of Wales, where Openreach is likely to have to play a larger role and where contracts are likely to awarded by the Welsh Government rather than by individual local authorities. It is very important, in our view, that the new UK Government funding programme is not unduly dogmatic or inflexible, either as regards the technologies being supported or the way in which the funds are administered. There may also be additional opportunities for the programme to be made more flexible as a result of withdrawal from the existing EU State Aid regime at the end of 2020.

177. We therefore recommend the Welsh Government engage (and we assume already are engaging) with the UK Government to ensure:

a. The possibility of using the funds to support 4G and 5G infrastructure capable of delivering speeds of 100 Mb/s rather than the 500 Mb/s threshold which appears to be being preferred by the UK Government.

b. The possibility to tender lots consisting of substantially more than 3000 households.

c. The desirability of prioritising the provision of FTTH infrastructure to businesses.

d. The desirability of being able to reallocate funds that are returned to the Welsh Government through the 'claw back' mechanism to other, potentially more beneficial, purposes if they are available, rather than being required to allocate them to the funding of more FTTH roll out at ever higher additional costs per household.

178. The last point reflects our concern that funds clawed back from existing superfast and FTTH programmes undertaken by the Welsh Government (currently amounting to around £80 million) are automatically used to then fund additional FTTH deployment at very high costs per household – likely well above £3000 per home. We are not persuaded that this is the best use of those funds, and at the very least we think the Welsh Government should critically review all potential uses of the funds before deciding what to. In our view, the new scheme ought to allow funds clawed back from FTTH operator grants to be reallocated to grants to other operators (e.g. from FTTH to 4G or 5G or vice versa) and also to be reallocated from grants to operators to other types of funding, such as vouchers to households. The new programme should have sufficient flexibility to allow public funds to be allocated in whatever way best serves the overall public interest, rather than any 'clawback' being automatically reinvested in support of the same operator deploying the same technology at ever greater cost per household.

143. We are aware of a small number of FTTH providers that have recently launched in Wales, including Beacons Telecom, but they appear very small indeed and unlikely to be in a position to bid credibly for Gigabit Cymru funding in the near future.

179. We think the current position on vouchers in Wales is in need of review. The Access Broadband Cymru scheme, which provides subsidies for upgrades to double broadband speed (£400 and £800 depending on the speed achieved) appears out of date in light of the UK Government's new Universal Broadband policy and the transition from superfast to other forms of broadband. The individual sums are too small for what is now required and do not align well with those for other schemes such as the Rural Gigabot Broadband Scheme. We are unclear as to how effective it has been in the past and we think there is likely to be a good case for now abolishing it altogether. In addition, having multiple schemes adds complexity to a process which many households and businesses may already find confusing and difficult to navigate (as the UK Government's various attempts to improve its websites seem to recognise). It would in our view be better for Wales to have a single voucher scheme that was better and more widely communicated, even if funds may be less targeted as a result. The evidence we have seen suggests that the main challenge for voucher schemes to date has not been inefficient targeting of funds, but lack of take up.

180. We also think the size of the subsidies that are made available via vouchers in future will need to be carefully assessed. The experience to date suggests that a combination of low take up of vouchers and rising costs of FTTH deployment have led to large increases in the value of vouchers of being offered – from £800 in 2019 to £3000 today for rural households in Wales today. This 'voucher inflation' has been a feature of both Welsh and UK Government broadband policy in recent years. There is a danger that, without proper review, these figures will continue to rise in the future, raising the prospect that some households could be offered vouchers of tens of thousands of pounds in an attempt to provide them with an FTTH connection. Given our assessment of the benefits of FTTH, presented in Chapter 3, we do not think this is likely to be a good use of taxpayer's funds.

181. A better use of public funds might involve the direct subsidy of 4G or 5G infrastructure in some parts of Wales. Indeed, we would argue that vouchers above a certain threshold value – perhaps £3400, the same threshold as adopted for the Universal Broadband commitment – should only be awarded in the next 5 years for the purposes of deploying FTTH if there is no realistic prospect of 4G or 5G home broadband availability.

182. Welsh local authorities (including as participants in City Deals and other co-operative arrangements) have an important role to play in supporting FTTH deployments in those communities where it is feasible and in encouraging greater investment by new, privately funded FTTH providers in Wales, such as we are seeing elsewhere in the UK. To do this, the Welsh Government should provide local authorities with new guidance and direction on making ducts and other public assets available to telecommunications operators on reasonable financial terms and in accordance with the aims of the new Electronic Communications Code. As BT suggested, this could be modelled on the Digital Infrastructure Toolkit that was produced by the UK Government in 2018[144]. The implementation of this guidance

144. https://www.gov.uk/government/publications/digital-infrastructure-toolkit

should be overseen and monitored by a new 'barrier busting' taskforce which we propose the Welsh Government establish (and which should have a much higher profile and more assertive role than the existing 'Digital Infrastructure Group' which performs more of a co-ordinating role[145]). We identify other actions which we propose the taskforce should undertake in Chapter 7.

183. We noted in Chapter 2 that the utilisation and realisation of benefits from the investments in digital communications infrastructure which have already been made in Wales remains disappointing and below that of the UK as a whole, despite adoption of superfast broadband under the Superfast Cymru scheme having been more encouraging. 62% of Welsh households can already obtain superfast broadband connections but choose not to do so. Evidence from the FSB suggests many small businesses appear unaware of the higher speeds which they can already obtain. Other business and many public sector institutions have yet to derive the full range of economic benefits from the digital connections which they have acquired.

184. The reasons for this failure to exploit the assets that have already been deployed in Wales are no doubt many and complex. Reflecting this, a large number of initiatives have been undertaken or proposed, by the Welsh Government itself, local authorities, charitable and commercial organisations, all of which seek to encourage the greater adoption or better use of broadband and digital technologies. In addition, new initiatives are being established in relation to the uses and applications for 5G technology, some of which we discuss later in Chapter 5. We think there is a tendency for these programmes to proliferate, with new initiatives being added before the effectiveness of existing programmes have been properly assessed. Wales should seek to learn, both from its own experience and from the experience of other nations which have more resources to commit to such activities, in order to ensure that it adopts best practice in this area[146].

145. We understand the existing Digital Infrastructure Group includes representatives from local authorities, city deals, DCMS and Welsh Government and seeks to share best practice etc. The taskforce we envisage would be led by a senior civil servant and would have clear instructions to identify and remove barriers and reform regulations in order to implement the recommendations contained in this report. They would be expected to implement significant change within a short period of time, with clear targets and deadlines. We would not envisage local authorities forming part of the group.

146. A useful recent study on schemes to encourage take up of FTTH connections elsewhere in the world was undertaken by WIK for the Broadband Stakeholders Group. Their key conclusions include: "1. Address advertising and customer communications to improve consumer and business understanding of the benefits of gigabit broadband – and ability to distinguish between the broadband networks available to them. 2. Incentivise take-up of new gigabit broadband connections and address issues of affordability for businesses and consumers. 3. Leverage digitisation to support the economy and society in a post COVID-19 era. 4. Facilitate eventual switch-off of the legacy copper network by securing buy-in from all relevant broadband industry stakeholders", see http://www.broadbanduk.org/wp-content/uploads/2020/06/WIK-report_BSG_02062020_final.pdf.

185. To this end, we make no specific proposals for new initiatives to promote the adoption of FTTH services in Wales. Instead, we recommend that Audit Wales be asked to take stock and systematically identify and review the effectiveness of the broadband adoption programmes that are already being undertaken in Wales, including the Gigabit Voucher schemes (which we consider likely to stimulate both adoption and to support deployment of FTTH). Audit Wales may also be asked to identify best practice outside of Wales and to consider its applicability and relevance. We would expect the Welsh Government to act on the findings of Audit Wales by reallocating resources to those programmes which are found to be effective and by closing those that are not. We think this process could be undertaken whilst the UK Government's new Gigabit Take Up Advisory Group is being established, and the findings could feed into their work as well.

186. We also recommend that the new Welsh Government Chief Digital Officer be asked to contribute to the work of Audit Wales, including by providing evidence on the adoption of broadband technologies by public authorities in Wales.

Part 2 – Chapter 5

Mobile communications in the UK

187. Unlike fixed communications services, the provision of mobile communications services in the UK has always been undertaken by the private sector under reasonably competitive conditions. The number of firms that can provide mobile communications services is determined, at least to some extent, by the availability of radio spectrum which is required to deliver wireless services. Although the UK Government has long had a policy of seeking to use 'market mechanisms' to allocate spectrum between users, notably through the use of auctions in which spectrum is allocated to the highest bidder, policymakers still retain a high degree of influence over how spectrum is allocated and, therefore, over how competition develops in the mobile sector. In addition, as we explain further below, policymakers can influence competition by opposing mergers which competitors might otherwise wish to undertake.

188. The UK Government initially awarded spectrum to support analogue mobile communications services in the early 1980s to two bidders – a consortium between British Telecom and Securicor and a consortium between Racal Electronics and Millicom, a Swedish mobile communications company. Mobile communications at that stage remained a niche product, largely consisting of phones installed in vehicles and unwieldy (and expensive) portable devices used almost solely for business purposes. Mobile communications only became the mass market phenomenon we recognize today after the introduction of the first generation of digital mobile communications technologies, known as GSM (and also as 2G or second generation mobile technology, for which the UK Government awarded licences in 1991.

189. Digital mobile communications had many advantages over analogue services. Quality was much better, more reliable and less vulnerable to interference and communications were more secure. But two other factors account for the accelerated growth of mobile communications: the adoption of a common global technology standard which produced huge economies of scale and greatly reduced the cost of producing handsets and the introduction of additional competitors into the UK market in 1993.

190. New entry was possible because European countries had identified spectrum at another frequency for GSM services, in addition to the spectrum already awarded to Cellnet (as British Telecom's mobile business was branded) and Vodafone (as Racal's business was branded). A brief discussion of radio spectrum is required to explain how the market has developed since[147].

147. Further information is available from many sources, see e.g. https://www.gsma.com/spectrum/wp-content/uploads/2017/04/Introducing-Radio-Spectrum.pdf

A brief introduction to radio spectrum

191. Radio spectrum is defined by reference to its frequency, which is measured in MHz ('megahertz') and GHz ('gigahertz' with 1000 MHz being equal to one GHz). A 'hertz' refers to the number of wavelengths passing through a point, so that the longer the wavelength the lower the frequency (and vice versa). Radio equipment is then tuned so as to operate at different frequencies, sometimes also referred to as 'bands'. It is by tuning radios to operate at different frequencies that we avoid interference between them. The mobile communications industry requires radio spectrum alongside many other commercial or governmental users, such as the military, satellite systems, television broadcasters and others. The allocation process generally involves Governments first identifying a band of spectrum between two frequencies and reserving that spectrum for a particular use. Since mobile communications devices can 'roam' across national borders, it is useful if the same band is identified in many countries. Having the same frequency also allows for the economies of scale in the production of radios and related hardware to which we have already referred. That is why Europe, acting through the European Council and Commission, has co-ordinated its allocation of radio spectrum for mobile communications for many years, and why Governments across the world also attempt to co-ordinate policies through UN institutions such as the World Radiocommunications Conference.

This need to co-ordinate widely is also why the identification and then allocation of a new radio spectrum band for a new application can take decades to complete.

192. Having identified a particular band, such as the '900 MHz' band, for mobile communications, the Government (or a regulator like Ofcom) will then sub-divide the band into smaller sets of frequencies which represent a 'spectrum licence'. Each licence can be thought of as a piece of spectrum over which the holder of that licence has exclusive rights. It entitles the user to operate radio equipment within that frequency without being interfered with by other users[148]. If interference does arise, the public authorities (like Ofcom) will take steps to identify and then remove the source of interference (pirate radio stations are an example of a producer of unlawful interference which harms the legitimate user of the frequency, and which are then closed down by a visit from enforcement officers once their location has been identified).

193. Thus, mobile operators will have rights to use particular bands, but also rights to exclude their competitors or anyone else from doing so. If the spectrum remains unused by the licensee, nobody else can use it unless and until it has been returned to the Government and reallocated. Because mobile communications technology is relatively modern and demand for mobile services is high, the mobile communications industry is a relatively intensive and efficient user of the spectrum it holds, at least in urban areas, particularly when compared to other users who often use much older radio technologies.

148. A mobile operator will be allocated a band of spectrum – for example Vodafone holds the frequencies between 925.1 MHz and 930.1 MHz. The operator themselves will then be responsible for ensuring that its own users of that spectrum (Vodafone has around 18 million customers in the UK) do not interfere with each other. This is done by allocating a tiny portion of the overall band to each individual user each time they connect to and use the network. This is done 'dynamically' in the sense that each user's device is likely to be able to use any combination of frequencies within the overall band, and the local base station to which the user's device connects will then determine which frequencies are used within that band at any particular point in time.

For example, over 50% of the radio spectrum below 5GHz in the UK is currently allocated to the public sector, with the UK Government engaged in a decade-long process of reallocating at least 500 MHz of this (i.e. around 20% of the total public holding) for commercial uses[149].

194. Different radio frequencies or bands are suited to different applications. Generally speaking, lower frequencies (i.e. those below 1 GHz) are attractive for mobile operators because they have better coverage characteristics. In other words, the radio signal will travel further for a given power output at lower frequencies than at high frequencies, and is better able to penetrate physical barriers, such as glass windows or walls. Lower frequencies therefore allow mobile operators to provide better geographic coverage, both inside and outside of buildings, than higher frequencies, for a given number of base stations or antennae. Conversely, operators who rely on higher frequencies will need to deploy more masts in order to achieve a similar level of coverage as those with lower frequencies. When spectrum is auctioned, significantly more is generally paid by mobile operators for lower frequencies than for higher frequencies (and mobile operators bidding in an auction determine the price they are willing to pay by comparing it with the additional costs of otherwise building more base stations). For example, Ofcom estimated that a mobile operator using spectrum at the higher 2.1 GHz frequency would have to deploy approximately 3 times the number of base stations (at an additional cost of £1.6bn) to otherwise provide the same coverage and quality of service as an operator using spectrum at the lower 900 MHz frequency[150].

195. There is, however, only a total of 1000 MHz of spectrum below 1 GHz, most of which is already used by non-mobile applications, including TV broadcasting. As a result, the mobile communications industry has found itself having to use higher frequencies and/or wait until low frequency spectrum can first be reallocated from other users. The mobile industry's low band spectrum over the past 20 years has mainly been obtained following the digitization of broadcast television. This 'switchover' process, which was completed in the UK in 2012, significantly reduced the radio spectrum required to support broadcast TV channels and allowed relatively small quantities of spectrum in the 600-800 MHz bands to be released and reallocated to the mobile industry for 4G and, now, 5G services. In addition, the mobile industry has obtained higher frequency spectrum, first at 1.8 GHz for 2G services, then at 2.1 GHz for 3G services (for which coverage has always been poor as a result) and now and in the future at 2.3 GHz, 3.4GHz, 3.6 GHz and 26GHz for 5G services.

196. Back in 1991, the first new band of spectrum to be allocated after 900 MHz was in the 1800 MHz range. The UK Government saw this as an opportunity to introduce more competitors into the market and obtained expressions of interest from Mercury Personal Communications (a subsidiary of Cable & Wireless), Unitel (a consortium including STC and US West) and Microtel (a subsidiary of Hutchison Whampoa with British Aerospace involvement). Mercury and Unitel merged before launching as Mercury One to One in 1993 and initially provided services only within the M25. Microtel launched as Orange in 1994.

149. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/77429/Spectrum_Release.pdf
150. https://www.ofcom.org.uk/__data/assets/pdf_file/0028/41797/annex10.pdf

197. Since Cellnet and Vodafone were, by this time, well established and already served the majority of businesses and car phone users who had represented the market for mobile services to date, One to One and Orange were forced to adopt a different strategy and develop services which would appeal to non-business users who had yet to purchase a mobile device. They did this with various innovations, including the development of 'pre-paid' mobile services, sales of handsets in supermarkets and other popular channels, 'lifestyle' advertising and the hosting of 'virtual operators' with separate brands which appealed to different groups of consumers, such as Virgin Mobile. In 1996, 16% of UK households owned a mobile phone. Ten years later, 80% of UK households did.

198. Today, mobile phone ownership in the UK is nearly universal and smartphone adoption is very high. Nobody, including the UK Government, appears to monitor or to report mobile adoption by region and we have been unable to find statistics about mobile usage or adoption which are specific to Wales. Data for the UK as a whole suggests that low income households, particularly in the rented sector, tend to rely upon mobile (often prepaid) connections for their communications needs rather than fixed connections even though BT is required by Ofcom to offer a 'social tariff' for a fixed connection and mobile operators are not. This is because the average cost of a mobile connection has fallen from £39 in 2003 to £12.87 in 2012 in real terms i.e. 2012 prices[151]. In contrast, the average cost of a fixed connection on a comparable basis only fell from £25 in 2003 to £21 in 2012[152]. Adoption of smartphones today is influenced more by age than by income, although here too the gap has been narrowing and 80% of 55-75 year olds in the UK now have a smartphone[153]. It might be supposed that rural households without mobile coverage at their property may have a greater dependency on fixed communications than UK households in general. One (now dated) study found that 50% of rural households relied on mobile broadband connections, compared to 60% of urban households, but very similar proportions (over 90%) had fixed connections[154].

199. Aside from the rapid adoption of mobile services, the main developments in the UK market have involved industry restructuring and the adoption of technologies which enable the provision of mobile data as well as voice telephony services. Mercury One to One was first acquired by Deutsche Telekom and rebranded as T-Mobile in 1999, and T-Mobile and Orange were subsequently merged to create Everything Everywhere or 'EE' in 2010. Although both T-Mobile and Orange had established themselves as significant competitors, with each having acquired more connections by 2004 than Vodafone[155], they remained much less profitable than either O2 or Vodafone. The merger of their operations was intended to improve their profitability, in part by allowing them to combine their existing networks and thereby increase coverage and improve quality.

151. And second hand devices and prepaid cards can be readily purchased in the high street without the need for contracts or installations.

152. https://www.ofcom.org.uk/__data/assets/pdf_file/0023/53735/cost_value_final.pdf, p.7-8

153. https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/technology-media-telecommunications/deloitte-uk-plateauing-at-the-peak-the-state-of-the-smartphone.pdf

154. https://ora.ox.ac.uk/objects/uuid:0f7b2c1b-96c7-4b62-87cd-4ae83768570c/download_file?file_format=pdf&safe_filename=15farrington-blank%2B2-speed%2BBritain%2BRural%2BIne.pdf&type_of_work=Report, p.18

155. https://www.ofcom.org.uk/__data/assets/pdf_file/0010/20305/uk-telecoms.pdf, p.311

200. BT spun off its UK mobile operations in 2002 as O2, and O2 was acquired by the Spanish operator, Telefonica, in 2005. In May 2020, O2 and Virgin Media announced their intention to merge, subject to agreement by the relevant competition authorities (which has yet to be obtained).

201. BT re-entered the UK mobile market by acquiring EE in 2015.

202. Vodafone has remained under the same ownership throughout the period, having been spun out of Racal in 1991.

203. In addition, there has been one new entrant since 1993. This was enabled by the auctioning of spectrum in the 2.1 GHz band for 3G services, which was undertaken in 2000. The UK Government viewed this as an opportunity to introduce another competitor into the UK and a spectrum licence that was reserved for such an entrant was eventually awarded to Hutchison Whampoa, who traded as 'H3G' (later 'Three'). H3G was the first to launch 3G services in the UK in 2003 but, like One to One and Orange before, struggled to reach profitability. In 2015, Hutchison Whampoa announced its intention to acquire O2 from Telefonica and to merge the two companies together. However the merger (which would have reduced the number of mobile network operators in the UK from 4 to 3) was prohibited by the European Commission (having been strongly opposed by Ofcom). Today, the UK retains four mobile operators – Vodafone, O2, EE and Three. Some other European countries also have four, although there has been a tendency in recent years for this to reduce to three in many European countries.

204. H3G entered the UK market alongside the other key development in mobile communications, which has involved the transition of the mobile handset from a telephone to an internet-connected smartphone through which an increasing proportion of our digital communication is undertaken. The 2G technologies of the 1990s primarily supported voice and SMS communications, with minimal data services (such as downloadable ringtones and simple games). The 3G or UMTS technology which was launched in the early 2000s was the first mobile technology to be specifically designed to support data services and to provide fixed broadband-like network performance.

205. The initial experience of 3G, both in the UK and elsewhere, was poor. This was partly because the technology was launched using the 2.1 GHz radio spectrum which, for the reasons explained earlier, had very poor coverage characteristics. As a result, 3G coverage was much more limited than the 2G coverage which many users were accustomed to by then. In addition, 3G handsets were initially difficult to use and the mobile internet services that were launched by the operators themselves were not compelling. As a result, operators like H3G had instead promoted 3G datacards and dongles as being an alternative to fixed broadband connections. By 2010, there were over 80 million active mobile devices in the UK, of which around 7% were 3G datacards or dongles[156] (equivalent to about 15% of households). About 10% were smartphones.

156. https://www.ofcom.org.uk/research-and-data/telecoms-research/broadband-research/broadband-speeds/broadband-speed-2010/mobile-bb-10

206. Those relying on 3G connections for their broadband services at that time were experiencing speeds of only 1.5 Mb/s on average (and significantly poorer in rural areas), compared to over 6 Mb/s from fixed broadband connections. After 2010, sales of 3G dongles and datacards which connected PCs to the internet flattened and then fell, to be replaced by iPads and similar devices which had a 3G connection embedded within the device itself[157] (and by better fixed superfast broadband connections as BT began to upgrade its copper network). In 2018, only about 2% of UK households still used datacards or dongles[158].

207. Adoption of smartphones accelerated dramatically after Apple launched the iPhone and the Apple app store in the UK in 2007, after which almost all smartphones adopted a touchscreen and app interface of the kind that we see today. Smartphones grew from being owned by only 17% of mobile users in 2008 to almost 80% in 2018 (and 95% among 16-24 year olds)[159]. In the process, smartphones have become, and remain today, the predominant device through which mobile data services are consumed in the UK. One consequence of the adoption of more expensive smartphone devices was a shift from prepay arrangements (which had driven the mass adoption of mobile voice telephony in the late 1990s) to a greater reliance on long term 'post pay' contracts in which the cost of the device is recovered by the operator over the term of the contract. In 2001, 70% of UK mobile connections were prepay. By 2017, this was 30%[160].

208. A further technological evolution occurred in 2012 with the introduction of 4G technology in the UK. When 3G technology was being conceived in the 1990s it was unclear what consumers would require of mobile broadband networks or how they would consume services over them. Many of the capabilities which were included in the 3G technical standards subsequently proved to be redundant. In contrast, the requirements for 4G technology were easier to discern with the benefit of the 3G experience. Users wanted faster speeds and lower latency (to allow webpages to load more quickly and to download and view video content without buffering and to view it on larger screens such as tablets) as well as much better coverage, including inside buildings. The mobile industry argued strongly that 4G technology required Governments to allocate radio spectrum with much better coverage characteristics than the 2.1 GHz spectrum that had been used for 3G, and so spectrum in the 800 MHz band was eventually withdrawn from the TV broadcasters and reallocated to the mobile industry for this purpose. The result was that 4G technology, which supported a mobile data experience that was far superior to 3G in most instances, reinforced the mass adoption of smartphones and the growth in mobile data consumption in the UK. Adoption of 4G was much faster than 3G as a result– over 50% of mobile connections were 4G within 4 years of launch compared to only 20% for 3G. 72% of mobile connections were 4G by the end of 2018[161] and over 90% of the UK's mobile data traffic is carried over the 4G networks today.

157. https://www.ofcom.org.uk/__data/assets/pdf_file/0013/20218/cmr_uk_2012.pdf, p.288
158. https://www.ofcom.org.uk/__data/assets/pdf_file/0022/117256/CMR-2018-narrative-report.pdf, p.22
159. https://www.ofcom.org.uk/about-ofcom/latest/features-and-news/decade-of-digital-dependency
160. https://www.ofcom.org.uk/__data/assets/pdf_file/0022/117256/CMR-2018-narrative-report.pdf, p.57
161. https://www.ofcom.org.uk/__data/assets/pdf_file/0028/155278/communications-market-report-2019.pdf

209. Average download speeds over 4G in the UK varied between 15 Mb/s and 30 Mb/s (depending on operator) in April 2018, compared to 3G download speeds of between 4 Mb/s and 8 Mb/s[162] (3G download speeds had improved since the 1.5 Mb/s in 2010 referred to earlier as a result of further upgrades to the 3G technology in the meantime). Note, however, that 4G of 15-30 Mb/s compares to an average fixed broadband download speed in the UK in 2018 of 54 Mb/s.

210. As broadband speeds increase, users tend to consume greater volumes of data, although a significant proportion (69%) of mobile data consumption in the UK is actually done through wifi connections rather than via the mobile operator networks. In 2018, average UK mobile data consumption grew by 25% over the previous year, to 2.9 GB per month. Again, however, this compares to average broadband data use over fixed broadband connections of 240 GB/month (for the household as a whole) over the same period. More recent data shows mobile data consumption in the UK still at around 3GB/month, but fixed data at 315 GB/month. As a result, the share of total data traffic that is carried by mobile networks in the UK today is estimated to be only 3% – amongst the lowest of all European countries considered. By way of comparison, mobile data traffic accounts for 34% of all traffic in Austria and 21% in Croatia, driven by the widespread use of 4G for home broadband services instead of FTTH in both cases (something which is not currently a feature of the UK market)[163].

211. EE had an early advantage in 4G services in the UK because it chose to use its existing 1800 MHz spectrum to launch with in 2012, rather than wait for the auction of the new 800 MHz spectrum to be completed. Since then, all four mobile operators in the UK have launched 4G services and almost all smartphones being sold today support 4G services. 72% of all UK mobile connections in 2018 were 4G-capable[164].

212. Since the 4G network is more efficient and supports better quality services than the 3G network, operators like Vodafone have indicated that they plan to retire their existing 3G networks within the next 2-3 years (and long before their 2G networks, which they currently have no plans to decommission)[165]. This would allow the radio spectrum which is currently used for 3G services to be re-used for 4G or 5G instead and for the additional costs of operating 3G antennae to be eliminated. Careful planning is required before a network is decommissioned in this way because a very small number of users who retain 3G-only handsets may otherwise find themselves unexpectedly unable to obtain data services.

162. https://www.opensignal.com/reports/2018/04/uk/state-of-the-mobile-network
163. https://tefficient.com/is-mobile-eating-the-internet/
164. https://www.ofcom.org.uk/__data/assets/file/0032/155399/telecoms-cmr.csv
165. https://www.ispreview.co.uk/index.php/2019/06/vodafone-uk-to-switch-off-3g-mobile-network-within-2-3-years.html

Competition between mobile operators in the UK

213. In this section we provide a brief overview of the state of mobile communications in the UK today, with some observations about the prospects for the future.

214. We have already noted that the number of mobile operators in the UK has changed over time, with the UK starting with two in the 1980s, reaching a peak of five competitors prior to the merger between Orange and T-Mobile in 2010, and remaining at four thereafter, despite the proposed merger between O2 and Three which would, if approved, have reduced the number of firms to three[166]. For most of its history the UK mobile industry has been characterized by competition between a number of network operators, and arguably a greater degree of competition than has prevailed in the market for fixed broadband services, where BT dominates in many areas. Moreover, in addition to the four mobile network operators, UK consumers have a choice of 'virtual' operator services that are provided by independent retailers who lease capacity from one or other of the main network operators, of which the most notable are Tesco Mobile and Virgin Mobile which together had a combined share of ~10% of connections in 2018.

215. The level of competition in the UK is relatively high by international standards and has led some in the industry to argue that the resulting relatively low levels of profitability in the UK explain the relatively poor levels of mobile coverage which some policymakers highlight. The lack of coverage is attributed to a lack of investment in network infrastructure because UK operators anticipate lower financial returns from such investments than their counterparts in other countries. However, it should be noted that similar arguments have also been employed by operators throughout Europe who highlight lower average levels of network investment in Europe relative to the United States. One recent report (of many) suggests European operators invested €83 per capita in communications infrastructure 2017 (both fixed and mobile), compared to €135 in the US and €188 in Japan[167].

216. There is good evidence to suggest that the retail prices paid by UK consumers for mobile services are significantly lower than the European average (and often amongst the lowest), and that the European average is itself lower than prices paid in the US or Japan[168]. In 2017, the average UK mobile consumer paid £18.30/month for a bundle which allowed them to consume almost 2 GB of data, 160 minutes of voice calls and around 80 texts (the average consumption of a UK mobile user in that period)[169].

166. The proposed merger between O2 and Virgin Media will not affect the number of mobile network operators in the UK, but Virgin Media operates a 'virtual' mobile operator. Whether the competition authorities will allow them to merge their mobile retail operations is unclear at this stage.

167. https://etno.eu/datas/publications/annual-reports/ETNO%20Annual%20Economic%20Report%202019%20final%20web.pdf, p.27

168. Comparison of mobile prices across markets is notoriously difficult, given differences in bundles, the inclusion of handsets, out of bundle charges etc. However, the OECD and European Commission have developed methodologies to do so, see https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=57336 and http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/CDEP/CISP(2017)4/FINAL&docLanguage=En. See also https://www.ofcom.org.uk/__data/assets/pdf_file/0030/113898/pricing-report-2018.pdf, p.48

169. https://www.ofcom.org.uk/__data/assets/pdf_file/0030/113898/pricing-report-2018.pdf, p12

Evidence as to profits is, however, more controversial, as is the link between the level of profits earned by UK operators and the level of investment in infrastructure which they undertake.

217. Ofcom considered this issue as part of its Digital Communications Review in 2016. It accepted that investment in networks would suffer if investors were unable to make an adequate return on their capital (normally considered to be the case when the Return on Capital Employed (ROCE) is less than the Weighted Average Cost of Capital (WACC))[170]. However, it also concluded that the UK mobile operators were making sufficient profits to more than cover their cost of capital, at least on average, and that there was in any event no clear evidence that a reduction in the number of operators in a mobile market would be associated with an increase in the level of investment[171]. Three, likely the most financially challenged of the UK operators, reported cashflows (EBITDA minus capex) of almost £180 million for H1 2019[172].

218. Notwithstanding uncertainties arising from the impact of the COVID-19 pandemic on demand for mobile services or the financial outlook of the industry, it does not appear likely that the competitive landscape in the UK mobile market will change significantly in the foreseeable future (other than a possible merger of the O2 and Virgin Media operations) or that the incentives to invest in infrastructure will change much either. Three appears to be on a sustainable financial footing and both UK and European competition authorities have shown themselves strongly opposed to any reduction in the number of network operators in the UK market. The ownership of operators may change, as it has in the past, but it seems reasonable to assume that the competitive conditions (and likely market outcomes) will not.

219. A focus on the number of operators in the UK is, however, a misleading way to think about the underlying network infrastructure of the UK. This is because the UK in fact has only two networks and four operators. This situation arises because Vodafone and O2 share significant parts of the network infrastructure they rely upon to deliver services, as do Hutchison and EE.

220. Network sharing has been a feature of mobile markets for many years, although the UK currently has a higher degree of sharing than some other markets. Operators have been encouraged (and have obligations under the Electronic Communications Code Regulations) to share towers and masts – known as 'passive' infrastructure – for many years in order to reduce the environmental and aesthetic impact of networks, as well as to reduce costs for the operators themselves. The limits to such tower sharing generally arise from the physical limits of the structures, which may not be able to support heavy antennae from all operators, or from owners of the land on which the towers are sited, who often demand additional rents in return for consents to share. Mobile operators may acquire the freehold to the land on which the tower is sited, or they may rent it. Specialist companies, of which the most significant are the Wireless Infrastructure

170. https://www.ofcom.org.uk/__data/assets/pdf_file/0016/50416/dcr-statement.pdf, para 4.63
171. https://www.ofcom.org.uk/__data/assets/pdf_file/0021/63444/digital-comms-review.pdf, para 4.50 and https://www.ofcom.org.uk/__data/assets/pdf_file/0029/78365/competition_and_investment_mobile.pdf
172. https://www.threemediacentre.co.uk/content/three-uk-reports-h119-results/

Group (which owns around 2000 sites) and Arquiva (which owns 7,400 sites and was recently sold to a Spanish infrastructure company, Cellnex) also acquire and then lease sites and masts to the operators.

221. Operators can also share other parts of the mobile network, including the antennae and other active radio equipment or even the spectrum allocated to each operator. These kinds of more complex sharing arrangements have developed since the late 2000s and normally occur at the initiative of the operators themselves rather than being required by regulators or planning laws (although some agreements require approval by the competition authorities before they can proceed[173]).

222. The first such arrangement in the UK was concluded in 2007, when T-Mobile and Hutchison/Three entered into a joint venture known as Mobile Broadband Network Ltd or MBNL. This was concluded at a time when both of these operators were struggling to match the 3G network coverage and capacity that had been achieved by the more established operators, Vodafone and O2. It involved, as most network sharing arrangements do, each company contributing its own towers to the joint venture and the joint venture then consolidating these assets and removing duplication. The aim is to engineer a network from the combination of these assets which is both superior in terms of coverage than either operator could manage independently, and lower cost to run (since duplicate sites can be retired). However, T-Mobile and Three also retained the ability to deploy their own, separate, equipment to meet specific demands in urban areas. The demands from one operator's set of customers in a particular city may differ from those of another, since UK operators often hold a stronger position in some cities compared to others for historic and other reasons. By 2010, the MBNL network included 12,000 sites across the UK (some of which may be owned by third parties like Arquiva or WIG), with a further 5,000 having been retired[174]. Following the merger between T-Mobile and Orange, the latter's sites were also incorporated into the JV and MBNL currently manages over 18,000 sites across the UK and provides shared radio antennae and other 'active' equipment to support the provision of 3G and 'passive' assets to support 4G.

223. Vodafone and O2 entered into a new network sharing arrangement, referred to as 'Beacon', in 2012. As with MBNL, the sites of the respective partners were consolidated and duplications removed. Vodafone would operate the active network in the west of the country (including Wales) and O2 in the east, Northern Ireland and most of Scotland, with each relying on the other when providing services outside their respective areas. Again, these arrangements support the provision of 2G, 3G and 4G services today and involve 17,000 sites. Vodafone and O2 have also agreed to share the deployment of a 5G network in the future but have excluded 2,700 sites in urban areas from the sharing arrangements so that each can meet the needs of its own customers in these cities independently of the other[175].

173. The agreement between Vodafone and O2 required approval from the OFT, for example, see https://assets.publishing.service.gov.uk/media/555de2d5e5274a708400003a/vodafone.pdf

174. https://hexus.net/business/items/telcos/27486-three-everything-everywhere-joint-venture-reaches-12000-shared-3g-sites/

175. https://mediacentre.vodafone.co.uk/news/vodafone-and-o2-finalise-5g-uk-network-agreement/

224. Although each network sharing arrangement will differ, it is quite common for them to be concluded only once the deployment of a new generation of mobile technology is relatively advanced and operators are concerned to reduce costs and make further, but relatively modest, improvements in network coverage. In the initial period, it is likely that one of the operators will wish to deploy its own network more quickly than the other in order to gain some form of competitive advantage. Thus, operators may compete to provide better coverage than the other at the early stages of a new technological era, but then agree to share once something close to parity in coverage has been achieved. This was the case, for example, with EE, which launched its 4G service in 2012 but did not conclude a 4G network sharing agreement with Three until 2014. Similarly, EE launched 5G in six cities (including Cardiff) in May 2019 (the first operator to do so in the UK) whilst Three launched in February 2020. The arrangements between Vodafone and O2, referred to above, also suggest that each may target different cities in the initial deployment of 5G before aligning their coverage in the longer term.

225. A further recent complication to network arrangements in the UK is provided by the UK Government's decision to require the removal of equipment supplied by Huawei by 2027[176]. This measure will be implemented by a new Telecoms Security Act which will ban the purchase of new Huawei equipment from December 2020 and requires operators to remove existing equipment by 2027. The consequences of this ban for the costs and roll out of 4G and 5G technologies in the UK are difficult to assess at this stage, although operators such as Vodafone have suggested they could be considerable. Vodafone (and Three) have sought to persuade Ofcom to abandon the proposed auction of new spectrum for 5G services to offset the financial impact of the Huawei ban but Ofcom has decided to proceed with the auction in early 2021, as discussed below. BT/EE has indicated that the financial impact of the ban for its business will be relatively modest (having made a provision of £500 million to cover costs).

226. So far, we have explained that mobile prices for consumers in the UK are relatively low, operators appear profitable (although not as profitable as they may wish or as operators are in some other countries), that 4G 'mobile broadband' services are now widely available and used in the UK (although the lack of use for home broadband services has mean that mobile data as a share of total traffic is much lower in the UK than many other countries), and that the UK, in common with other countries, is at a relatively early stage in the deployment of 5G services. We have also explained how network deployment is undertaken in the UK, often under sharing arrangements. We now turn to consider how the UK market performs in terms of network coverage.

176. https://www.gov.uk/government/news/huawei-to-be-removed-from-uk-5g-networks-by-2027

Mobile network coverage in the UK

227. As we have already noted (and discuss further below), consumers and policymakers in the UK have become increasingly concerned about the ability of the UK mobile market to deliver what they consider to be an acceptable level of network 'coverage'. Research by Ofcom suggests that rural users in the UK are less satisfied with their mobile voice performance than urban users (92% vs 84%), and this is likely to be related to coverage (since handsets, apps and other features are universally available to all users, irrespective of location). The latest research suggests that mobile users in Wales are significantly less satisfied (78% 'very' or 'fairly' satisfied) than mobile users in England (86%)[177].

228. 'Coverage', when applied to mobile communications services, is not a straightforward concept. Mobile operators deploy their network infrastructure – masts, antennae and backhaul capacity – in order to convey traffic from mobile devices to their intended destination. The extent to which such traffic can be conveyed will depend on the signal strength and quality of the radio network, which themselves depend on a wide variety of factors. Coverage is therefore a crude measure of signal strength and of the prospects of being able to use a mobile device for a particular purpose at a particular location. The better the coverage, the greater the probability of traffic being conveyed and of user demand being satisfied[178].

229. The benefits and beneficiaries of mobile coverage, as well as the challenges in provision, are likely to vary depending upon whether it is provided inside of buildings or outside. Provision of coverage outside a building is also likely to involve some level of provision of coverage inside but the two are far from being synonymous. As noted earlier, different radio frequencies will penetrate buildings to differing degrees.

230. Coverage can be provided to support different services. The most obvious distinction is between voice services, which can be supported by 2G technology, and data services which can be supported by subsequent generations, including 4G and 5G. The benefits of coverage for voice telephony, and the beneficiaries, may be different from those for data.

231. Coverage is generally assumed to mean being able to obtain a signal wherever you are in a particular geographic area. But expanding coverage may also reduce the time required to travel to another location to obtain a signal, without allowing for instant access to the network. The fact that users may still have to move to obtain a signal does not mean that increases in coverage are without value to them.

177. https://www.ofcom.org.uk/__data/assets/pdf_file/0028/113689/consumer-mobile-experience-2018.pdf, p.26

178. Ofcom, for example, now uses 95% probabilities of making a call or completing a data session as a basis for its various coverage measures, see https://www.ofcom.org.uk/__data/assets/pdf_file/0022/135157/Consultation-Coverage-obligations-in-the-700-MHz-and-3.6-3.8-GHz-spectrum-award-Ofcoms-approach-to-verifying-compliance.pdf, para 2.6.

232. Mobile coverage, however defined, is also notoriously difficult to measure. A study of 'not spots' by PA Consulting found that for about 10% of the sites where coverage was not available, the operators' own planning tools had predicted that it would be[179]. Mobile operators' own claims may be unreliable for obvious commercial reasons but it is also likely that operators do not know for themselves the precise extent or performance of their network. Even when an operator has deployed infrastructure in the area, the availability of a signal and the consequent user experience will depend on a wide range of factors, including impediments to the signal (hills, buildings or other structures), the materials used in the construction of individual buildings (for in-building coverage), and the nature and characteristics of the devices being used. Many of these factors change over time and are beyond the control of the operators' themselves. Ofcom has devoted as much resource and effort to understanding mobile coverage as any regulator, but when it started measuring and reporting on mobile coverage in 2011, it thought 6.4% of the UK geography remained uncovered for 2G/voice services. By 2015, it had revised this figure up to 16%. We explain later that there still appear to be significant differences in view as to the real extent of mobile coverage in Wales today.

233. The UK National Infrastructure Commission has concluded:

"UK operators regularly refer to their coverage in advertising and when selling phones and contracts in store and Ofcom also reports regularly on the state of mobile coverage in the UK. Both parties base their coverage estimates on computer predictions by mobile operators, which are difficult to relate to the service levels experienced by consumers and – taken at face value – can paint an overly optimistic picture"[180]

234. Ofcom continues to rely on coverage data from the operators themselves, although it also seeks to validate this with its own measurements (which are necessarily limited)[181]. The latest coverage data from Ofcom (from September 2019 and January 2020) suggests[182]:

4G/data coverage

a. 80% of UK households have indoor access to 4G services from all four operators (73% in Wales).

b. 99% of UK households have access to 4G services from at least one operator.

c. Rural households have less choice, with only 42% of households having indoor coverage from all four operators (compared to 86% for urban households).

179. https://www.ofcom.org.uk/__data/assets/pdf_file/0025/68173/pa_consulting_main_report.pdf, p.2

180. https://www.nic.org.uk/wp-content/uploads/Connected-Future-Report.pdf, p.71

181. See https://www.ofcom.org.uk/__data/assets/pdf_file/0014/32054/mbb-nov14.pdf. Ofcom uses its own engineers to measure network performance, normally in a small number of cities, to assess network performance.

182. Some data is drawn from the Ofcom 2019 Connected Nations and Annual Report (September 2019 data) https://www.ofcom.org.uk/__data/assets/pdf_file/0023/186413/Connected-Nations-2019-UK-final.pdf and some from the more recent Spring update (January 2020) https://www.ofcom.org.uk/__data/assets/pdf_file/0028/195256/connected-nations-spring-update-2020.pdf

d. O2 has the best urban indoor 4G coverage (99%), and EE the best rural indoor coverage (76%).

e. 67% of the UK landmass has 4G coverage (some called 'geographic coverage') from all four operators (58% in Wales, 43% in Scotland). This is substantively unchanged from last year.

f. EE has the best 4G geographic coverage in both the UK (84%) and in Wales (81%). O2 the worst in both the UK (76%) and Wales (68%).

g. At least one operator provides 4G geographic coverage in 89% of areas in Wales, compared to 91% across the UK as a whole.

Voice coverage

h. 93% of UK households have voice coverage (i.e. 2G) from all four operators, with Vodafone and O2 each providing coverage in 99% of households and EE and Three in 96%. (This reflects the historic advantages which Vodafone and O2 have as the first operators to offer 2G services back in the 1990s, as discussed earlier[183]).

i. Again, rural households have less choice than urban households – 68% of rural households have voice coverage from all four operators even though 99% have coverage from at least one.

j. 79% of the UK landmass has voice coverage (i.e. 2G) from all four operators, indicating that 4G data coverage remains inferior to 2G voice coverage. 99% have voice coverage outside of the property, although this falls to 94% in rural areas. Voice coverage has not improved significantly in the UK since 2017.

k. Vodafone and O2 again have significantly better geographic voice coverage than EE or Three.

l. Ofcom also measures mobile coverage of motorways and roads. Voice coverage inside vehicles is available from all operators on 81% of motorways/A roads and 61% of B roads, with relatively little difference between operators. Emergency calls can be made on any network (irrespective of the service provider) and so coverage is 99% for motorways/A roads and 96% for B roads. 10% of Welsh roads have no coverage from any operator, compared to 5% in the UK as a whole, 3% in England and 9% in Scotland.

235. A number of observations can be made about this data:

a. Almost all households in the UK today have indoor access to both voice and 4G services from at least one operator, although coverage in Wales appears to be slightly poorer than for the UK as a whole. The much more significant difference between rural and urban households is that urban households generally have access to the services of most or all operators, whereas a rural households will need to select a particular operator in order to obtain coverage (as discussed below, this means they live in 'partial' not spots). This means that rural households (a) have less choice of network provider than their urban counterparts (b) may have no coverage if they are unable to identify the relevant network operator to serve their premises. The lack of choice of provider is not likely to lead to higher prices or poorer

183. Interestingly, the latest Ofcom data for 2019 differs from coverage data included in the UK NIC report from 2016 which we discuss later. The NIC report that EE not Vodafone/O2 had the best voice coverage, both landmass and indoor (p.31, https://www.nic.org.uk/wp-content/uploads/Connected-Future-Report.pdf). However, the NIC report also argues that Ofcom needs to improve the way it measures and reports coverage. The latest figures therefore confirm that past measurements have been unreliable, with voice coverage appearing to reduce between 2016 and 2019. EE has consistently had the best 4G coverage.

services (since UK network operators set prices and offer services on a national rather than local basis), but it may mean that the household has to accept poor coverage in other geographic areas as a cost for obtaining indoor coverage where they live.

b. Despite a relatively high level of political concern about mobile coverage in the UK in recent years, which we discuss further below, neither overall 2G voice coverage nor overall 4G coverage has improved much in recent years, either in Wales or in the UK as a whole. Individual operators have invested to improve their own coverage in areas where other operators already provide coverage (known as 'partial not spots') but have not extended coverage into areas where none exists at all (known as total 'not spots'). EE is the best operator for 4G coverage in both the UK as a whole and Wales, and provides a similar level of coverage in each.

c. The reasons for the lack of progress in coverage are quite straightforward. Operators have some incentive to reduce the gaps in coverage between themselves and their competitors and, given the sharing arrangements that already exist in the UK, it is normally relatively easy to do this. In contrast, extending coverage to areas not currently served by any operator will generally require the installation of new towers, with corresponding costs. In the past, the requirement to do this normally arose because of a need to meet a regulatory obligation in a spectrum licence. Thus, all four operators agreed with the Government in 2014 to extend voice coverage to 90% of the UK landmass by 2017, and O2 (but not the other operators) had an additional 4G spectrum licence obligation to provide indoor coverage to 98% of premises by 2017 (with a minimum of 95% indoor 4G coverage in each nation)[184]. Vodafone and O2 have now met the voice coverage obligation (each today covers 91% of the landmass) but it would appear from the data cited above that EE and Three have not[185]. O2 has also met the 98% indoor 4G coverage obligation, largely by focusing on urban households (O2's indoor coverage in rural areas is in fact inferior to EE's). None of the UK operators currently have any regulatory obligation to extend their coverage beyond the levels already achieved, which explains why little progress had been made until the UK Government embarked on discussions for a Shared Rural Network (see below).

d. Questions remain about whether the focus should be on indoor mobile coverage or outdoor/geographic coverage. As noted earlier, the vast majority of the time (75%) UK users of smartphones are connected to the mobile internet via wifi and a fixed broadband connection, rather than using the mobile network itself[186]. Thus, most households with a fixed broadband connection do not require 'indoor coverage' in order to benefit from mobile services. Today, most 4G devices also allow voice calls to be made over the wifi connection. It might therefore be argued that indoor coverage is of marginal significance to many households and that the focus should be on the provision of coverage in areas where a wifi connection is not available. On the other hand, a small

184. https://www.ofcom.org.uk/spectrum/information/cellular-coverage
185. We understand this is due to Ofcom adopting a different methodology to measure 'coverage' in the meantime.
186. https://www.ofcom.org.uk/__data/assets/pdf_file/0028/113689/consumer-mobile-experience-2018.pdf, p.1

minority of households (3% in Wales) do not have access to either a fixed broadband connection that would be capable of supporting a 4G device (ie. 10 Mb/s) or 4G indoor coverage. Ofcom also report that around 34,000 households in Wales may have access to 4G coverage but will have no fixed broadband connection[187] (although some may have access to a Fixed Wireless Access network provided by a local operator using non-mobile (normally WiMAX) wireless technology in non-mobile radio spectrum[188]). These households will require some form of indoor coverage, either to the mobile network itself or via a 'wifi box (or 'tethering' via bluetooth) which itself connects to the mobile network[189].

5G technology

236. The UK is currently at the early stages of deploying the next generation of mobile technology, referred to as 5G. Vodafone, O2, EE and Three have all launched a mobile 5G service in a small number of cities and are selling some 5G-capable smartphones. Three also launched a 5G 'home broadband' service in London which offers an alternative to a fixed broadband connection (and involves the provision of a router and wifibox in the home). Apple has yet to launch a 5G-enabled iPhone, but is rumoured to plan to do so later in 2020.

237. A large number of claims are made about the new 5G technology, but it still remains to be seen how the technology will perform under mature conditions. The technology will support conventional smartphones but offer much higher speeds. Current 5G speeds in the UK are in the region of 175 Mb/s, which is both 5 times average 4G speeds (of around 30 Mb/s) and significantly faster than the majority of fixed broadband connections in the UK today. However, 5G networks in the UK are currently relatively unutilized, and performance may reduce somewhat as demand increases. In addition, 5G networks will have much lower latency, which refers to the delay involved in the transmission of data (as opposed to the volume of data transmitted). Low latency networks are important for applications like gaming, where responsiveness is critical. Many proposed 5G applications envisage the use of virtual reality headsets and other new types of devices which would connect to the network.

238. 5G technology is also intended to support much higher levels of data consumption which, as noted earlier, tends to accompany higher broadband speeds. 5G users in Korea, which is the most advanced 5G market in the world at present, use around twice the volume of mobile data per month as their 4G counterparts, or 18 GB/month[190]. This is about six times

187. https://www.ofcom.org.uk/__data/assets/pdf_file/0023/186413/Connected-Nations-2019-UK-final.pdf, p.15

188. Examples of such operators include Airband, https://www.airband.co.uk/. Ofcom reports that 403,000 households in Wales could be served by Fixed Wireless Access providers in 2019, although actual numbers of connections are a very small fraction of this and perhaps 1500 households in Wales are currently capable of being served by FWA but not by a 4G mobile operator , see https://www.ofcom.org.uk/__data/assets/pdf_file/0023/186413/Connected-Nations-2019-UK-final.pdf, p.16

189. https://www.vodafone.co.uk/mobile-broadband/dongles-and-mobile-wifi

190 https://images.samsung.com/is/content/samsung/p5/global/business/networks/insights/white-paper/5g-launches-in-korea-get-a-taste-of-the-future/5G-Launches-in-Korea-Get-a-taste-of-the-future.pdf

average UK usage today. For 5G, the growth in data traffic (currently growing at around 40% p.a.) is expected to arise not only from increased usage by existing smartphone users but the connection of billions of new 'internet of things' (IoT) devices to the mobile network. In order to support higher levels of data consumption, 5G technology is both more efficient than its predecessor and designed to operate in much larger bands of spectrum than has been the case in the past. This means, in turn, that the mobile industry will need to be allocated very large quantities of radio spectrum which will only be found at much higher frequencies than we have seen to date. For example, Ofcom is currently encouraging trials in the 26 GHz band which provides access to a total of 3250 MHz of spectrum, a huge quantity in comparison with the few hundreds of MHz currently allocated to UK mobile operators. In the long term, 5G may require 30-40,000 MHz of spectrum to support all the applications that are envisaged (although whether Governments will be able to identify and reallocate such a quantity of spectrum to the mobile industry remains to be seen.)

239. As already noted, an important application of 5G technology relates to what is often referred to as the 'internet of things' (IoT). This involves the installation of sensors and other simple devices in objects, such as industrial machines, robots, vehicles or infrastructure such as street lights or smart roads, with these devices then being connected via the 5G network to monitoring or other systems. 5G technology would allow the mobile network to support a very wide range of different applications, some of which may require high speed connections, some of which may require low latency, and others of which will not. It is designed to allow the connection of 1 million such devices per km^2. A 5G network can, in principle, be customized and configured so as to support all of these applications simultaneously (through a process sometimes referred to as 'network slicing'). A large number of trials and demonstrations of such applications have been undertaken using 5G[191], but commercial implementation remains at an early stage. Many IoT applications can also be supported over existing 4G networks, or other specialist infrastructure which is built specifically for this purpose, such as Sigfox. Some IoT applications require very localized coverage (e.g. to support sensors within a factory) whilst others require very extensive coverage (e.g. to support applications in vehicles).

240. It is difficult at this stage to predict the impact of 5G for the UK, or for Wales specifically. The deployment of 5G in the UK appears to be proceeding at a similar rate to other European economies (Switzerland is an exception, where 5G already covers 90% of the population), and coverage is confined to urban areas at this stage. However, delays in the UK auction of 700 MHz spectrum – some years later than in many other countries – are likely to inhibit the further expansion of 5G coverage beyond urban areas.

191. E.g. https://www.ericsson.com/en/future-technologies/research/research-collaboration-cases-related-to-5g

241. The slow pace of 5G to date in part reflects the limited availability of 5G capable devices and the performance of existing 4G technologies (which still satisfy most consumer needs today), and in part the spectrum frequencies which have been made available to the operators to support the deployment of 5G. Thus far, the UK Government (through Ofcom) has only auctioned spectrum in the 3.4 GHz band for 5G services (in April 2018). All four operators obtained between 20 MHz and 50 MHz of spectrum each. As explained earlier, relatively high frequency spectrum of this kind has relatively poor coverage characteristics (but it is a band which has been adopted for 5G throughout Europe and so provides opportunities for economies of scale in devices and other network equipment). 5G coverage using 3.4 GHz spectrum is only likely to be economically viable in urban areas. In addition, the existing operators have greater incentives to deploy 5G in urban areas where they may already be experiencing congestion in their existing 4G networks (which 5G capacity would help to alleviate), rather than deploying in rural areas where 4G networks still remain relatively underutilized. We expect that 5G coverage in the UK will remain limited, and confined to urban areas (including Cardiff but, today, no other Welsh city) until the operators can obtain access to more suitable 5G spectrum.

242. Ofcom currently plans to make additional 5G spectrum available in early 2021. This consists of 120 MHz of spectrum in the 3.6-3.8 GHz band, which will have similar coverage characteristics to the existing 3.4 GHz 5G band. However, it also includes 80 MHz of spectrum in the 700 MHz band (again, reallocated from broadcast TV), which can be expected to be used by operators to significantly improve 5G coverage, including in more rural areas. Following the recent agreement with the UK Government on the Shared Rural Network, which we discuss below, none of these spectrum licences will include coverage obligations.

243. We have explained that 5G, in a mature form, is likely to require very large quantities (perhaps tens of thousands of MHz) of spectrum in order to support the speeds and capacity requirements that are envisaged and that this will, of necessity, involve the use of spectrum at much higher frequencies than the mobile industry has been accustomed to using in the past. Since higher frequencies involve shorter range and less coverage, 5G is likely to require the deployment of additional base stations in order to provide a service that is widely accessible. Deploying more base stations also allows the same frequencies to be reused more intensively, which further increases capacity. These base stations will not be 15 or 25 metre towers of the traditional kind but small cell antennae which can be located on lampposts and other kinds of street furniture in urban areas. There is still considerable uncertainty about how and when small cells might be used – they are very likely to provide additional capacity in high-demand locations such as sports stadia, transport hubs, or inside buildings, but whether and the extent to which they are deployed more extensively is unclear. The UK NIC report, discussed further below, found that 42,000 additional small cells might be required to deliver 5G to an area the size of the City of London. This compares to around 40,000 mobile sites in the whole of the UK today.

244. Deployment of such small cells is at a very early stage in the UK and is likely to involve a number of challenges. Aside from planning processes (which can and, we are advised by Welsh Government, likely will be simplified) and popular concerns about health (which are likely to be overcome[192]), each small cell site will require access to a fibre connection in order to transmit the traffic from that site back to the 'core network' of the operator. Although a significant number of the existing mobile sites in the UK are now connected with fibre and BT (and other fixed operators) continue to expand their fibre infrastructure for other reasons, the availability of fibre to connect thousands of new sites is uncertain at this stage and likely to be a constraint in some cases. As significant, each site will also require access to power (ICT infrastructure, of which mobile networks are a major component, currently account for 1.15% of global electricity grid consumption and 0.5% of global carbon emissions[193]). This is relatively straightforward in an urban environment but can be challenging in rural areas. The 5G technology has been designed with significantly greater energy efficiency per site than existing 4G networks, but the mobile industry and its suppliers sometimes ignore the (off-setting) impact of massively increasing the 'site density' of 5G infrastructure. Whether the benefits of 5G can be obtained with more or less energy consumption than arises today is not, so far as we are aware, a question that has been subject to independent research.

Home broadband

245. We explained earlier that 3G technology had initially been used by some UK households using dongles to provide a fixed broadband alternative but that demand for such services had subsequently been replaced by other options. 4G technology was primarily designed for smartphones rather than as a fixed broadband alternative. All four UK operators offer 4G home broadband services today but take up of these services in the UK is much lower than in many other countries. Of course, 4G home broadband is subject to uncertainties about network coverage, so that performance may vary within a property as well as between properties. The higher costs of delivering data over wireless networks and the more limited capacity to do so, compared to fixed networks, also means that existing UK 4G home broadband connections tend to compare poorly with superfast fixed broadband alternatives. For example, an O2 home broadband service will provide 75 GB of data/month to a household for a little under £40[194]. EE offers 200GB for £40[195]. Vodafone offers an unlimited plan for £33[196]. All are capable of delivering average speeds of around 30 Mb/s (and EE's much higher). This compares to BT's superfast fixed broadband products, all of which offer unlimited data at speeds of at least 36 Mb/s from £25-30/month[197]. Current users of 4G home broadband products will therefore tend to be either households who cannot access superfast fixed broadband services

192. Claims of links between the COVID-19 virus and 5G technology emerged during the pandemic, leading to attacks on mobile towers in some parts of the UK. These appear to have stopped in recent months.

193. https://www.ericsson.com/en/blog/2019/9/energy-consumption-5g-nr

194. https://www.o2.co.uk/shop/tariff/pocket-hotspot/pro-netgear-m1?productId=cd2f3246-e1da-4b0c-af51-6207917f0e1b&contractType=paymonthly. All operator websites accessed on 22 August 2020

195. https://shop.ee.co.uk/dongles/pay-monthly-mobile-broadband/4gee-home-router-2/details#choosePlanAnchor

196. https://www.vodafone.co.uk/mobile-broadband/pay-monthly-contracts/mobile-wifi/vodafone/r219-mobile-wi-fi-hotspot/

197. https://www.bt.com/broadband/deals?s_cid=con_ppc_maxus_vidZ60_T1&vendorid=Z60&ds_rl=1000604&ds_rl=1276299&ds_rl=1276299&gclid=EAIaIQobChMIheCakdmu6wIVWeDtCh2EAQs2EAAYASAAEgJBR_D_BwE&gclsrc=aw.ds

or households which can, but which are reluctant to commit to a fixed term contract for broadband services at a specific address (e.g. because they occupy a rental property or use the property infrequently).

246. 5G technology introduces the possibility of a more compelling home broadband product and the auction of 700 MHz spectrum in 2021 should enable such services to be offered in areas where existing fixed broadband provision is poor (and so demand for mobile home broadband can be expected to be correspondingly higher). As noted earlier, Three's initial launch of 5G services in the UK involved the offer of a home broadband rather than a smartphone product. Unlike existing 4G home broadband services, Three offers unlimited data with 5G for around £30/month[198]. Perhaps unsurprisingly (given BT's ownership), EE's 5G home broadband offers 1000 GB at £70/month[199] (recall that current average UK household data consumption is over 300 GB/month). Initial evidence is that users of such 5G products obtain speeds averaging around 200 Mb/s, which is superior to BT's existing superfast broadband services (although still inferior to FTTH).

247. Operators in some other countries have pursued similar strategies to Three. Verizon, the largest mobile operator in the US, launched 5G as an alternative to fixed broadband in April 2019[200]. Verizon promote its 5G product as allowing households to obtain ultrafast broadband services, averaging over 500 Mb/s, without the inconvenience of waiting for the installation of a fixed broadband connection, or the disruption and additional wiring required when it happens. However, Verizon is using much higher frequency radio spectrum (at 28 GHz and above) to support this service than the spectrum (at 3.4 GHz) being used by UK operators, and so its product tends to serve urban rather than rural users. Similar products have been launched in European markets like Austria and Croatia[201], as well as in Australia[202] and New Zealand[203]. In New Zealand, Spark, the former retail arm of the fixed broadband operator but now an independent company has grown the share of its fixed broadband connections from near-zero to 20% in 2019 by using 4G and 5G technology to compete directly with its former parent.[204]

198. http://www.three.co.uk/store/broadband/home-broadband
199. https://shop.ee.co.uk/dongles/pay-monthly-mobile-broadband/huawei-5g-cpe-pro/details#choosePlanAnchor
200. https://www.verizonwireless.com/5g/home/
201. https://tefficient.com/is-mobile-eating-the-internet/
202. https://www.zdnet.com/article/optus-makes-5g-home-fixed-wireless-generally-available/
203. https://www.noted.co.nz/tech/tech-tech/why-wireless-broadband-is-the-most-compelling-early-use-of-5g
204. http://investors.sparknz.co.nz/FormBuilder/_Resource/_module/gXbeer80tkeL4nEaF-kwFA/H1%20FY20%20Results%20Summary%20FINAL.pdf

248. Research commissioned by Huawei, a leading global manufacturer of 5G equipment, provides what is probably the most recent and comprehensive overview of 5G home broadband deployments to date:

"With 5G, performance of FWA [which we refer to as 'home broadband' in this report] is expected to be more similar to that of full-fibre, thereby allowing operators, consumers, and policymakers to consider it as a viable option to deliver gigabit connectivity to the parts of the country where deploying a fixed solution would be inconvenient or too costly. In particular with FWA:

- It is capable of reaching gigabit speed. In Switzerland, for instance operators have been able to offer speeds close to 2Gbps;
- It can be rolled out quickly. As operators can use their existing mobile sites, at a lower cost of capital compared to fibre. It is estimated that, for suburban areas in countries such as Germany and the UK, 5G FWA can have a cost per line between five and six times lower than FTTH/P;
- Consumers can set it up easily. It requires a plug-and-play device, which can often be delivered on the same day of ordering and they take it with them when they move home.

249. They report that:

"In the US, one of the reasons that saw the approval of the merger between T-Mobile and Sprint was the commitment from the two operators to build a 5G network that would cover 85% of the rural population within three years, and 90% within six years, including the rollout of a 5G home product as an alternative to fixed broadband.

5G FWA is also becoming common in Austria, where Telekom Austria and T-Mobile have deployed in rural regions where laying cables would be complex, slow, and expensive, and in Switzerland (where only 30% of households can get FTTH/P), and mobile operator Sunrise has reached nationwide 5G coverage by the end of 2019. In Italy, Fastweb has committed to providing 5G FWA to 60% of the country by 2024, with a view to prioritise the small and medium cities – so-called 'grey areas' – and get them served by 2023. In Norway, the regulatory authority Nkom has required Telenor to provide wholesale access to its 5G FWA solution, because it is considered a substitute product where Telenor is switching off its copper network and, as a result, Telenor's competitors need it to replicate similar retail offers.

In some countries 5G FWA is already spurring on competition between providers. In Finland, Telia was the first operator to offer 5G FWA, and all other mobile operators soon followed in order to avoid losing ground. As a result of this race, Finnish customers are enjoying 1Gbps speeds with unlimited data from all operators, and one of them (DNA) even offers a speed guarantee of at least 100Mbps. While this is still rare, Optus in Australia is also offering a 50Mbps speed guarantee for its 5G FWA service. As the technology becomes more popular, it is likely other operators will guarantee minimum performance levels"[205]

UK Government policy for mobile communications

250. Historically, the UK Government has relied upon the private finance of mobile infrastructure and competition between the UK network operators to extend coverage and upgrade existing networks with new generations of technology. This means that whilst the UK Government has spent almost £2 billion of public money in the past decade to extend superfast fixed broadband coverage in the UK, it had spent only £35 million of public funds on mobile infrastructure until the latest Shared Rural Network agreement (where it has agreed to invest £500 million).

251. The Government can have a significant influence on both the rate and extent to which new mobile technologies are deployed through the process of spectrum licensing. The UK was relatively late to deploy 4G infrastructure because the 800 MHz spectrum required to enable the operators to do so was auctioned by the UK Government some years after its counterparts in other European countries (due to litigation by operators and other factors). The auction of further spectrum for 5G in the UK is now expected to be undertaken in early 2021, again after a series of delays, and again much later than the same spectrum has been awarded to operators in many other European countries.

252. The UK Government has also sought to influence the rate at which 5G technologies are adopted, both by mobile operators and by users or other providers, through the provision of funds for various research programmes. In 2017 the Government published 'a 5G strategy for the UK'[206] (the European Commission had published a similar document in 2016[207] which included a list of measures to achieve the target of 5G in cities and major transport routes by 2025). The UK Government's thinking was informed by a UK NIC report (and represented a formal response to it) that was published in 2016.

205. https://www-file.huawei.com/-/media/corporate/local-site/uk/pdf/gigabit-britain.pdf, p.21
206. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/597421/07.03.17_5G_strategy_-_for_publication.pdf
207. https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=17131

The UK NIC 5G report

253. The UK NIC report ('Connected Future') in 2016[208] was the first NIC report on telecommunications (and so preceded its later work on FTTH). The NIC made a number of policy recommendations, most of which were adopted by the UK Government in its 2017 5G strategy document. Importantly, the NIC shared the view of European policymakers that 5G would, at least initially, be a technology which promised most benefits in cities and if coverage were provided along the road and rail transport infrastructure, rather than in rural areas or in other sectors.

254. The UK NIC proposed that Ofcom should revise the way it measured mobile coverage (relying less on the prediction models used by mobile operators themselves and more on actual measurements taken by its staff or users), for a universal service obligation for mobile to be developed (akin to the 'fixed broadband universal service obligation' of 10 Mb/s which the Coalition Government adopted and which is due to be implemented by 2020 and discussed in Chapter 2) and for action to be taken to reduce the number of 'not spots' in the UK. The NIC's findings appear to have been heavily influenced by a view that the UK's record in 4G had been comparatively poor. It suggested that 4G coverage was significantly less than that achieved in many other countries, including Korea, Japan, China, India the US, Spain and Sweden (although the study which the UK NIC cites also shows the UK to be better than France, Germany and Italy)[209].

255. The UK NIC report included a detailed consideration of current mobile coverage of road and rail routes in the UK, and the potential costs for improvement (although it does not appear to have sought to quantify the benefits that might arise from such investments). There are a number of findings in the report:

a. Existing motorway infrastructure has duct and fibre-optic cables alongside which are currently used to support CCTV, signage and other specialist functions. Currently, this infrastructure (or access to gantrys and other sites) is not used by the mobile operators themselves (who provide coverage from sites which are located on private land adjacent to the roads). To provide 5G coverage of all UK motorways and major A roads (which would require new fibre optic cables) would, according to the UK NIC, cost between £1.7 and £5 billion if existing assets were used by the operators, or between £4 and £8 billion if not[210].

b. Similarly, UK railways have trackside wireless infrastructure (both fibre optic cables and sites) which are used for driver communications, signalling and other functions. Passenger communications rely either on connections to mobile operator masts located on private land outside of the railway, or on-train wifi systems which then connect to commercial mobile networks. It is unlikely that existing trackside networks could be used to support reliable mobile broadband services on trains, but the cost of doing so with a new trackside system on the

208. https://www.nic.org.uk/wp-content/uploads/Connected-Future-Report.pdf

209. Comparisons of coverage of this kind are apt to be misleading, in our view, as they involve comparison with countries with very dense populations (Luxembourg) or very flat terrain (Netherlands). The UK will never be able to match the coverage of achieved by these countries.

210. https://www.nic.org.uk/wp-content/uploads/5G-Infrastructure-requirements-for-the-UK-LS-Telcom-report-for-the-NIC.pdf, p.9

main UK rail routes is estimated to be £500-600 million. The UK NIC also found that the then current on-train wifi standards set by the Department of Transport would provide only 256 kb/s to each user, assuming only 1 in 4 of the passengers on the train were seeking a wifi connection[211].

c. The UK NIC cites research by KPMG which estimates the socio-economic benefits from 'connected vehicles' in the UK to be £51 billion p.a. by 2030[212] (which is a similar order of magnitude to the €50 billion p.a. from 5G in the automotive sector for the whole of Europe in the European Commission 5G study referred to above). However, it is unclear how much of this £51 billion requires 5G infrastructure. The NIC also cites research on other 5G applications in many of the same sectors referred to by the European Commission 5G study – mobile office applications, healthcare (remote diagnosis and monitoring/prevention and assisted living), transport and utilities (smart meters and smart grids).

256. The main components of the UK Government's 2017 5G strategy reflected many of the UK NIC's recommendations. They included:

a. The launch of a '5G trials and testbeds' programme which was first announced in the 2016 Autumn Statement and to which £200 million was allocated. The programme is intended to help participants better understand the economics of deploying 5G technologies and applications under various scenarios. Participants include industry, academia and public sector organisations who jointly bid for funding. Six projects have been completed to date, including a trial on connected and assisted vehicles, a 'rural' project in the Orkney Islands, Shropshire and Somerset which has been 'using cow collars to monitor the wellbeing of livestock in real time, autonomous tractors and drones to monitor and cultivate crops, and sensors in salmon enclosures'[213], a rural tourism project using augmented and virtual reality in the North Pennines, a transport project (on roadside and rail coverage), cybersecurity and various urban and industrial projects. Monmouthshire County Council participated on one such project (5G Rural Integrated Testbed or 5GRIT) which examined rural applications[214].

b. The Government allocated a further £35 million under the Rural Connected Communities fund to continue trials in February 2020[215]. Monmouthshire Country Council was again part of a 'Connected Communities in the Rural Economy' consortium which won £5 million. The aim of both these and the 'trials and testbeds' programme is to 'help fill in gaps' where the case for commercial activity is not yet clear, reflecting the fact that the future applications of 5G technology are both much more diverse and much more uncertain than was the case for 4G (where faster broadband connections to smartphones was, and has been, the primary application).

211. https://www.nic.org.uk/wp-content/uploads/Connected-Future-Report.pdf para 2.34
212. https://www.smmt.co.uk/wp-content/uploads/sites/2/CRT036586F-Connected-and-Autonomous-Vehicles-%E2%80%93-The-UK-Economic-Opportu...1.pdf
213. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/815755/July_2019_-_5GTT_Programme_Update_Publication_.pdf, p.5
214. http://www.5grit.co.uk/
215. https://www.gov.uk/government/news/new-65-million-package-for-5g-trials

c. The UK Government established a 'Digital Infrastructure Officials Group' and a 5G centre of expertise (to oversee the trails and testbeds programme) within the DCMS to co-ordinate all 5G-related activities across Government. This was one the recommendations from the UK NIC. There are today a wide range of 5G-related initiatives being undertaken across central and local Government, including transport, cybersecurity, digital skills etc[216].

d. The UK Government is working with local authorities to develop plans to support the roll out of small cells and 5G technology at a local level. Local authorities control many assets, such as street furniture, to which mobile operators may require access for 5G. Developing 5G coverage of the road infrastructure will also require local authority engagement. This was another recommendation from the UK NIC. Since then, some cities, such as London, have developed their own detailed plans to support 5G deployment[217].

e. The UK Government has been addressing barriers which prevent infrastructure sharing (such as attempts by landlords to extract additional rents when other operators seek to share existing masts) through changes to the Electronic Communication Code powers which mobile operators can invoke against landlords and landowners throughout the UK in an effort to make it easier for operators to upgrade and to share existing infrastructure[218] and through changes to the permitted development rights which govern the planning process in England and which enable operators to install masts and other equipment without seeking full planning permission[219].

f. Requiring Ofcom to revisit the way it measures mobile coverage, as also recommended by the UK NIC and discussed above. This remains a work in progress.

g. Defining a minimum level of mobile coverage and how it would be achieved by 2025, again as recommended by the UK NIC and discussed below.

h. Addressing, with the mobile industry, how to improve coverage of both the road and rail infrastructure. This included a £35 million investment to support trackside upgrades to the Trans-Pennine route and a call for evidence from DCMS and Department of Transport in December 2017 as to the commercial models that might be employed to deliver such coverage[220]. In August 2018 Ofcom provided advice to the Government on the spectrum requirements for rail coverage, identifying the 26 GHz band as the most promising for this purpose. It would appear that the UK Government has yet to make any final decisions on how trackside coverage will be delivered in the UK. Similarly, the UK Government continues to fund trials and consult on how to improve roadside coverage.

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216. For an overview, see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/838931/5G_Programme_Cross_Government_Activity_Mapping__1_.pdf

217. https://www.london.gov.uk/press-releases/mayoral/agreement-to-address-mobile-not-spots

218. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/523788/Electronic_Communications_Code_160516_CLEAN_NO_WATERMARK.pdf. Similar statutory powers are granted to most developers of infrastructure in the UK.

219. www.legislation.gov.uk/uksi/2016/1040/pdfs/uksiem_20161040_en.pdf

220. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/670551/Commercial_options_for_delivering_mobile_connectivity_on_trains__Call_for_Evidence.pdf

i. A range of measures to encourage the extensive deployment of fibre infrastructure (i.e. FTTH) to connect to mobile base stations and carry traffic back to the core network. These were discussed in Chapter 2.

j. Ensuring that Ofcom develops a spectrum licensing programme so as to allocate sufficient spectrum in a timely manner to support 5G deployment. Ofcom's plans to auction 5G spectrum in 2021 were discussed earlier. The UK is behind the rest of Europe in this regard.

257. In December 2017, the Government provided an update on progress on the 5G strategy. The Government stated that it aimed to provide 95% geographic mobile (not specifically 5G) coverage of the UK by 2022 and 'full and uninterrupted mobile phone signal on all major roads'[221]. The Government identified the forthcoming auction of 5G spectrum in the 700 MHz band as providing an opportunity to impose coverage targets on mobile operators which would contribute to the delivery of these targets.

258. In July 2018 the Government published the results of its Future Telecoms Infrastructure Review[222]. We discussed the fixed broadband and FTTH aspects of this report, which remains the most expansive statement of UK Government telecommunications policy, in Chapter 2. The FTIR also contained some analysis of mobile communications, although most of the policy proposals had already been foreshadowed in the 5G Strategy document of a year earlier[223].

259. The FTIR confirmed a Government target that 'the majority' of the UK population (not landmass) should have access to 5G services by 2027. The Government estimated that deploying 5G over existing sites in the 700 MHz band (so as to provide national coverage) and at 3.4 GHz in specific locations (so as to provide additional capacity in high demand areas) would cost £4-5 billion and was expected to be undertaken over a period of 4-5 years (i.e. between 2019 and 2024/5)[224].

260. The review considered various models as to how 5G infrastructure might be delivered. One involved the creation of a single 'national wholesale network' which would effectively involve all four operators sharing a single network which would be owned and operated by a structurally separate entity. Such a model has been adopted in some countries, such as Mexico, but not in Europe. The Government rejected this approach in favour of competition between networks (although, as explained earlier, competition occurs between two shared networks in the UK today). However, the UK Government is also keen to encourage the development of new 'sub networks' which would supplement the national networks of the main mobile operators. These might, for example, be private, local networks operated

221. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/677598/Next_Generation_Mobile_Technologies__An_Update_to_the_5G_Strategy_for_the_UK_Final_Version_with_Citation.pdf, p.10

222. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/732496/Future_Telecoms_Infrastructure_Review.pdf

223. Including: Recently adopted changes to the Electronic Communications Code powers conferred on operators to better facilitate the upgrading and sharing of infrastructure; Requiring Ofcom identify new spectrum bands to support 5G; Supporting small cell deployment, including by new third party providers (akin to Arqiva and WIG's existing role in large cell deployment by the industry) and Continuing to fund the 5G trials and testbeds programmes.

224. Ibid p.57

by a factory owner using IoT applications and 'small cell' networks owned by third parties. The Government aims to facilitate such networks by ensuring that appropriate spectrum is available for use on a localized basis, using what is called 'shared access' models (similar to wifi, in which multiple local users have access to spectrum rather it being reserved for the exclusive use of any individual user). Ofcom has subsequently developed a shared access licence regime under which users can apply for licences to share spectrum in the 1800 MHz, 2.3 GHz, 3.8 GHz and 24 GHz bands. These licences allow a user to install low power equipment within a radius of 50 metres or medium power equipment at a single location[225]. The regime was introduced in late 2019 but there appears limited take up at this stage.

261. In September 2018, Ofcom provided advice on four measures to improve mobile coverage (in addition to obligations in spectrum licences)[226]. These were:

a. Use of public subsidy to provide coverage in 'total' not spots (i.e. areas where there is currently no coverage by any operator). Ofcom estimated the cost of this to be £3-6 billion (of which half is capex and half opex over 20 years[227]), assuming reliable provision of speeds of 2 Mb/s. Ofcom noted that it would be difficult or unfair to subsidise 'partial not spots' where one operator already provided coverage on a commercial basis.
b. Require mobile operators to roam on each other's networks, as occurs when a UK user visits a foreign country and roams abroad. Under this scenario, an O2 customer would obtain coverage in areas where O2 had no network by roaming on, say, EE's network in those areas (and reverting back to O2 when coverage became available again). This would obviously improve coverage in 'partial' not spots but do nothing to address total not spots. Ofcom estimated that geographic coverage for all four operators might increase to 90% as a result (compared to 80% for voice and 66% for 4G today).
c. Facilitating greater infrastructure sharing, for example by encouraging the emergence of independent or 'neutral' network providers.
d. Planning reforms (see below) and other measures to reduce the costs of deploying mobile infrastructure, such as providing business rates relief on mobile sites (as has been provided to firms deploying fixed fibre networks).

262. Mobile operators have consistently opposed the roaming proposals but have been broadly supportive of the other measures. Roaming is opposed on various grounds, including concerns that calls and data sessions will drop as devices switch between one network and another and that incentives to compete on the basis of coverage will be reduced (as some operators could 'free ride' on the networks of others).

225. https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/shared-access
226. https://www.ofcom.org.uk/__data/assets/pdf_file/0017/120455/advice-government-improving-mobile-coverage.pdf
227. These costs were not broken down by region.

Ofcom appear to have concluded that effective implementation of this option would only be achieved with the co-operation of the industry itself and that this will not be forthcoming. Without it, the Government risks protracted litigation which, even if unsuccessful, may then produce a poorly implemented solution. Despite this, the Government decided to keep the option of mandated roaming on the table by including it in the 'strategic steer' which it uses to inform Ofcom's objectives and on which it consulted in February 2019[228].

263. In August 2019, the UK Government consulted on further changes to the planning process in England[229], as it had promised to do in the FTIR. The consultation closed in November. If adopted, the changes would allow mobile operators:

i. To deploy equipment cabinets of any size (for power etc.) without having to wait 56 days for approval (or rejection) by the Planning Authority, as applies today. This is intended to accelerate the rate at which new sites can be deployed or upgraded.

ii. Allowing the width of existing masts to be increased by more than one third without prior approval from the Planning Authority, as applies today. This is intended to encourage operators to upgrade existing sites (rather than develop new ones) and to remove delays in doing so. Operators in England can already increase the height of existing masts (or replace with a new mast) up to 25m (15m prior to 2016) without seeking planning consent.

iii. Allowing the installation of masts on buildings within 20m of highways without requiring planning consent, as applies today. This is intended to help operators improve coverage of highways.

iv. Increasing the height of masts which operators are permitted to deploy without prior approval or consent. Since 2016 this has been 25m in non-protected areas in the UK, and 20 m in protected areas. The Government is consulting both on whether the limits should be changed, and whether any distinction should remain between different types of land.

264. The outcome of this consultation has yet to be announced[230].

265. During 2018 and early 2019 Ofcom also consulted on coverage obligations for the spectrum licences to be issued in the forthcoming 700 MHz auction, including how compliance with those conditions might be assessed[231]. In broad terms, Ofcom proposed that two of the licences issued should include obligations to:

a. Provide good voice and data coverage to at least 90% of the UK landmass within 4 years (i.e. to achieve levels of 5G coverage similar to the 2G coverage the operators had committed to achieve by 2017). Specific obligations were included for each of the regions, such that England and

228. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/842918/SSP_-_as_designated_by_S_of_S_.pdf, p.11

229. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/827162/Proposed_reforms_to_permitted_development_rights_to_support_the_deployment_of_5G_consultation.pdf

230. In March, just prior to the COVID-19 pandemic, the UK Government said "The Government is in the process of considering the responses to the consultations and will publish its response in due course.", see https://www.whatdotheyknow.com/request/647734/response/1547061/attach/2/Response.pdf?cookie_passthrough=1

231. https://www.ofcom.org.uk/__data/assets/pdf_file/0022/135157/Consultation-Coverage-obligations-in-the-700-MHz-and-3.6-3.8-GHz-spectrum-award-Ofcoms-approach-to-verifying-compliance.pdf

Northern Ireland both required at least 90% coverage, Scotland 74% and Wales 83%.

b. Provide outdoor coverage to at least 140,000 additional premises not currently covered.

c. Deploy 500 new wide area mobile masts[232].

266. These proposals were also opposed by the mobile operators. However, it would appear that they, along with the threat of mandated roaming, induced the operators to collectively develop an alternative set of proposals for improving mobile coverage in the UK. As a result, in October 2019, the UK Government announced agreement in principle with all four UK mobile operators[233]. The key elements of that agreement in principle were:

a. A target of 4G coverage to 95% of the UK landmass by the end of 2025 (compared to ~70% today). Each individual operator would have to achieve ~92% coverage by 2026 (and 88% by 2024), with the collective result being 95% coverage for the UK as a whole. Within this, England and Northern Ireland will achieve at least 91%, Wales 86% and Scotland 85% (for all four operators[234]).

b. The mobile operators to jointly invest £530 million (over 20 years) in a Shared Rural Network. It appears this would require the establishment of a new four-way joint venture company specifically for shared rural sites (i.e. outside of the existing network sharing arrangements between EE and Three and between Vodafone and O2). The aim of this venture would be to eliminate 'partial' not spots by allowing all operators to access the UK's existing network infrastructure.

c. The Government to contribute £500 million to the Shared Rural Network to extend coverage into areas that are currently total not spots (it is unclear how these figures reconcile with Ofcom's estimates of £3-6 billion to extend coverage to 100% to which we referred earlier, nor to the UK NIC's estimates of £1.7-5 billion to cover all major roads).

d. The Government will also allow use of the Emergency Services Network (ESN), which is being delivered by EE but includes Government funding of an additional 300 sites (so called Extended Area Service sites, of which it appears around 40 will be in Wales[235]) in the most remote rural locations to support the network[236]. It should be noted that the ESN was originally expected to go live in 2017 but has been subject to significant delays and cost overruns. The National Audit Office, which has been highly critical of the project, remains sceptical that it will be delivered by the revised date of 2022[237].

e. Ofcom would abandon the proposed coverage obligations in the 700 MHz auction as a result of this agreement, which will be enforced through new obligations in the licences of the operators[238].

232. Ofcom's approach was more complex in that the 'coverage obligations' were subject to bidding independently of the spectrum itself, but would carry a discount (up to a limit set by Ofcom) which would then reduce the cost of the spectrum acquired. Ofcom expected this discount to be in the range of £300-400m, see https://www.ofcom.org.uk/__data/assets/pdf_file/0019/130726/Award-of-the-700-MHz-and-3.6-3.8-GHz-spectrum-bands.pdf

233. https://www.gov.uk/government/news/1-billion-deal-set-to-solve-poor-mobile-coverage

234. https://www.ofcom.org.uk/__data/assets/pdf_file/0027/174645/letter-nicky-morgan-to-sharon-white-25-oct-19.pdf

235. https://www.assembly.wales/laid%20documents/cr-ld12069/cr-ld12069-e.pdf, p.28

236. https://www.gov.uk/government/publications/the-emergency-services-mobile-communications-programme/emergency-services-network

237. https://www.nao.org.uk/report/progress-delivering-the-emergency-services-network/

238. https://www.ofcom.org.uk/__data/assets/pdf_file/0027/174645/letter-nicky-morgan-to-sharon-white-25-oct-19.pdf

267. The parties claimed that the effect of these commitments would be to extend mobile coverage to a further 280,000 households in the UK and to 16,000 km of roads. The Welsh (and English and Northern Irish) coverage commitments were slightly better than those proposed by Ofcom for the 700 MHz spectrum, whilst the Scottish commitments are substantially better and the overall gains, in terms of households covered and extra masts, are also significantly better than those proposed by Ofcom.

268. In March 2020 the UK Government announced that a formal agreement on the SRN had been concluded with the four mobile operators, on terms that were similar but not identical to those previously agreed in October 2019[239]. For example, coverage for Wales for all four operators reduced from 86% in the October agreement to 80% in March. Coverage from all four operators in Wales was reported to be 58% as at March 2020[240], meaning that the country should still see a significant improvement in both choice between mobile operators and overall coverage once the SRN agreement has been implemented.

Welsh Government policy for mobile communications

269. Mobile communications is not a devolved matter and has received relatively little attention in Wales compared to superfast fixed broadband, for example. However, the Welsh Government produced a 'Mobile Action Plan' in 2017[241] which noted, amongst other things:

"Wales has particular characteristics in terms of topography and population density which pose challenges for mobile operators when deploying mobile infrastructure. The infrastructure required goes beyond the masts and antennae to include fibre connectivity, power supply and access. The immediate challenges are primarily focused in rural areas but networks must also service existing sites, in order to add capacity in the urban areas, in response to rising demand for mobile data. Furthermore, the introduction of new technologies, such as 5G, will require a densification of the urban networks, including the provision of fibre backhaul and power to support it."

239. https://www.gov.uk/government/news/shared-rural-network
240. https://www.ofcom.org.uk/__data/assets/pdf_file/0028/195256/connected-nations-spring-update-2020.pdf
241. https://gov.wales/sites/default/files/publications/2019-06/mobile-action-plan.pdf

270. In the Action Plan the Welsh Government committed to a review of the planning regime/permitted development rights for mobile operators, as the UK Government had already adopted new legislation for England in 2016. In December 2017 the Welsh Government published a report by Arcadis, a consulting firm, on mobile coverage in Wales and the potential impact of changes to the planning process[242]. This found:

a. Both geographic and population coverage varies enormously by local authority in Wales. For example, less than 1% of Cardiff's landmass and 0.12% of the Cardiff population lacks access to a mobile connection, whereas 51% of the Ceredigion landmass and 28% of its population lacks access (we received similar evidence on coverage from the Mid Wales Growth Partnership, which is presented in Chapter 7).

b. Increasing existing mast limits from 15m to 25m as the UK Government had done in England, thereby allowing operators to increase the height of masts without full planning consents, would improve landmass coverage by 2.6%. Increasing to 30m would improve coverage by 3.8%. The authors find that the topography of rural Wales (with many line of sight obstacles) means that taller masts will produce relatively limited coverage gains. They conclude that new masts will be required to make significant improvements in coverage.

c. The evidence showed that where operators intend to install new masts, they prefer to seek prior approval than to pursue a full planning application. However, in both cases, the vast majority of applications (~95%) are approved. Only about 20% of the full planning applications took more than 56 days to approve.

271. The authors of the report conclude that increasing the height for masts requiring prior approval under the permitted development rights regime to 25m (in line with England and Scotland, both of which had already done so) would encourage operators and others to pursue more applications, the vast majority of which would, on previous evidence, receive approval.

272. The authors also recommended that changes to existing masts be permitted where the width of the mast would be increased by no more than 1 metre or one third, whichever is the greater. This change had already been made in Scotland (and as noted above, is now being proposed for England). The authors also proposed the adoption of new rules relating to the deployment of small cells, including removing restrictions on the number of such cells that can be deployed on buildings (other than dwellings, buildings in protected areas or listed buildings), as had been adopted in Scotland. The reports also includes various other recommendations intended to improve the prospects for improving mobile coverage in Wales.

242. https://gov.wales/sites/default/files/publications/2018-11/planning-for-mobile-telecommunications-an-assessment-of-permitted-development-rights.pdf

273. In February 2019 – three years after similar changes had been adopted in England and Scotland – the Welsh Assembly adopted the Town and Country Planning (Permitted Development) (Amendment) (Wales) Order 2019 which broadly aligned the Welsh planning regime with that of England and Scotland[243]. Since then, as discussed earlier, the UK Government has consulted on further changes to the English planning regime which are intended to support the deployment of 5G infrastructure. Nothing similar is contemplated by the Welsh Government, so far as we are aware[244].

274. Other actions identified in the 2017 Action Plan include:

a. An audit of existing public asset registers to assess 'their suitability for use by mobile infrastructure providers'. This is intended to help mobile operators identify lamp/signposts, bridges or other assets to support 4G or 5G deployments. The Economy, Infrastructure and Skills Committee published a report on progress of the Mobile Action Plan in January 2019 and it was told that a 'Digital National Asset Register' (of public assets) was being developed[245].

b. A review of non-domestic business rates (an issue also identified by Ofcom in their advice to the UK Government). We understand a consultation was undertaken in 2018, but no action followed from this.

c. Consideration of public subsidy schemes for 'in fill' solutions. The Minister told the Economy, Infrastructure and Skills Committee in early 2019 that "a business case is being developed for publicly funded mobile infrastructure in areas that have no mobile connectivity"[246]. The Welsh Government have told us: "A business case for a Welsh Government funded intervention in not spot areas has been developed to outline business case stage and funding of £15 million identified. Engagement events had been held with the telecommunications industry and local authorities across Wales to develop and refine the business case. An initial 50 mobile action zones had been identified across Wales where there was no mobile phone connectivity (based on Ofcom data) but there were features on the ground that demonstrated latent demand such as homes, business, roads, rails and tourism sites. Of the 50 sites, 25 would be chosen for intervention. That intervention would primarily focus on public funding of mobile infrastructure (masts etc.) in a similar fashion to the Scottish 4G infill project. In addition there would other potential interventions in the mobile action zones on non-domestic rate relief, planning and use of public assets. Work was already underway to seek state aid compliance through GBER including publication of the required notices. In summer 2019 an open market review process had been developed to refine the Ofcom data to ensure the

243. http://www.senedd.assembly.wales/documents/s86059/CLA5-10-19%20Paper%2017.pdf

244. The Welsh Government advised us that Planning Policy Wales was updated in December 2018. The document contains some paragraphs of guidance for planning officers in relation to telecommunications, including mobile telecommunications (see pages 77-79 at https://gov.wales/sites/default/files/publications/2019-02/planning-policy-wales-edition-10.pdf) which appear helpful but remain too general. In our view, more specific guidance is required and revision of TAN19 is the way to do it.

245. https://www.assembly.wales/laid%20documents/cr-ld12069/cr-ld12069-e.pdf, p.15

246. https://www.assembly.wales/laid%20documents/cr-ld12069/cr-ld12069-e.pdf, p.25

intervention would only be focused on areas of market failure for state aid reasons and was due to go live. However following the announcement of the potential shared rural network proposals it was decided to pause further work on the project ahead of a decision on the SRN."[247] We make recommendations on how the Welsh Government might now proceed elsewhere in this report.

d. The Welsh Government would 'explore' how to improve connectivity along transport routes. The Economy, Infrastructure and Skills Committee were told "improved mobile connectivity was included in the Transport for Wales contract for Wales and Borders rail services. Discussions regarding improvements to mobile coverage along all of the arterial routes are "advanced" at this stage". The Welsh Government told us: "We have been working with Transport for Wales on improving 4G coverage on the rail network. Transport for Wales rail were set specific 4G coverage targets through their franchise agreement. Through the mobile action plan there are plans to increase the target and extend coverage further and to cover more passenger journeys. Transport for Wales have undertaken extensive planning work to design a solution that not only meet the obligations with regards to mobile coverage in the rail franchise agreement but also to extend coverage further as par the action plan. This work is ongoing but has been severely impacted by covid 19."[248]

275. In addition, the Welsh Government responded to recommendations contained in an August 2018 report entitled 'Industry 4.0' from the Economy, Infrastructure and Skills Committee[249] by asking Innovation Point, a small consulting firm, to "advise on, stimulate and exploit opportunities in the emerging 5G landscape, coordinate the work of key stakeholders and delivery partners and establish an appropriate governance framework for that activity". Innovation Point was expected to assemble an expert advisory group to "support their work on behalf of the Welsh Government that is intended to help prepare and shape a coherent national 5G programme that delivers impact, innovation and scale in a Wales that contributes to the wider 5G UK ecosystem"[250]. An expert group was assembled in October 2018 but we understand that this has since been disbanded and support staff have been transferred to the Welsh Government. We understand they supported the application for £5 million funding of the Connected Communities in the Rural Economy consortium, to which we referred earlier.

276. The Scottish Government has been taking a more pro-active approach to mobile communications policy than the Welsh Government in recent years. In August 2019 the Scottish Government published a strategy entitled 'Forging our Digital Future with 5G'[251]. Its motivation for doing so, with which we agree, is clearly stated:

247. Written comments received from Welsh Government officials, 2 October 2020
248. Written comments received from Welsh Government officials, 2 October 2020
249. https://www.assembly.wales/laid%20documents/cr-ld11717/cr-ld11717-e.pdf
250. https://www.assembly.wales/laid%20documents/gen-ld11768/gen-ld11768-e.pdf, p.5
251. https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2019/08/forging-digital-future-5g-strategy-scotland/documents/forging-digital-future-5g-strategy-scotland/forging-digital-future-5g-strategy-scotland/govscot%3Adocument/forging-digital-future-5g-strategy-scotland.pdf?forceDownload=true

"...the FTIR [the UK Government's Future Telecoms Infrastructure Review, discussed in Chapter 2] is focused on the deployment of full fibre connectivity and the Scottish Government believes that there is now a requirement to show leadership at a national level by creating a supportive policy framework to facilitate the development and deployment of 5G to meet the 2027 ambition.

The Scottish Government believes a 'do-nothing' approach will most likely lead to a repeat of previous UK-wide deployments of digital infrastructure (mobile and broadband) where more populous urban areas are the focus of investment and rural areas are at the end of the queue. This is exacerbated by the current uncertainty of commercial business models which would underpin widespread 5G deployment. This will place rural communities at a continuing disadvantage when online service delivery is essential to drive improvements, efficiency and gains in productivity; alongside the societal impacts of this inequality."[252]

277. The Scottish Government's strategy has aspects which are similar to those we recommend for the Welsh Government. In particular, the Scottish Government states that it will:

"explore models which could help reduce the industry's deployment and operational costs – to facilitate network deployment in rural and remote areas. This could potentially use existing public sector assets and/or deployments arising from the Scottish Government's Scottish 4G Infill programme as a testbed in which to target public investment in rural areas to reduce the 5G "notspots" in the future."[253]

278. This is consistent with our recommendation that the Welsh Government engage with the mobile industry to consider whether further changes in the Welsh planning regime and the provision of additional public funds could be used to further extend and accelerate 5G deployment within the context of the existing Shared Rural Network initiative (or as part of a separate agreement), using the 700 MHz spectrum that is expected to become available in early 2021.

252. Ibid p.10
253. Ibid, p.12

279. The report also highlights a large number of existing policies which the Scottish Government is pursuing and which are expected to assist with the deployment and adoption of 5G technologies. These include:

a. Work with city councils in Glasgow and Dundee to make public assets available for use in 5G deployments (which we also recommend),

b. Work with Transport Scotland to facilitate access to infrastructure and provide coverage of roads (which we recommend the new barrier busting task force undertake in Wales),

c. Work with IoT Scotland, CENSUS (Centre for Sensor and Imaging Systems) and SWAN to promote developments in IoT, including its adoption by the public sector,

d. The existing 4G In Fill programme (referred to above) and R100 programme (discussed in Chapter 2),

e. The reforms to the planning regime which have already been undertaken in Scotland,

f. The provision of relief from business rates (for fibre deployments for 10 years and for 4G Infill investments) (which we do not recommend at this stage unless the industry provides better evidence of the benefits for Wales).

280. The Scottish Government also proposes to take new actions, including:

a. The development of new 5G use cases (which we suggest the Welsh Government attach less priority to since 5G applications are already being developed elsewhere and can be applied on a global basis).

b. The provision of guidance to local authorities and other bodies to facilitate the use of public sector assets for the use of 4G and 5G infrastructure, including in relation to rental fees (and the development of an asset register), which we recommend the Welsh Government also provide.

c. Further work on the digitization of Transport Scotland assets (which we recommend the barrier busting taskforce do in Wales with Transport for Wales but in co-ordination with initiatives already being undertaken by the UK Government).

d. A further 'wide review' of permitted development rights, which were previously revised in 2017. We assume this is likely to contain many of the proposals already made in the UK Government's August 2019 consultation package, the results of which we are still awaiting (and which we recommend the Welsh Government also pursue as a matter of urgency).

e. To publish revised guidance which will replace the existing Planning Advice Note 62: Radio Telecommunications. The Scottish Government says "This will provide useful information and advice to planning authorities, the telecommunications industry and the public to enhance understanding of the need for additional communications infrastructure, both to serve the growth in customer demand and in response to changing technical requirements. The guidance will advise on good practice in appropriate site selection and design, illustrating how equipment can be sensitively installed to minimise physical impact"(we similarly recommend that TAN19, the Welsh planning guidance, be fundamentally revised as a matter of urgency).

f. Supporting local authorities in mapping and procuring infrastructure (we make no specific recommendations on this at this stage, although would expect the new barrier busting taskforce to work closely with local authorities and respond to any requirements that are identified).

g. Exploring 'neutral host' or shared infrastructure models (we suggest this forms parts of the wider discussions between the Welsh Government and mobile industry to improve 4G coverage and accelerate 5G deployment).

Chapter 6

Economic benefits of mobile broadband

281. In this chapter we consider evidence as to the economic and social benefits of mobile communications infrastructure. We focus particularly on the evidence of the benefits of 5G and of mobile coverage more generally[254]. We also conclude with some general observations about the evidence of the likely economic and other benefits of new digital communications technologies for Wales.

282. Evidence of socio-economic benefits from mobile is less extensive than the literature on fixed broadband which we reviewed in Chapter 3. A review by Deliotte for the UK Government in 2018 found "a lack of conclusive evidence on the impact of specific generations of mobile broadband technologies or the particular features of each generation"[255]. It is reasonable to suppose that many of the benefits attributed to fixed broadband technologies, as discussed in Chapter 3, would also be realized by using a home broadband connection. There are, however, additional benefits that may be specifically attributable to mobile technologies, including the ability for the individual to connect at locations outside of the home or the office and features of mobile broadband, such as the use of apps and different user interfaces, which are less or not prevalent in a fixed broadband environment.

283. The first study to specifically address the impact of moving from one generation of mobile technology to another was undertaken in 2012[256], and used a sample of 96 countries in the period 2008-11. It found that at a given level of mobile adoption, substituting 10% of 2G connections with 3G connections increased GDP per capita growth by 0.15% (which implies that the full transition from 2G to 3G could have yielded growth of ~1%). A later study by Imperial College found that a 10% increase in 'mobile broadband' (predominantly 3G given the period 2002-2014) increased GDP growth by between 0.6% and 2.8%[257]. The economic impact of 3G adoption would therefore appear to be comparable to that of fixed broadband adoption (with the difference being that widespread adoption of new mobile connections tends to occur more rapidly than widespread adoption of new fixed broadband connections, where infrastructure takes longer to deploy and upgrades of handsets or other devices by consumers occur less frequently).

254. For a literature review, see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/714112/The_impacts_of_mobile_broadband_and_5G.pdf. Studies include the IHT Markit global study for Qualcomm, which is available at https://www.qualcomm.com/media/documents/files/ihs-5g-economic-impact-study-2019.pdf; the TMT study for the GSMA which is global but specific to millimetre wave band spectrum, see https://www.gsma.com/spectrum/wp-content/uploads/2019/10/mmWave-5G-benefits.pdf and the Tech4i2 study for the Swiss operators at https://asut.ch/asut/media/id/1465/type/document/Study_Tech4i2_5G_socioeconomic_impact_switzerland_February_2019.pdf

255. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/714112/The_impacts_of_mobile_broadband_and_5G.pdf

256. https://www.gsma.com/publicpolicy/wp-content/uploads/2012/11/gsma-deloitte-impact-mobile-telephony-economic-growth.pdf

257. https://spiral.imperial.ac.uk/bitstream/10044/1/46208/2/Goodridge%202017-05.pdf

284. Moving from 2G to 3G allows users to have access to the mobile data services for the first time. We are, however, more interested in the impact of obtaining faster access to mobile data services (or access with lower latency or greater stability), of the kind which a move from 4G to 5G might involve. One way to address this would be to consider the evidence of moving from 3G to 4G, which begins to capture the benefits of improvements in network speed and capacity (although in the UK would also capture improvements in coverage between 3G and 4G).

285. We do not, however, yet have good measurements of the gains from moving to 4G. A study by Capital Economics for EE, published in 2014, predicted that the transition from 3G to 4G in the UK could yield growth of the order of 0.7% of GDP, equivalent to £12 billion p.a. at 2014 prices[258].

286. The Capital Economics study does contain a number of interesting observations:

a. The authors estimated that the UK mobile operators would invest around £5.5 billion over a 3-4 year period to undertake the upgrade to 4G in the UK. This compared to the UK Government's annual transport budget of £8.6 billion in 2015/16, the 10 year budget for Crossrail (since revised) of £15 billion and the cost of a nuclear power plant of £4-6 billion. We note it also compares to the UK NIC's estimate that an update to national FTTH would cost £33 billion.

b. The report breaks down results by region. It estimates that the UK industry generated around £19 billion p.a. of revenue in 2013, of which £1 billion is earned in Wales[259] and £4.5 billion of GVA, of which £200 million is in Wales (with 1,900 direct jobs in Wales out of a total of 35,400 across the UK).

c. The report considers the benefits that may be derived from households who are unable to access fixed superfast broadband services and who might use 4G home broadband services as an alternative, estimating this at 0.02% of GDP. It also says:

"EE's rollout of 4G LTE to 2,000 residents and businesses in rural Cumbria. This is an area where fixed line fibre networks are not commercially viable. The Northern Fells Broadband Group estimated that the cost of delivering superfast broadband to this area of Cumbria using fibre would be around £10 million. The cost of delivering superfast broadband wirelessly using 4G LTE is approximately ten per cent of this."

287. As with fixed broadband, many of the economic benefits of mobile broadband arise from improvements in business productivity. Mobile broadband allows workers to remain productive outside of the office and may improve productivity inside the office (although this is sometimes contested, as mobile devices also distract workers and workers outside the office may be more difficult to monitor and manage).

258. https://newsroom.ee.co.uk/download/230212/capitaleconomicsreport-improvingconnectivitynov2014.pdf
259. Ibid p.15

Faster mobile broadband allows downloads and uploads of data to be accomplished more quickly – the Capital Economics study reports data to suggest that UK business users saved an average of 13 minutes a day as a result of using 4G rather than 3G to access services – or for more data to be consumed. A study of the US adoption of 4G estimates that by 2016 4G technologies contributed an additional $100 billion to GDP ($450 billion vs $350 billion in the absence of 4G), with the report emphasizing the massive reductions in the unit costs of data transmission and corresponding increases in data consumption that have occurred in the US (costs per Mb fell by 99.7% in the period 2006 to 2016)[260]. Although we would not place much weight on these figures, the UK has experienced similar reductions in unit costs and growth in mobile data consumption over the period, much of it attributable to the transition from 3G to 4G technology.

288. Any projection of the benefits of 5G needs to be approached with great caution since the technology itself is still evolving and may be very different from previous generations of mobile technology, or from the transition from superfast to ultrafast fixed technologies. It would therefore be unwise to extrapolate too much from other technologies.

289. One of the few studies to estimate the socio-economic benefits of 5G was undertaken for the European Commission in 2016[261] and was used to inform the target, which all European Member States including the UK have adopted, that 5G should be available in cities and all major transport routes in Europe by 2025. Note that the study itself seeks to quantify the benefits that would be gained if 5G coverage were 95% of the landmass, which is significantly more ambitious than the targets which were subsequently adopted. Most other studies of benefits in Europe rely upon case studies which do not allow robust quantification of benefits, or comparison with costs[262].

290. The authors of the European Commission study identified benefits from 5G totalling €113 billion p.a. by 2025 from a wide range of sources (but do not estimate the impact on GDP growth). Costs of deploying 5G infrastructure are estimated at €56 billion to 2030. The figures themselves are less important than their relative size and attribution. The study identifies €62.5 billion of 'direct' benefits which are realized by consumers and producers through the application of 5G technologies to different activities. Of these, the vast majority (over €42 billion) are attributed to 'automotive' (which requires ubiquitous coverage of the road infrastructure). The automotive industry has been an early adopter of 5G technology, both in

260. https://api.ctia.org/wp-content/uploads/2018/04/Recon-Analytics_How-Americas-4G-Leadership-Propelled-US-Economy_2018.pdf

261. http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=17802. The other often cited (global) study is undertaken by IHT Markit for Qualcomm, see https://www.qualcomm.com/media/documents/files/ihs-5g-economic-impact-study-2019.pdf

262. E.g. https://www.vodafone.com/content/dam/vodcom/files/public-policy/gigabit-society-5g-04042017.pdf

the production of vehicles (which involve complex supply chains, robotics and thousands of components), remote diagnostics, and in the provision of new capabilities such as autonomous or assisted driving. Large gains in energy efficiency/ reduction in congestion and safety are anticipated.

291. In comparison, €8 billion is attributed to transport (i.e. telematics in commercial vehicles), €6 billion to utilities and €5 billion to healthcare. 'Indirect' benefits are those which benefit society more generally, rather than specific sectors. These amount to another €50 billion p.a., of which €30 billion are productivity gains in the workplace. Another €10 billion is attributed to the provision of 5G home broadband services to households in Europe that lack access to fixed broadband connections.

292. In short, a significant proportion of the benefits case in this study rely upon the application of 5G technologies in the automotive sector and in 'the workplace' (which includes use of 5G outside of the office for business purposes), rather than other applications. The realisation of benefits in the workplace would seem a reasonable assumption given the evidence we have of productivity gains from 4G adoption. Mobile technologies have also been and are already extensively used in vehicles – the first consumer mobile devices were car phones – but the aspirations for 5G in the automotive sector are unlike anything seen to date. There must be greater uncertainty about whether, or how quickly, such benefits might be realized given the high degree of uncertainty about the future of the automotive industry more generally and the dependency on near-universal coverage of the existing road infrastructure if those 5G benefits are to be realized. It is also unclear whether 5G is in fact required for some applications such as autonomous vehicles (which may use radar or other technologies to communicate rather than 5G).

293. Studies of 5G in the UK are relatively limited at this stage:

a. A report by Barclays estimates that 5G could add 1% of UK GDP by 2030, although they detail concerns that UK businesses are currently unaware and unprepared to exploit the benefits of 5G (with only 9% of businesses engaged in any planning to use it)[263]. The Barclays model assumes 95% population coverage and adoption by 80% of the population by 2030.

b. O2 commissioned research which predicts large economic benefits from 5G by 2026. The company claims that in the period 2016 to 2026, 4G and 5G technologies will add £18 billion of GVA to the UK economy, compared to £17 billion added by the adoption of superfast broadband and FTTH technologies[264]. O2 argue that the main reason why mobile technologies deliver greater economic benefits is that they can be deployed much more quickly than FTTH and are much more widely adopted (fixed superfast broadband adoption in the UK remains around 60%, whereas 4G adoption is over 80%).

263. https://www.barclayscorporate.com/content/dam/barclayscorporate-com/documents/insights/innovation/5g-a-transformative-technology.pdf
264. https://news.o2.co.uk/press-release/uk-5g-infrastructure-outstrip-economic-benefits-fibre-broadband-2026/

c. The report by Assembly, commissioned by Huawei, to which we referred in Chapter 3, considered the economic impact of gigabit connectivity in a scenario in which 20% of the coverage was provided by 5G rather than FTTH.

d. Research published in October 2019 by 5G Rural First, assisted by Plum, considered the prospects for and impact of 5G for rural communities in the UK. They note that rural regions contribute 16% of the UK's GVA (or around £300 billion p.a.) Rural Wales contributes a higher proportion – 20% – to the Welsh economy (compared to 16% for rural England and 27% for rural Scotland). The report explores various commercial opportunities for 5G applications (including use for TV broadcast services and agri-tech) and concludes that the deployment of 5G infrastructure in rural areas with a population density greater than 30 persons per km2 ought to be commercially feasible if shared spectrum technologies (discussed above) are used. It estimates that an additional £17bn of GVA could be added (so 6% of the £300 billion p.a. already generated by rural UK) over a 10 year period if good quality 5G services were available[265].

e. A report by Deloitte, commissioned by the Scottish Futures Trust, and published in August 2019, evaluated the impact of accelerated 5G deployment for Scotland. It estimated that 5G deployment would add £17 billion or 8.3% to Scottish GDP by 2035 (including 160,000 jobs and 3,000 new businesses), rising to £34 billion by 2050. The report also considers social impacts in terms of rural inclusion (which was valued at £700 million as a result of extending 4G coverage from 65% to 90%), environmental benefits and benefits for the digitization of public services. The study found that Scottish communities in rural areas stood to gain the greatest (proportionate) benefit from 5G, since it would represent a more significant improvement over their existing digital infrastructure than was the case in more urban areas. GDP gains of 11% in rural areas were predicted, compared to 8% in urban areas[266].

294. We discussed the NIC 5G report in Chapter 5 and presented some of the findings as to the benefits of coverage of roads and railways. Although the UK NIC report echoed other policymakers in drawing attention to persistent shortfalls in mobile coverage in the UK, it did not attempt to quantify or assess the socio-economic benefits that might be obtained from improvements in mobile coverage in the UK, or to compare these against the costs of provision.

265. https://www.5gruralfirst.org/wp-content/uploads/2019/10/5G-RuralFirst-New-Thinking-Applied-to-Rural-Connectivity-1.pdf
266. https://www.scottishfuturestrust.org.uk/storage/uploads/deloittesfteconomicimpact4g5gfinalreportforpublication.pdf

Benefits of mobile coverage

295. Much of the evidence there is on the benefits of mobile coverage involves surveys. These indicate that a lack of mobile coverage affects younger people more acutely, particularly in terms of feeling disconnected with the rest of the world, and that this – alongside the more restricted commercial and economic opportunities which arise when there is no mobile coverage – may lead them to migrate to urban areas and so exacerbate the trend in rural depopulation (and, arguably, loss of diversity) which is already underway in many rural areas[267].

296. It is also argued that mobile data coverage is required to support 'smart farming' (including both sensors and drones)[268] and rural health and social care delivery[269], but we have not seen attempts to quantify these benefits robustly. We are also aware of claims that improved geographic coverage enhances tourism revenues for the local economy, although others claim that the visual impact of the masts may have the opposite effect. One study for Ofcom found that those who live in remote areas (of the UK) without any mobile coverage tend to adjust their lifestyles and working practices to take this into account. That is, they continue to live largely as they did before mobile communications became accessible to the rest of society. The report finds that it is the urban dwellers, now accustomed to living with constant and instant mobile connectivity, who are most frustrated when coverage is not available[270]. Many policymakers are likely to fall into this category.

297. A study for the Scottish Government in 2014 attempted to quantify the productivity benefits of accelerating 4G coverage. It found that it was unlikely the Government could take any measures that would actually expand 4G coverage in Scotland, although it could take a number of measures to accelerate the rate at which 4G was deployed. These included revising the planning approvals process, reducing non-domestic rates and making public land and other assets available for mobile sites. The authors found that if 4G was deployed 4 years earlier as a result, then this would add around £18 million GVA over the period 2013 to 2023[271]. We referred earlier to the subsequent 2019 Deloitte report, which estimated the social inclusion benefits from extending 4G coverage from 65% to 90% at £700 million.

267. https://www.rand.org/pubs/research_reports/RR641.html

268. An attempt to value the benefits of smart farming was undertaken by PwC for the Irish Government, valuing benefits of reduced mortality, especially amongst calves, see PwC at http://www.dccae.gov.ie/communications/SiteCollectionDocuments/Broadband/Updated%20Expert%20reports/PwCCostBenefitAnalysisSupplementaryReport.pdf. The Australian Regional Telecommunications Review of 2015 (https://www.communications.gov.au/sites/default/files/rtirc-independent-committee-review-2015-final.pdf?acsf_files_redirect) refers to the use of sensors in agriculture (to monitor crop performance or climate conditions), alongside more conventional benefits such as reporting of accidents at remote locations or vehicle breakdown assistance.

269. https://www.researchgate.net/publication/232006664_Rural_mobile_phone_coverage_is_an_issue_for_the_NHS

270. https://www.ofcom.org.uk/__data/assets/pdf_file/0025/62656/illuminas_final_report.pdf?lang=en_gb

271. https://www2.gov.scot/resource/0044/00445653.pdf

298. One of the reasons why there is limited cost benefit analysis for mobile coverage, in contrast to that for fixed broadband coverage which was discussed in Chapter 3, is that public money has rarely been used to support investments in the mobile infrastructure. Such investments normally require some attempt to quantify the relative benefits and costs in order to ensure that the expenditure represents value for money to the taxpayer. In contrast, most investments in mobile infrastructure have been undertaken by the mobile operators using their own funds. These operators do undertake detailed economic assessments before deciding whether to install infrastructure or extend coverage, but they are not published and will exclude broader social or economic benefits which the operators themselves cannot translate into revenues.

299. Prior to the Shared Rural Network, which we discussed in Chapter 4, there had been only one instance where public funds have been used to support mobile coverage in the UK, being the Mobile Infrastructure Project (MIP) which ran from 2011 to 2016. It eventually delivered 75 new masts (coverage for 7000 households or 14,000 residents) at a cost of £35 million[272]. This was a disappointing outcome – £150 million was initially set aside to fund up to 575 new sites, covering 60,000 households. The cost benefit analysis which was subsequently undertaken states that a typical mast would be expected to generate £1000 of profit per household covered over a period of 20 years. Some of the masts which were deployed with MIP funds cost £8000 or even £9000 per household.

300. The aim of the project was to extend mobile coverage to households in areas where there was none from any operator at present (i.e. not spots) in order to "improve productivity, promote digital inclusion and improve access to and delivery of public services". One of the important consequences of the poor performance of the MIP project was that it persuaded the Government to bring forward legislative changes to planning law in order to make it easier to install masts.

301. The UK Government estimated the economic and social benefits obtained from the MIP by relying upon 'willingness to pay' data derived from a survey by RAND. This survey, conducted in late 2013, asked consumers in unserved areas what they would be prepared to pay for voice or mobile data access in order to obtain a valuation of the benefit they attributed to it. Other benefits which those consumers did not take into account (such as the value to other users of being able to contact those users) would not be accounted for. Unsurprisingly, consumers value access to both mobile data and voice services (e.g. 4G) more than access to voice (2G). Residents in these areas valued mobile access to both voice and data at £13.40/month, and businesses at £30 per phone per month. Tourists valued mobile access at 20-40 pence/day. On this basis, the Net Present Value of the economic benefits from the MIP over the period 2012/13 to 2032/3 was £28 million, and the costs £38 million, giving a benefit to cost ratio of 0.73. In most circumstances, a benefit to cost ratio of below 1, which means economic value has been destroyed rather than created, would be poorly received. In this case, the UK Government claims

272. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/651008/MIP_Impact_and_Benefits_Report.pdf

that additional benefits, which could not be captured in the willingness to pay measure, would likely ensure the long term ratio rose to above 1 (although it offered no evidence to support this).

302. In 2018, the Scottish Government announced a '4G infill programme', initially aiming at 16 sites and an expenditure of £25 million[273] but subsequently expanded to 45 sites, mainly areas with no coverage from any operators in the Highlands and Islands. The first mast came into service in February 2020 – much later than originally intended – and the scope of the project appears to have been significantly reduced (to 'up to 24 masts'). This is attributed to a lack of interest on the part of the mobile operators themselves, which may itself reflect their focus on the much larger Shared Rural Network initiative for the UK as a whole[274].

Observations of the economic and other benefits of new digital communications technologies

303. We have considered a range of evidence as to the likely benefits and costs of investments in new digital infrastructures, either in the UK, in Wales or evidence from elsewhere in the world. These produce a wide range of estimates and comparison between different studies needs to be undertaken with great caution, since different methodologies are often being applied over different time periods and different things are often being measured. In addition, projections or predictions of benefits for technologies which have yet to be deployed at any scale often rely on extrapolations from previous generations of technology. The past may or may not be a reliable indicator of the future in such cases.

304. We have considered two types of study. One type involves estimations of the size of the overall economic benefits that might be obtained from investments in broadband infrastructure. These disregard whether the investment is made by the private sector or comes from public funds. The first and most obvious conclusion from these studies is that the size of the economic benefit depends upon the rate of adoption of the technology. If adoption of fixed broadband connections grows from 10% of the population to 20%, studies suggest GDP can grow by almost 1.5%. Wales currently has superfast broadband adoption by around 35% of the population (38% of the homes passed). If superfast adoption could be doubled – irrespective of any new investment in infrastructure – then Welsh GDP might be several percentage points higher than it is today.

305. We currently understand less about the impact of increases in fixed broadband speed, which is a main (although not the only) benefit of deploying fibre to the home technology. It is reasonable to suppose that connecting businesses to fibre infrastructure will yield significant productivity benefits and, importantly, that without access to fibre infrastructure a number of businesses would relocate altogether, thereby removing their economic contribution from the Welsh economy entirely. This in itself provides a good rationale for seeking to deploy fibre to businesses wherever possible (recognising that the COVID-19 pandemic may also

273. https://www.ispreview.co.uk/index.php/2018/03/scotland-unveil-25m-mobile-infill-project-boost-4g-coverage.html
274. https://www.ispreview.co.uk/index.php/2020/02/first-mobile-mast-live-in-scotlands-delayed-4g-infill-scheme.html

lead to greater gains from homeworking in future). What evidence we have suggests that significant improvements in broadband speeds (from basic to superfast or from superfast to ultrafast) probably add 1-2% points to business output or GVA. Studies of the move from one generation of mobile technology to another (2G to 3G or 3G to 4G) suggest gains of a similar magnitude, equivalent to around £500 of additional economic output per year for every person in Wales.

306. The IPSOS Mori finding that FTTH increased turnover by almost 6%, discussed in Chapter 3, should we think be treated with a degree of caution given the sample size, but may suggest the potential for FTTH technologies to unlock new and additional sources of productivity and innovation which are not possible with superfast broadband technologies[275]. Similarly, the Deloitte prediction that Scottish GDP could be over 8% higher as a result of widespread 5G deployment appears relatively high at first sight, but could be feasible if many of the new IoT applications associated with 5G were to be widely and rapidly adopted.

307. That said, we are not persuaded that the UK NIC's report which we discussed in Chapter 2 and on which the FTIR and current UK Government's commitment to nationwide FTTH seems to be based, offers compelling evidence of the need for FTTH in every household in the UK. The ability to play Virtual Reality games or consume 8k TV services – the two services identified by the UK NIC's consultants as only capable of being delivered with FTTH – is not in our view likely to justify the expenditure of tens of thousands of pounds to provide FTTH connections to the hardest to serve households, or to require they wait for many year until FTTH arrives, when better alternatives exist in the meantime.

308. Importantly, although the long term benefits of both FTTH and 5G would appear to be of a similar order to magnitude, we also know that the costs and speed of deploying them can differ significantly. Estimates for the total cost of nationwide FTTH are of the order of £30 billion, whilst those for 5G are generally less than £10 billion. The evidence to date suggests that 5G home broadband would be expected to cost several orders of magnitude – perhaps a third – less per household to deploy than a fibre connection[276]. It could also be deployed much more rapidly. This suggests that where existing mobile infrastructure already exists, the use of 4G or 5G home broadband connections are likely to have superior benefit to cost properties than any fibre connection, particularly in rural areas. This would lend support to a policy of seeking to maximise 4G or 5G home broadband provision, at least over existing mobile infrastructure in rural Wales, as we recommend.

309. Low single digit percentage productivity gains are significant given that GVA and GDP in Wales grew by 3.3% for the most recent reported period (2018)[277]. One consequence of the relatively large economic impact

275. The IPSOS Mori findings suggest increasing economic returns as speed increases, with much higher gains when speeds increase by over 500 Mb/s (5.8%) than when they increase by 100-200 Mb/s. This is possible, but somewhat counter-intuitive and at odds with other evidence, which suggests diminishing benefits as speeds increase (although benefits nonetheless).

276. EE's 4G evidence suggests a factor of 10, the Assembly research for Huawei suggests a factor of 4 or 5.

277. https://gov.wales/regional-gross-domestic-product-and-gross-value-added-1998-2018#:~:text=Gross%20Value%20Added%20(GVA)%20(,%2C%20up%202.9%25%20on%202017

of digital communication technology is that public sector investment to support infrastructure, even in comparatively high cost to build areas, can still yield large benefit to cost ratios. The second type of evidence we have considered has sought to calculate these.

310. The evidence we presented in Chapter 3 showed that the use of public funds to support superfast broadband deployments in Wales have been economically justified, even if we would treat the very high ratios (7:1 (SQW) and 13:1 (Miller)) with some caution. This partly reflects the high levels of take up of superfast technology (around 50%) which the programme has achieved in Wales. The equivalent ratio for superfast programmes elsewhere in the UK was closer to 2:1. It also compares very favourably with benefit to cost ratios on other UK public infrastructure projects – HS2 and Crossrail had ratios of between 2:1 and 3:1, many local transport projects have ratios between 1:2 and 1:3, as do most rail schemes[278].

311. But we also know that the subsidy costs of the remaining Superfast Cymru Phase 2 projects which are now being undertaken and which deploy FTTH, have increased dramatically. At a cost per household of over £2000, the benefit to cost ratios on the latest projects are likely to be much lower than 7:1. The same may apply to households served under the Gigabit Voucher Scheme in Wales, where the total cost to the UK taxpayer is now £3000 per household.

312. The conclusion we draw from this is not that further public subsidy of FTTH infrastructure by the Welsh Government is not justified. However, there is a risk that the benefit to cost ratio declines rapidly with efforts to extend FTTH to ever more difficult to serve areas of Wales. Large sums (in the hundreds of millions of pounds) could be spent to connect an ever diminishing pool of homes, for relatively modest economic and other benefits. There is no compelling reason to dogmatically require every household in Wales to be served by FTTH technology, but there is a strong case for seeking to extend the benefits of advanced digital technologies, including 4G and 5G, to as many households as possible in as flexible and cost effective a manner as possible.

313. In these circumstances, we think there is good reason to reallocate public funds which might otherwise be spent on extending FTTH to instead accelerate and extend the deployment of 4G and 5G home broadband services once mobile operators have obtained the right spectrum to allow them to do so. In saying this, we also recognize that the evidence as to the economic and other benefits of investments in extending mobile coverage, which we presented earlier in this chapter, is both limited (to the ill-fated Mobile Infrastructure Project) and not particularly positive. Nonetheless, we think the economic case for extending 4G and 5G mobile infrastructure in many parts of Wales is likely to be superior to that of FTTH.

278. https://www.bennettinstitute.cam.ac.uk/media/uploads/files/The_Imperial_Treasury_appraisal_methodology_and_regional_economic_performance_in_the_UK.pdf, p.9

Chapter 7

Stakeholder views and conclusions on mobile broadband

Stakeholder views

314. In this chapter we summarize the evidence we received from stakeholders in response to our Call for (written) Evidence and in the small number of in person meetings that we were able to have prior to the introduction of social distancing in March 2020.

315. There was widespread concern amongst respondents that the delay by the Welsh Government in revising planning laws, as the English and Scottish Governments had done three years earlier (and now propose to do again) had and would continue to place Wales at a disadvantage with regard to the provision of mobile coverage. UK Mobile also noted that the Government has not revised the associated guidance to local authority planning departments, TAN 19, since 2002.

316. We agree with stakeholders and recommend that the Welsh Government adopt legislation which at least aligns Welsh planning rules for telecommunications infrastructure with the other nations going forward. Without this, we share BT's concern that even the existing commitments under the Shared Rural Network agreement, which promise significant benefits to Wales, will not be met.

317. We also consider that the Welsh Government should be prepared to be more ambitious than this and should consider granting mobile operators more extensive rights (perhaps in relation to the height of masts which may be deployed without consents in certain circumstances) than are available elsewhere in the UK. This would make Wales a leader, rather than a laggard, in terms of the planning environment for digital mobile infrastructure. It would properly reflect the greater emphasis on mobile broadband infrastructure which we consider should be adopted in Wales (and would more closely align Wales with the approach being adopted by the Government in Scotland).

318. However, we think that more favourable provisions should only be adopted if Welsh households and businesses can be assured of obtaining significant improvements in broadband connectivity as a result. This would require the mobile industry, perhaps represented by Mobile UK, to commit to further improving coverage in Wales, beyond the commitments already provided under the Shared Rural Network programme. This could take the form of additional sites in Wales (possibly with public funds to support) or the early upgrading of these sites to 5G technologies using the 700 MHz spectrum which Ofcom is due to award in early 2021. It would be for the operators to consider what additional investments its members could undertake if more favourable planning regulations were to be adopted in Wales. Discussions of this kind may take some time (as those preceding the conclusion of the Shared Rural Network agreement demonstrated) and it is critical that they do not delay the adoption of measures in the meantime to align the Welsh regime with the other regions. We therefore recommend that the Welsh Government pursue these activities in parallel.

319. We also recognize that the application of new planning regulations is undertaken by local authorities. We agree with Mobile UK that new TANs for telecommunications infrastructure in Wales are long overdue (as is the revision of the Code of Practice on Mobile Phone Network Development). In addition, new guidance is required on the provision of access to assets owned by local authorities, including ducts and sites for masts, including the charges to be levied for leases under the new Electronic Communications Code and the new Telecoms Infrastructure (Leasehold Properties) Act when it comes into force.

320. We consider that the detailed proposals made by Mobile UK for Welsh Government action to work with the highways authorities and Network Rail to improve access to their facilities for mobile operators in Wales have merit. We therefore recommend that the Welsh Government establish its own 'barrier busting' taskforce, led by a senior official, to progress these and other issues. The taskforce should be given deadlines by which actions are expected to be completed and should liaise with its counterparts at the DCMS and the Scottish Government.

321. Taken together, a rapid revision of the planning regulations, the issuance of new guidance to local authorities, and the creation of a 'barrier busting' taskforce would demonstrate the Welsh Government's commitment to taking tangible actions to support the further deployment of both fixed and mobile digital infrastructure in Wales. This would then provide a credible basis for discussions with the UK mobile industry on further actions that would enable 4G and 5G coverage to extend beyond that currently envisaged by the Shared Rural Network agreement[279].

322. We note that no specific proposals were made by stakeholders in relation to the use of public funds to support the deployment of mobile infrastructure. We consider that this should be explored as part of the discussions with the industry about what benefits Wales might obtain in return for such investments.

323. In the following paragraphs we summarize the evidence received from each stakeholder.

Active Building Centre

324. The Active Building Centre, based at the University of Swansea, was created as part of the Government's Industrial Strategy and contributes to work intended to halve energy use in new buildings by 2030.

325. They considered that 5G had a number of benefits, both for remote and less remote communities. These included higher bandwidths (relative to many current fixed broadband technologies, by which we assume they mean VDSL), lower latency and ability to connect a large number of objects of devices ('Internet of Things'). They also considered that 5G had 'greater coverage ability', although it was not clear to us what they were comparing with in this context. We agree with their assessment of

279. It was suggested to us by Welsh Government (in correspondence of 2 October 2020) that the existing planning regime already allows Welsh authorities to grant consents in return for commitments by operators to invest in coverage. However, individual planning consents are obtained on a case by case basis and involve a degree of uncertainty, even if most are eventually approved. This process cannot, in our view, form the basis of any industry-wide agreement or strategy for extending 5G coverage of the kind we envisage. The planning regime would have to provide operators with rights to deploy equipment.

the properties of 5G, other than in respect of coverage, where, as we explained in Chapter 4, performance depends primarily on the radio frequencies which are being used rather than the technology itself.

BT

326. BT told us that EE provided coverage to 82% of the Welsh landmass. Under the Shared Rural Network EE expects to extend 4G coverage to 88% of the country by 2026 (and has agreed with Ofcom to accept enforceable licence conditions which reflect this). BT noted that Wales suffers disproportionately from 'partial' not spots, being areas which are served by at least one mobile operator but not by all of them (an issue we discuss in Chapter 5 of this report). BT said EE has a process in place to share its mobile infrastructure with other operators on commercial terms if they requested to do so.

327. BT told us that Wales would benefit from the Emergency Services Network (ESN), which EE was supplying, through the addition of 75 sites built by EE and a further 93 to be delivered by the Home Office. It said many of these were at locations in Wales where there was currently no mobile coverage and that EE intended to offer 4G on a commercial basis from them. We discuss the ESN in Chapter 5. BT seemed to suggest that some sites may be difficult for them to activate because the Home Office had so far failed to deliver the appropriate infrastructure to support them.

328. BT referred to the recent changes to planning legislation in Wales, which we discussed in Chapter 5. They said:

"We note that the Welsh Government, after some delay, did make some changes to the planning regime governing mobile infrastructure in Wales in February 2019. This came two years after a report first recommended such changes were made to bring the planning regime into alignment with that which existed in England at the time. The changes, while welcome, were largely too late to support any acceleration of planned 4G deployment in Wales on EE's part. Had the reforms been made earlier, 4G coverage in Wales would likely have been more extensive than is the case today."

329. BT also told us:

"If the PDR regime could be applied to masts of 35 or even 50 metres in height, the number of new sites needed could be expected to fall substantially. This number is not insignificant given the costs involved in providing power and 'backhaul' connectivity to sites in the very remote areas where most would be located."

330. We consider that there are strong arguments for at least aligning the Welsh planning regime for mobile infrastructure to that proposed for England and that there may be a good case for going further than this. We agree that this would likely reduce the costs of deployment for operators like EE. We note, however, that BT did not suggest that a consequence of this would be that it was able to extend its coverage beyond that already committed to under the Shared Rural Network agreement. In our recommendations, we suggest that the Welsh Government explore this matter further with the mobile operators, including EE.

331. As discussed in Chapter 4, BT said that the UK needed new approaches to regulation and public policy, as well as public funding for deployment in areas where it was not otherwise commercially viable. In terms of specific actions, they proposed:

- The Welsh Government align its planning approach for 4G and 5G infrastructure to that being consulted on by the English Government, as discussed above.
- That the recently implemented broadband USO policy operates as an 'effective safety net', although it was not clear what actions BT thought needed to be taken in order for this to be the case.
- Continued Welsh Government support for the Shared Rural Network.
- A recognition that 5G deployment requires that a 'mature 4G network' is already in place. We understand this to mean that BT might not support the adoption of targets for 5G coverage within the existing Shared Rural Network arrangements, or that such targets should only be considered once the existing 4G commitments had been completed.

Country Land and Business Association

332. The CLA Cymru represents nearly 3000 rural businesses, including many farms, in Wales.

333. The CLA told us that the Shared Rural Network "could finally act as the policy tool required to bring rural areas up to the same levels of 4G coverage experienced by urban areas" provided two conditions were met. The first was that planning consents for new masts were "much more flexible".

334. The second was the implementation of the new Electronic Communications Code in determining valuations for renewed and new leases on sites on which mobile infrastructure was installed. The CLA said that the Code was having the unintended effect of lowering valuations to levels at which it was "financially unsound" for landowners to grant consents. This resulted in "stagnation" and would delay or even prevent the deployment of the Shared Rural Network. It was not clear to us, however, what steps the CLA thought the Welsh Government should take to address this concern.

Design Commission for Wales

335. The Commission said that 4G or 5G services would only be suitable substitutes for FTTH broadband if they were provided at an 'affordable monthly fee' and without data caps or throttling which would limit the volume of data consumed. We broadly agree that FTTH connections generally offer 'unlimited' volumes, but do not think it follows that a wireless '5G home broadband' service with a large data cap would not deliver significant benefits to

some households. We noted in Chapter 5 that existing 4G home broadband services currently appear to be offered by UK operators at broadly comparable prices to other fixed broadband services but recognise that this could change in the future.

Growing Mid-Wales Partnership

336. The Growing Mid-Wales Partnership is a regional partnership comprising of representative bodies from across the private, public and voluntary sector in Mid Wales.

337. They told us mobile coverage in Mid-Wales also lags behind the nation as a whole, with almost 10% of premises lacking any 4G coverage. They attribute this to topography and low density of population. They told us:

"In terms of an objective for mobile coverage for Mid Wales, we would suggest during peak usage period a guaranteed minimum mobile phone network speed of 10Mbps on the basis that there is a 50% signal strength in Mid Wales. This is in order to ensure adequate connectivity service for businesses and citizens is maintained during peak visitor times."

Mobile UK

338. Mobile UK is a trade association representing the four UK mobile network operators[280].

339. They told us that 4G and 5G technologies should be considered strong candidates for delivering household broadband (as fixed technologies like FTTH), that public funds should be allocated accordingly (by which we assume without regard to whether the technology used is mobile or fixed) and that policy in Wales should give as much attention to mobile infrastructure as it did to fixed broadband. At our meeting with them, they told us that Ofcom coverage data was not entirely reliable, but that no better sources were currently available.

340. Mobile UK identified reform of planning regulations in Wales as being an urgent priority, both to promote 5G and to support implementation of the Shared Rural Network. Like BT, they said that Wales needed urgently to adopt measures similar to those proposed in England and Scotland, but also that the TAN 19 planning guidance, which had not been updated for many years, should also be revised[281].

341. In addition, they suggested action on access to Public Assets (to provide access at rates consistent with those envisaged by the new Electronic Communications Code and using standard template agreements) and Business Rates Relief for new mobile infrastructure development (particularly

280. Richard Feasey and Adrian Davies also met with Hamish McLeod, Director of Mobile UK, on 17 February 2020.

281. 'Technical Advice Notes' are issued to local planning authorities by the Welsh Government to provide practical guidance on the application of legislation and to assist in the development and implementation of local development plans. TAN 19 relates to telecommunications and was issued in 2002, see https://gov.wales/sites/default/files/publications/2018-09/tan19-telecommunications.pdf

in hard to reach areas). We were told at our meeting that Norfolk Council[282] and Cambridge were examples of local authorities pursuing supportive mobile infrastructure initiatives.

342. Mobile UK made a number of detailed proposals in relation to their request for Facilitation of Engagement with Highways Authorities and Network Rail. These included engaging with Highways Authorities with the aim to:

a. Help improving response times from requests from the industry, particularly where from a safety perspective (i.e. satisfaction with visibility splays, footpath width, siting of poles/cabinets concerning dangerous roads, opening notices and potential collision etc.). Where potential issues do arise, the industry would like improved engagement and response times to find reasonable solutions to ensure mobile connectivity can be maintained, and the roads returned to use.
b. Facilitating quicker confirmation of adoption status (without an excessive fee requirement).
c. Working with industry providers to rapidly approve traffic management and opening notice requests.
d. Remove the Christmas embargo for telecoms proposals that need opening notice or traffic management. During the Christmas period telecoms services are at peak demand yet if there is an issue with a site it is difficult to get it fixed/maintained or upgraded (or a site built) due to the embargo and so it has a negative local impact just when demand and dependence are highest.

343. In relation to Network Rail, they requested that the Welsh Government:

a. Help improve the time it takes to gain access to trackside and improvements in engagement with Asset Protection Teams (Aspro). Currently, response times, although automated to within five days, often pan out to 20-28 days and some recorded cases are still open from 2016. Evidence provided by the industry for average waiting times: a. The average length of time taken to get onto a site for grounds maintenance is 70 working days. b. The average length of time to get onto a site to maintain at height is 78 working days. c. Times for build/decommission or upgrade is longer. (Although it is not clear to us that these figures relate specifically to Wales, rather than to the UK as a whole.)
b. Mobile UK would like to raise its concern about recent updates to Network Rail Property Department's new approvals processes and charges which equate to a 280% increase compared to legacy costs. Also, Network Rail's Property Department has introduced the same testing to be completed on sites less than 100 metres to the track including sites on third party land. Industry providers believe that there is no statutory basis for this and that it is having a detrimental impact on the ability of infrastructure providers to roll-out and upgrade sites both in time and cost.
c. Mobile UK would like the Welsh Government to assist on progressing and fast-tracking engagement with Network Rail regarding the Electronic Communications Code towards reaching agreement on sites.

282. BT also cited Norfolk as an example of 'best practice' in our meeting with them.

344. They also said that "In light of the Shared Rural Network agreement with the UK Government and the ongoing collaboration with the Welsh Government, Mobile Action Zones should be reconsidered on an all-Wales basis and refocussed to support and enhance roll-out of the SRN".

National Trust

345. The National Trust told us that it did not object to new masts located near its properties when 'good schemes' were proposed, but that a greater reliance on mobile communications could involve significant new infrastructure. It supported "best practice in design, siting, screening and landscaping to help mitigation of a future digital communications investment programme." They proposed the establishment of an independent landscape advisory group to ensure that any deployment of infrastructure in Wales was done in a way which was sympathetic to the external landscape.

Our conclusions on mobile broadband

346. We have been struck by the contrast between Welsh Government policy in relation to mobile and that in relation to fixed communications infrastructure (which we considered in Part 1, particularly Chapter 2, of this report). Whilst the Welsh Government has been relatively active and relatively ambitious (including compared to the UK or Scottish Governments) in supporting the deployment of superfast fixed infrastructure, it appears to have been markedly less engaged with respect to mobile (and much less than ether the UK or Scottish Governments). So far as we are aware, the Welsh Government has no specific targets for improving mobile coverage in Wales or for 5G in particular. To the extent that measures might be taken to improve coverage, such as increasing the height limit for permitted development of mobile masts, the Welsh Government has lagged behind both the UK and Scottish Governments in taking action. We have not found evidence of any initiatives to improve either coverage or support 5G, or evidence of significant Welsh participation in the various 5G initiatives being sponsored by the UK Government as part of its 5G strategy. Parts of the Mobile Action Plan from 2017, which is one of the very few policy documents on mobile infrastructure to have been issued by the Welsh Government, have still not been implemented.

347. We recognize that Welsh policymakers face a different industrial context with mobile communications, compared to fixed. For example, competition between firms in mobile in Wales is similar to the competition which prevails in the rest of the UK, something which is not the case for fixed communications. We have concluded that this competitive environment is unlikely to change in the foreseeable future and that any gains in coverage arising from competition between the existing UK operators appear have been exhausted. Further gains are likely to require interventions by policymakers, as in the case of the new Shared Rural Network.

348. Welsh mobile users can today obtain the same services at the same prices as their counterparts in the rest of the UK. The latest Ofcom data (about which we have reservations, as noted below) suggests that almost all Welsh households will have access to a 2G voice connection and a 4G connection from at least one operator at their home and that 89% of the Welsh landmass is covered

for 4G by at least one operator and 81% by EE alone. On this view, the key difference is not the availability of a mobile signal, but the choice of mobile providers which, for many rural Welsh households, will not exist (a point emphasized by BT in their submission to us). This means that, in order to maximise the coverage available to them under current conditions, some Welsh mobile users will need to switch to the best network for their coverage needs (which may not be the network provider they have previously relied upon).

349. Two observations follow from this. First, UK policymakers as a whole appear very dependent upon the Ofcom coverage data cited above and elsewhere in this paper to inform their policymaking, including the setting and enforcement of coverage targets. But, as noted earlier, other studies of mobile coverage in Wales paint what at first sight appears to be a very different picture. The Arcadis study for the Welsh Government in 2017 found that over 20% of households in Gwynedd, Ceredigion and Powys still lacked access to any form of mobile connection. Mid-Wales Partnership told us it was still 10% today. It may be possible both for 99% of the UK population to have access and for over 10% of households in relatively unpopulated Welsh authorities to lack access to a mobile signal – but further work is required to reconcile these differing views. We recommend that the Welsh Government invest some effort in forming a more accurate view of mobile coverage in Wales with a view to this informing both the coverage data being produced by Ofcom and both Welsh and UK Government policy.

350. Second, it is interesting to note that although the main difference between Wales and England, and between rural and urban users more generally, is not a lack of mobile coverage but a lack of choice of provider, UK policymakers have not generally sought to address coverage concerns by encouraging users to switch to the 'best' network for their purposes. Instead, the agreement between the UK Government and the mobile industry for the Shared Rural Network is intended to eliminate 'partial' not spots altogether by ensuring that all four operators provide services from every site. If this is successful, then today's lack of choice of provider in many rural areas ought to be a thing of the past for most Welsh households after 2026.

351. Welsh policymaking in this area should also take a number of other points into account. First, we have explained that the deployment of new mobile technologies depends to a significant degree of economies of scale at a national, regional or even global level (likely to a greater extent than with fixed communications infrastructure). Wales will not develop a 5G infrastructure or ecosystem that is independent of UK-wide or global developments and attempts to do so are unlikely to be effective or a good use of the nation's resources. The UK and Scottish Governments have taken various initiatives to fund and develop 5G 'use cases' but we do not recommend the Welsh Government does the same.

352. Second, although policymakers in the UK have been concerned about a perceived shortfall in mobile coverage for many years, the economic benefits of extending coverage appear quite marginal. We have not seen the cost benefit analysis for the Shared Rural Network programme but we need to recognize that the economic benefits of providing digital communications services in very sparsely populated areas are likely to be quite modest compared to the cost. The case for promoting 4G and 5G infrastructure, as we recommend, is partially based on evidence that the economics of using public funds to deploy FTTH in those same areas would be significantly worse still. This is why we recommend that the Welsh Government does everything in its powers to maximise the availability of 4G and 5G infrastructure in Wales before deciding to invest in FTTH in the hardest serve areas of the country.

353. The full extent of the economic benefits of moving from 4G to 5G also remain uncertain at this stage. To the extent that benefits from 5G have been identified in studies, most relate to the automotive sector and assume extensive 5G coverage of roads (which we note was a key focus for the UK NIC in their report on mobile). There is, however, good reason to believe that the potential economic opportunity afforded by 5G and the Internet of Things is significantly greater than anything obtained from previous generations of mobile infrastructure.

354. Third, many – but by no means all – of the policy levers for extending mobile coverage or moving to a new generation of mobile technology lie with the UK Government rather than with the Welsh Government. The most significant of these is the release of new radio spectrum in the appropriate frequencies, which is currently undertaken by Ofcom on a national basis and over which we do not expect the Welsh Government to have much influence.

355. Since 2014, coverage obligations in UK spectrum licences have tended to include both a UK-wide commitment and separate sub-commitments for each of England, Wales, Northern Ireland and Scotland. It is not clear to us how engaged the Welsh Government has been in the past when Ofcom has been developing its views on coverage commitments for Wales, although we have been advised that both formal and informal representations have been made. The recent agreement between the UK Government and the mobile operators on the SRN has resulted in the adoption of new licence commitments which are intended to ensure that the commitments made by the operators are enforceable by Ofcom (although EE warned us of difficulties in meeting these if the Welsh planning regime did not improve).

356. Although we welcome the SRN agreement we think it regrettable that the UK Government did not anticipate 5G roll out within its scope. We take EE's point that 5G will be built upon an existing 4G infrastructure but the fact remains that Ofcom will issue valuable 5G spectrum licences early in 2021 without requiring the mobile operators to deliver any specific level of 5G coverage in consequence (since part of the SRN agreement involved the removal of such obligations from the new spectrum licences). The UK Government has therefore given up what has previously been an important regulatory lever for extending coverage of new mobile technologies. This means both the UK and Welsh

Government will have to rely on other means to obtain further commitments from the industry in relation to 5G.

357. In this context, we find that previous changes to the permitted development rights planning regime in Wales have been 3 years later than in the rest of the UK. There is some evidence to suggest that these changes may not make much of a difference to either the rate or the extent of mobile coverage in Wales (although BT/EE claimed otherwise in their evidence to us), but that is no reason for Wales to be such a laggard. We are also conscious that the impact of differences in the planning regime between nations may become more acute in the next period as mobile operators decide where to allocate their resources in order to fulfil their commitments to the Shared Rural Network. It is critical that Wales is not at the end of the queue as the SRN is implemented. There is a real risk that this will be the case unless the planning regime is brought into line with that proposed by the UK Government for England in August 2019 and likely to be adopted in both England and Scotland in the near future. This should be accompanied by a fundamental revision of the TAN19 guidance to local authorities (which governs the application of the planning regulations and policy to both fixed and mobile communications infrastructure) to ensure that it reflects the priorities of today and tomorrow, rather than those of 2002 when the existing guidelines were written. It is commendable that the Welsh Government's existing Code of Practice on Mobile Phone Network Development is currently be revised, but also telling that this is for the first time since 2003[283]. The Welsh Government is not acting with sufficient urgency on these matter, in our view.

358. Although we consider alignment of the permitted development right planning regime with that being proposed for England to be an urgent requirement, we think the Welsh Government ought to seek to be more ambitious than this. If Wales is to place greater reliance on mobile technologies to meet its communications needs than other nations, as we propose in this report, then it will need a policy environment which reflects this aspiration and plays a role in its realization, as the Scottish Government have recognized with their 5G strategy. We think the UK Government's approach to the Shared Rural Network offers a model under which public authorities offer support, financial or otherwise, in return for commitments from the industry to translate such support into meaningful outcomes for society.

359. In this case, we recommend that the Welsh Government explore, with industry, the additional 4G coverage and accelerated 5G delivery that might be obtained if:

a. The Welsh Government were to adopt further amendments to the planning regime in Wales (beyond those proposed by the UK Government in August 2019) to further facilitate the deployment of 4G and 5G mobile infrastructure using 700 and 800 MHz spectrum (such as raising the limit for masts from 35m to 50m under some circumstances).

283. We were advised by Welsh Government officials of the plans to revise the existing Code, which can be found at https://gov.wales/sites/default/files/publications/2018-09/code-of-practice-on-mobile-phone-network-development.pdf

b. The Welsh Government were to provide additional public funding, above and beyond that in the existing SRN agreement, in order to extend 4G and 5G coverage still further in Wales.

360. It is very important that the outcome of these discussions – which may be protracted – should not delay the alignment of the Welsh permitted development rights planning regime with that being proposed in England. If a suitable agreement can be reached, it might be incorporated into the existing Shared Rural Network arrangements concluded between the UK Government and the industry, or into a separate agreement. We have not had an opportunity to discuss our proposals with the UK Government at this stage, but we consider that they ought in principle to be supportive of efforts by the Welsh Government to improve the provision of mobile infrastructure in Wales. More generally, we think the UK Government ought also to consider the adoption of 5G coverage targets for the whole of the UK within the scope of the SRN.

361. The Welsh Government already has a Mobile Action Plan, but few of the proposed actions appear to have had any impact on the development of mobile infrastructure in Wales since it was adopted in 2017. We have struggled to find evidence of meaningful progress on some of them. We thinks Wales needs to make progress on a number of fronts (in addition to the actions on the planning regime discussed above). We therefore recommend that the Welsh Government establishes, again as a matter of urgency, a (small) 'barrier busting' taskforce to be led by a senior official and with accountability for ensuring that our recommendations are implemented within a set of clearly defined timelines. Amongst other things, the taskforce would be responsible for taking actions in relation to the following issues:

a. We consider that the Welsh Government's existing actions in relation to coverage of road and rail transport routes are out of step with the much more significant and far reaching work now being undertaken by the UK Government. At the same time, we remain unclear whether extensive 5G coverage of transport routes will yield the benefits claimed by the UK NIC (and the UK Government), particularly in a Welsh context. As a first step, we suggest the taskforce assist Mobile UK in its discussions with the North and Mid Wales Trunk Road Agent (NMWTRA), the South Wales Trunk Road Agent (SWTRA) and with Network Rail with a view to resolving the issues which we listed in paragraph 342. Once this is accomplished, further work in relation to 5G applications on transport routes should be considered.

b. We heard concerns from EE that the delivery of coverage for the ESN may be adversely affected by delays on the part of the Home Office. We suggest the taskforce engage directly with the Home Office to determine whether and the extent to which these issues affect coverage in Wales and to satisfy itself that they will be resolved or take action to do so.

c. We have concluded that the Welsh Government needs to be more directive in requiring Welsh local authorities to apply the new Electronic Communications Code when setting rates for access to sites or property which they control (as UK Government Ministers have recently

been[284]), and in requiring Welsh local authorities to identify assets which might be suitable for use by telecommunications operators. In developing guidance on these matters, the taskforce might consider Norfolk County Council[285] as one potential benchmark which all Welsh local authorities should be expected to match or exceed and should consider rolling out the UK Government's Digital Infrastructure Toolkit[286].

362. We have considered the role 4G and particularly 5G infrastructure may play in providing ultrafast (100 Mb/s+) broadband connections to those premises which lack access to fibre-based fixed infrastructure, either because fibre will take years to deploy or because the costs of doing so are likely to be prohibitive, even if subsidised. We found many examples of 4G and 5G home broadband applications elsewhere in the world, as well as 4G and 5G products already available from UK operators (although noting that data usage as a proportion of total data usage remains extraordinarily low in the UK as a whole today (at only 3%). Better exploitation of 4G and 5G infrastructure should form a significant part of the Welsh Government's digital communications strategy.

363. We think it is reasonable to suppose that Welsh households that currently obtain fixed broadband speeds of less than 100 Mb/s will require, and benefit from, speeds in excess of 100 Mb/s (but well below 1Gb/s) over the next 10 years. We think it is also reasonable to assume that, on current plans, a significant number of Welsh households and businesses will be unable to obtain such speeds from FTTH connections which may take 10 years or more to deploy, or which may never be deployed at all given uncertainties about the implementation and likely costs of the UK Government's FTTH policy which we discussed in Chapter 2.

364. Although our call for evidence referred to 4G and 5G as being the 'lowest cost technology to provide superfast connections to some Welsh households', our conclusion is that there will also be a significant number of additional Welsh households and businesses for which 5G technology will deliver speeds of the order of 100 Mb/s several years earlier than FTTH technology. We consider that the benefits of earlier and wider adoption and use of faster 4G and 5G home broadband connections may be at least as significant as the lower costs of deploying them, relative to FTTH.

365. It follows that in many cases, 5G home broadband may prove to be an excellent transitional or temporary solution but may also be a hedge against the risk that the deployment of FTTH proves more challenging than the UK Government envisages. We have also noted that some stakeholders have told us that the commercial prospects for FTTH are likely to improve as time passes, whether because deployment costs fall with experience or new innovations or because growing demand brings forward revenues on later investments. Estimates of the costs of deploying FTTH in the UK appear to have fallen significantly over the past 5 years. If so, 5G home broadband should allow fixed broadband suppliers like BT to defer

284. See http://www.broadbanduk.org/2020/08/27/dcms-mhclg-updated-valuation-guidance-aug-2020/

285. See https://www.norfolk.gov.uk/what-we-do-and-how-we-work/campaigns/digital-connectivity

286. We note that similar recommendations are made in a report published in September 2020, as our report was being finalised, entitled 'Upwardly Mobile: how the UK can gain the full benefits of the 5G revolution', see https://www.cps.org.uk/files/reports/original/201001000814-CPSUPWARDLYMOBILE2.pdf

or delay some of their FTTH investments in more marginal areas. This could reduce both the overall cost and the demand on Welsh Government public finances (even if we envisage that the accelerated deployment of 5G will require some additional financial assistance from the Welsh Government).

366. If home broadband over mobile networks were to be a policy priority for the Welsh Government, as we recommend it is, then consideration would need to be given to additional policy levers which can be employed by the Welsh Government to promote it. The option of adding new coverage commitments to 5G spectrum licences already seems to have been foregone by the UK Government. The focus should be on coverage of premises (and particularly businesses) rather than geographic coverage or coverage of transport routes (as the UK NIC proposed), and specifically on 5G coverage rather than 4G or 2G voice coverage. Policymakers should also consider the decommissioning process which might allow mobile operators to terminate mobile home broadband services when FTTH connections become available and thereby re-use the spectrum for other mobile applications (as well as allowing BT to decommission the fixed copper network at the same time). These are all issues which we would have liked to explore with stakeholders but for the COVID-19 pandemic. We suggest the Welsh Government explore them as part of the discussions with the industry about maximizing 4G and 5G availability in Wales.

Chapter 8

Summary of all our recommendations

367. This chapter presents a summary of all our recommendations, many of which we have already introduced in Chapters 4 and 7. Although we have explored the issues relating to fixed and to mobile broadband communications infrastructure in separate Parts of this report, our conclusions and recommendations should, as we explained in Chapter 1, be considered as a whole.

368. With the exception of the Superfast Cymru programme, which we consider to have performed as well or better than similar programmes in the rest of the UK, Welsh digital communications policy has fallen behind both England and Scotland since 2017. There are no targets for Wales other than those adopted by the UK Government for FTTH or as part of the SRN negotiations. The Phase 1 Superfast Cymru programme meant that Wales used to lead the rest of the UK in FTTH coverage, but the gap has been steadily closing and Wales is likely to fall behind as Openreach and the new FTTH operators focus their resources elsewhere.

369. We think the Welsh Government needs to become more assertive, and act with greater speed, if these trends are to be reversed. Doing so would send a strong signal to private investors, both new FTTH operators and the mobile industry, that Wales intends to be a more attractive place for them to invest. Our recommendations are intended to ensure that this happens.

370. The full list of our recommendations is:

a. The Welsh Government should continue to engage actively with the UK Government and Building Digital UK during the development of the new Gigabit funding programme, which should be more flexible than the previous superfast programme. In particular, the Welsh Government should seek to:

i. Ensure that the tendering arrangements can accommodate the relative lack of competitive provision of FTTH infrastructure in Wales today and likely greater role to be played by Openreach in the programme. This includes tendering lots of significantly more than 3000 households.

ii. Ensure that funds can be applied to technologies which currently deliver 100 Mb/s, such as 4G and 5G home broadband services, and not only in 'limited cases' as the UK Government currently seems to envisage.

iii. Ensure that funds that are 'clawed back' under an FTTH contract can be reallocated flexibly to any scheme, rather than having to be allocated to new programmes being undertaken by the same operator. In this context 'any scheme' should include FTTH deployed by another operator, 4G/5G broadband deployed by mobile operators, or voucher schemes of any kind.

iv. Allow funds to be provided on condition that availability of FTTH connections to businesses is prioritised over the needs of households.

b. In doing so, the Welsh Government should assume that Wales is unlikely to obtain access to the £1.3 billion of funds which we estimate would be required to deliver fibre to every household and business in Wales and nor should it dogmatically mimic the UK Government's commitment to FTTH. The Welsh Government should instead develop its own strategy to maximise the economic and other benefits from lower cost investments in 4G and 5G mobile infrastructure.

c. The Welsh Government should seek to encourage entry and investment by new FTTH operators in Wales, as we are now seeing elsewhere in the UK. One step in doing this is for the Welsh Government to provide all local authorities with specific guidance and direction on making ducts and other public assets available at fees which encourage their utilisation by operators and which are in accordance with the aims of the new UK Electronic Communications Code.

d. The Welsh Government should undertake a rapid review of its existing broadband voucher schemes. Having done so, it may conclude that the Access Broadband Cymru scheme is out of date and should be closed. Communication of the Welsh voucher arrangements should be simplified and improved in order to significantly improve take up (for which targets should be set). At the same time, the Government should guard against 'voucher inflation' which is otherwise likely to be driven by the very high costs of FTTH deployment in some parts of Wales. Awarding vouchers for many thousands of pounds per household in the next 5 years should only be considered if all feasible alternatives – including the provision through subsidised 4G or 5G home broadband connections – have been exhausted. The Welsh Government should adopt a self-imposed cap of £3400 per household, similar to that which applies under the Universal Broadband scheme, at least for the next few years.

e. The Welsh Government should replace the existing all Wales Digital Infrastructure Group with a new 'barrier busting' taskforce, led by a senior official, with clear objectives and deadlines in which to achieve them. The taskforce should lead the development and implementation of new guidance that is issued by the Welsh Government, including (but not limited to) that relating to the use of public assets and levy of fees for them, the implementation of a new planning regime for telecommunications (TAN19), liaison with Network Rail, Transport for Wales, the North and Mid Wales Trunk Road Agent, the South Wales Trunk Road agent, and liaison with the equivalent taskforce in the UK Government.

f. The Welsh Government should not invest funds into 5G case studies, proof of concept activities, testbeds or trials, but should instead aim to ensure that successful applications that are developed elsewhere in the world can then be adopted in Wales.

g. We make no specific proposals for new initiatives to promote the greater adoption of FTTH services when and where they become available in Wales. Instead, we recommend that Audit Wales be asked to identify and review the effectiveness of the broadband adoption programmes that are already being undertaken in Wales, and to identify best practice outside of Wales, and make recommendations to the Welsh Government. Existing activities which are

ineffective should be ended and resources reallocated. The Welsh Government should also seek to liaise closely with the UK Government's new Gigabit Digital Take-up Advisory Group.

h. We recommend that the Welsh Government Chief Digital Officer be asked to contribute to the work of Audit Wales by providing evidence on the adoption of broadband technologies by public authorities in Wales.

i. The planning regime for telecommunication in Wales should be brought into line with that currently being proposed for England (and likely to be replicated in Scotland) as a matter of urgency. This should be accompanied by the wholesale revision of the TAN19 guidance to local authorities, as well as revisions to the Code of Practice on Mobile Phone Network Development, both of which are now over 15 years old.

j. We recommend the Welsh Government undertake a small project to obtain better data on existing levels of mobile coverage and performance in Wales. This should be used to inform data already produced by Ofcom and the assumptions made by both the Welsh and UK Governments when developing policy or enforcing targets.

k. We recommend that the Welsh Government explore, with industry and in parallel with the implementation of recommendation (i), the extent to which further 4G coverage and accelerated 5G delivery could be achieved in Wales within the next 5 years, likely using the 700 MHz spectrum that will be available from 2021, if:

i. The Welsh Government were to adopt further amendments to the planning regime in Wales above and beyond those currently proposed by the UK Government for England, to further facilitate the deployment of mobile infrastructure.

ii. The Welsh Government were to provide additional public funding, above and beyond that in the existing SRN agreement, in order to further extend mobile coverage in some parts of Wales. Such funds could be reallocated from the share of the £5 billion Gigabit funding programme which the Welsh Government expects to obtain from the UK Government (and could represent a significant proportion of that allocation).

l. We recommend that the Welsh Government ask the UK Government to consider introducing 5G coverage and performance targets (alongside those already adopted for 4G) into the existing Shared Rural Network arrangements. If this is not supported, and if progress is made with the UK mobile operators, then the Welsh Government should pursue a separate agreement with the mobile operators which would incorporate such targets.

m. We recommend that the barrier busting taskforce be asked to assist Mobile UK and/or mobile operators in their discussions with Highways Authorities and Network Rail with a view to resolving the issues which we list in paragraph 342 of this report.

n. We recommend that the Welsh Government engage directly with the Home Office to determine whether and the extent to which delays in the delivery of ESN affect coverage in Wales and to satisfy itself that they will be resolved or to identify actions which the Welsh Government can take to assist.

Glossary

ADSL – Asymmetric Digital Subscriber Line, a technology employed by BT in the 1990s and early 2000s to deliver broadband services over its existing copper lines. The service is 'asymmetric' because the rate at which data can be delivered to the households (download) is many times greater than the rate at which data is carried from the households to the core network (upload).

Audit Wales – a statutory body responsible for the external audit of expenditure made by public bodies in Wales, which also undertakes enquiries into various public policy matters. Our report recommends that Audit Wales be asked to undertake an enquiry into the effectiveness of existing policies to promote the take up of broadband services in Wales.

BDUK – Broadband Delivery UK, a body established in the Department for Culture Media and Sport responsible for overseeing the allocation of public funds to fixed broadband operators in the UK. Replaced by Building Digital UK.

DCMS – the Department of Culture, Media and Sport, the UK Government department responsible for digital infrastructure policy.

DOCSIS – Data Over Cable Services Interface Specification, a technology employed by cable operators such as Virgin Media to deliver broadband services over their existing coaxial cable networks.

ESN – Emergency Services Network, a programme administered by the UK Home Office (and being implemented by EE) to replace the existing Airwave network that is dedicated for use by the emergency services throughout the UK.

FTTC – Fibre to the Cabinet (sometimes referred to as 'fibre to the kerb' or 'fibre to the node'), a network architecture for delivering superfast broadband services by replacing existing copper lines with fibre connections to the cabinets which are normally located in streets. The connection between the cabinet and the individual household remains a copper line and VDSL equipment is placed inside the cabinet in order to support the provision of superfast broadband services over those lines.

FTTH – Fibre to the Home (sometimes referred to as 'fibre to the premises'), a network architecture for delivering ultrafast broadband services by replacing all elements of the copper network with a fibre connection. Fibre connections may be dedicated to individual households, or parts of the FTTH network may be shared.

FWA – Fixed Wireless Access, a generic term for wireless technologies which are specifically designed to deliver point to point connections between a base station and a number of individual households. The technology does not allow for mobility (so 4G and 5G are not FWA technologies for the purposes of this report).

G.Fast – a DSL technology (see ADSL), deployed by BT in some areas, allowing for the provision of ultrafast broadband services over very short copper lines. G.Fast is the next iteration of DSL after FTTC, and involves the replacement of the copper line between the cabinet and a pole or other structure that is located very close to the household itself. The connection to the household from the G.Fast box remains a copper line, but the rest of the network is fibre.

GHz – Gigahertz, a measure of the frequency in the electromagnetic spectrum, used to define the boundaries of the spectrum licences which are awarded to mobile operators in the UK.

GSM – Global System for Mobile Communications, otherwise often referred to as '2G'. The second generation of modern mobile technology and the first to be digital. Adopted in the UK during the 1980s and 1990s, although GSM networks still remain in operation today.

Home broadband – the term used in this report to refer to broadband services that are delivered to fixed locations such as households by means of 4G and 5G networks.

IoT – Internet of Things, a generic term referring to the wireless connection of very large number of objects (such as sensors) to enable them to share data and otherwise communicate with each other. Many IoT applications will be enabled by 5G networks, although other wireless technologies can also support IoT.

Latency – the delay experienced in the transmission of data over a broadband network, following a request to do so. Low latency is required for applications such as gaming and some IoT services. 5G technology can ensure significantly lower latency than previous generations of mobile technology.

Mb/s – Megabyte per second, a measure of the speed at which a given volume of data can be transmitted by a broadband connection.

MHz – see GHz, 1 GHz is equal to 1000 MHz.

Ofcom – Office of Communications, the statutory body responsible for regulating both fixed and mobile digital infrastructure (including the allocation of radio spectrum) in the UK.

SRN – Shared Rural Network, a joint venture between the UK Government and UK mobile operators to extend 4G mobile coverage to 95% of the landmass in the UK by 2025.

Superfast broadband – a generic term for broadband connections capable of supporting speeds of at least 30 Mb/s, often provided by means of FTTC technology.

TAN19 – Technical advice note 19, guidance issued by the Welsh Government to local planning officers in relation to proposals for the installation of telecommunications equipment.

Ultrafast broadband – a generic term for broadband connections capable of supporting speeds of at least 100 Mb/s, often provided by means of FTTH technology (and potentially 5G).

VSDL – Very High Speed Digital Subscriber Line, the next generation of fixed broadband technology after ADSL (see ADSL), installed by BT in cabinets as part of the FTTC infrastructure (see FTTC).

WiMAX – a type of FWA technology (see FWA).

2G – see GSM.

3G – (sometimes referred to as UMTS), the third generation of modern mobile technology and the first to specifically support mobile broadband services. Deployed in the UK in the early 2000s.

4G – the fourth generation of modern mobile technology and the one currently used by the majority of UK users to access data services from their mobile devices.

5G – the fifth generation of modern mobile technology, currently available in some but not all parts of the UK, with many 5G devices and applications still under development. 5G technology is designed both to provide superior performance to 4G for traditional personal mobile broadband connections (in terms of both speed and latency), but also to support a wide range of new industrial and other applications (see IoT).